PRICE—TWENTY-FIVE CENTS

FM AND TELEVISION

MAY 1945

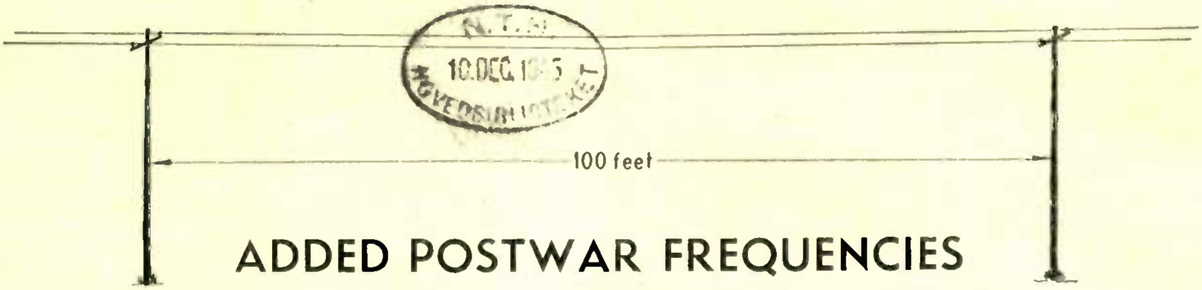
V-E DAY SIGNALS THE EXPANSION OF RADIO SERVICES

1937 | 5 CH. | This space represents the number of channels which the FCC considered adequate for FM broadcasting in 1937.

1940 | 40 CHANNELS FOR FM BROADCASTING | In 1940, recognizing the superior public service afforded by FM broadcasting, the FCC increased the band to 40 channels, represented by this space.

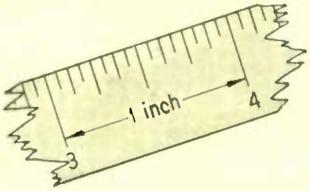
1945 | 30 CHANNELS IN RESERVE | 90 CHANNELS FOR FM BROADCASTING | 30 CHANNELS IN RESERVE

Now, the FCC proposes to increase the FM broadcast band to 90 channels, represented by the solid black space above, and to reserve 60 channels, represented by the shaded spaces, for further expansion of FM broadcasting in accordance with future needs.



ADDED POSTWAR FREQUENCIES

This distance of 100 ft. represents the band of frequencies from 25 to 30,000 mc. which the FCC is making 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.



PREWAR 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 Victory in Europe is an accomplished fact.

Directory of Manufacturers

★ ★ *Edited by Milton B. Sleeper* ★ ★

The *Quiz Kids* say:

"DUMONT TELEVISION IS COSMIC LEGERDEMAIN"

You will agree that these diminutive stars,* while rarely at loss for correct answers, are seldom available when prospective operators of postwar Television stations have questions to ask. Fortunately, DuMont Television "know how" can be tapped as needed . . . cost and engineering data on every phase of station design, construction and operation . . . the accumulated knowledge gained through more than 4 years' station management and production of programs.

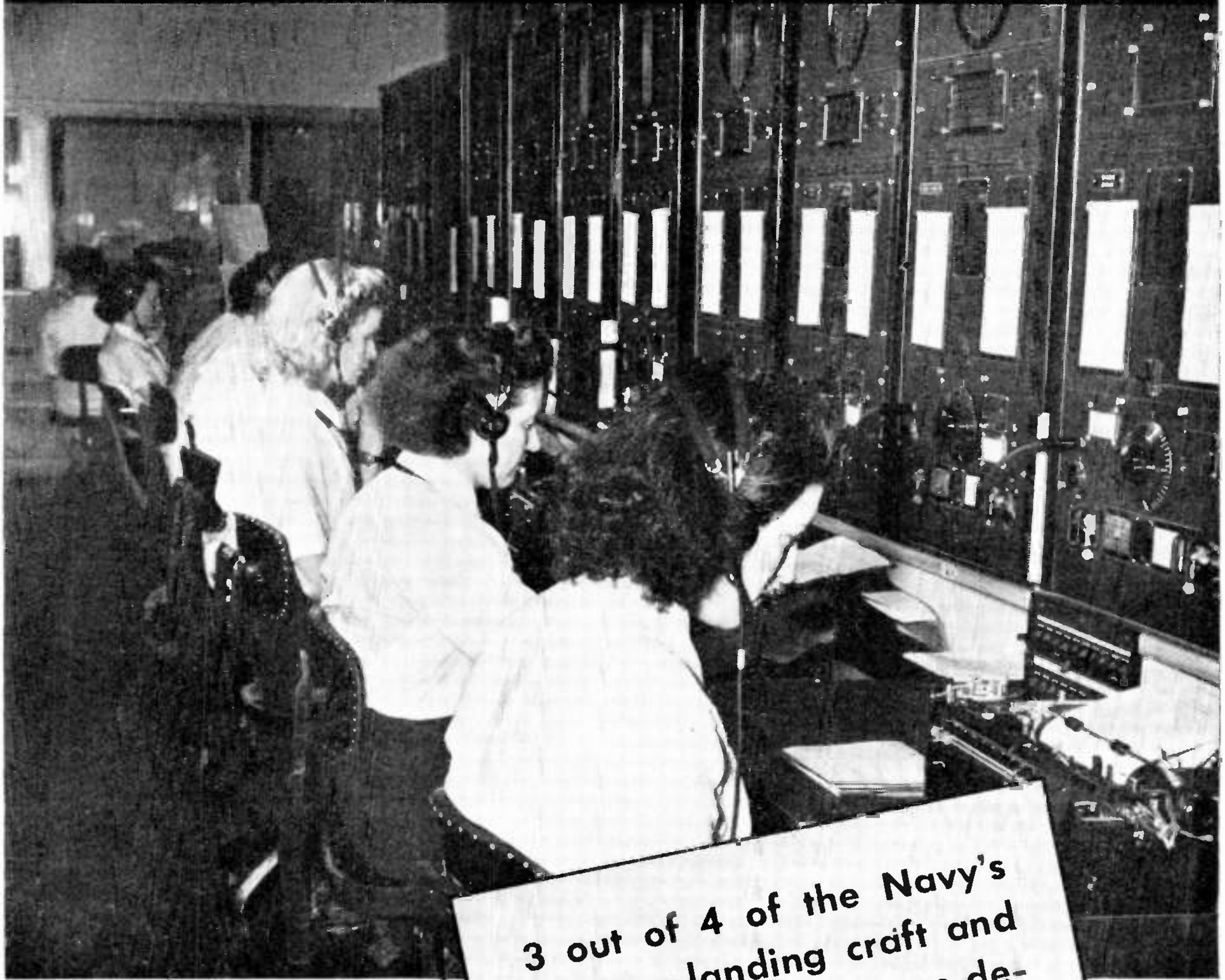
The low operating cost, extreme flexibility and rugged dependability of DuMont Television transmitting equipment are being convincingly demonstrated week-in and week-out in 3 DuMont-equipped stations. New postwar designs embody all wartime advances. You can arrange *now* for early peacetime delivery of station equipment and training of personnel through the DuMont Equipment Reservation Plan. Visit DuMont's Station WABD, New York. Call, write or telegraph for appointment . . . Station Equipment Sales Division, Allen B. DuMont Laboratories, Inc., 515 Madison Avenue, New York 22, N. Y.

*Appearing Sunday evenings on the Blue Network.

DUMONT *Precision Electronics and Television*

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

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. Shore stations use them too.

The picture above shows Waves in the radio room of the U. S. Naval Air Station, Floyd Bennet Field, New York.

HRO

NC-200

NATIONAL COMPANY

MALDEN MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD

PATENT APPLIED FOR.—PHOTOGRAPH SHOWS SIZE OF JENNINGS "WALNUT" CAPACITOR IN RELATION TO HAND.

The latest and most highly successful electronic component is the Jennings "Walnut" size Capacitor, now in full production.

WALNUT VC, SERIES M — AMPERE SERIES 20

●

CHARACTERISTICS

Capacity Range 6-50 mmfd. | **Maximum Current 20 Amperes Peak**
Maximum Voltage 30KV Peak | **Specially designed for high frequency operation**
Self-healing in case of overload

We can now accept orders for early delivery of this greatly improved, compact, plug-in type capacitor.

WRITE FOR BULLETIN FM

JENNINGS RADIO MANUFACTURING COMPANY • 1098 E. WILLIAM ST. • SAN JOSE 12, CALIFORNIA

FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 5 MAY, 1945 NO. 5

CONTENTS

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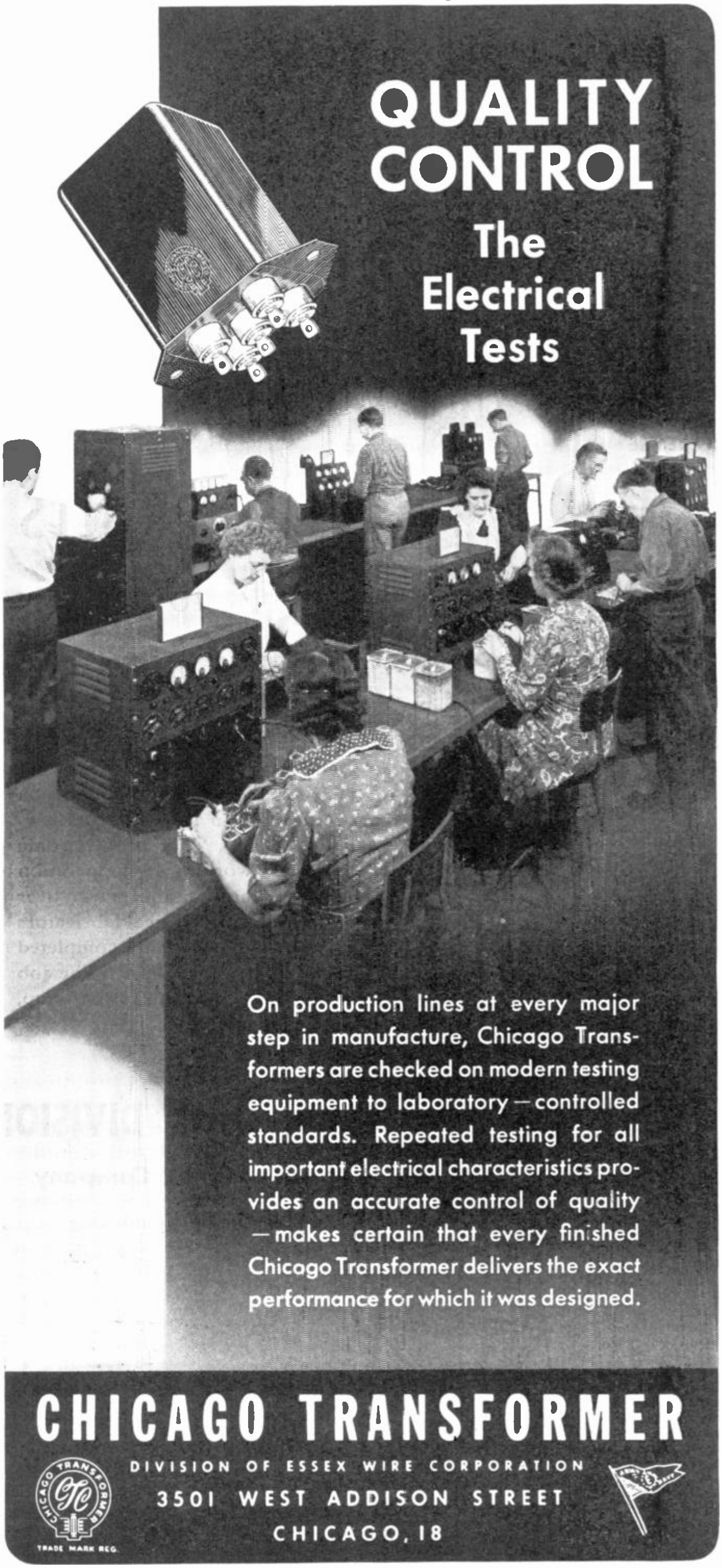
THIS MONTH'S COVER

UP TO the end of World War 1. frequencies of .01 to 5 mc. were being used. In the 23 years following, up to the time of Pearl Harbor, commercial use was extended to 25 mc. These were for AM services. If the spectrum width up to 25 mc. is represented by 1 in., then the new extension of the spectrum, up to 30,000 mc., must be represented by 100 ft., as our cover shows. A considerable part of the new spectrum will be used for television, but the major part will be assigned to FM services, which include broadcasting, facsimile, communications, and relay systems. The extent of industry expansion resulting from FM and television development will be so enormous that it cannot be predicted or even realized at this time.



WHAT'S NEW THIS MONTH

1. After V-E Day
2. A Matter of Opinion
3. Television—A Correction

1. Mr. and Mrs. Average Citizen will never know that it was chiefly our democratic, competitive system of broadcasting, together with our liberal provisions for encouraging amateur communications, that readied the radio industry of this Country, long before Pearl Harbor, to meet the demands put upon it by the war. Without that preparation, research and production never could have supplied the communications and radar equipment necessary to the enormous task of military coördination which made possible the Allied victory in Europe.

Now the industry will be exposed to sacrifice at the altar of social ideologies, to bureaucratic mismanagement of reconversion, and to selfish policies of influential corporations. Irreparable harm can be done to an industry whose peaceful service to public interest, convenience, and necessity should again make an important contribution to maintaining this Country's *potential* military strength, by which future aggression may be effectively discouraged.

The protection of the radio industry against adverse influences from without and within may prove to be the greatest of the FCC's many grave responsibilities.

2. Here is a very interesting letter from the General Manager of a CBS affiliate in Missoula, Montana:

Dear Mr. Sleeper,

From articles in the various trade papers, it seems that television programs of not more than from two to six hours per day will be feasible, depending upon the size of the community and the cost of producing these programs. Now why not combine the allotted frequencies of FM and television and permit the television applicant to broadcast audio FM on his television frequency, thus permitting full 24-hour use of each frequency if the need requires it? Television receivers can be built to operate their FM sections only, like present-day radio sets, over which announcements can be made concerning special television broadcasts during the day.

(CONTINUED ON PAGE 75)

SYLVANIA NEWS
ELECTRONIC EQUIPMENT EDITION

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

SYLVANIA'S CHART AIDS STANDARDIZATION OF TUBES

Reference List Recommendations Reduce Radio Tube Types

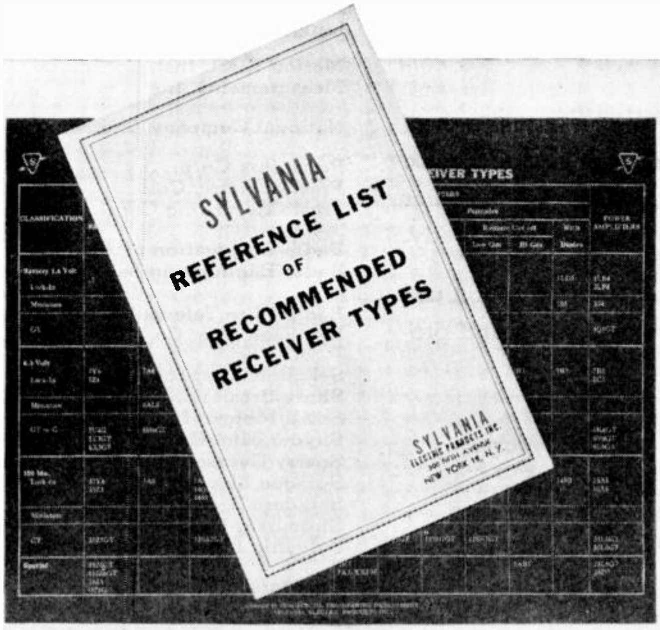
As an aid to the standardization of radio receiver tube types, Sylvania has prepared the chart reproduced below—another item in Sylvania's long-time program of technical assistance to the radio industry.

The number and variety of tube types have grown in recent years, and this trend has intensified war scarcities.

Naturally, it would seem to be advantageous to radio set manufacturers to further standardize tube selection and limit their variety. This would probably meet with approval in many parts of the radio industry, particularly among radio servicemen since they are in an active position when it comes to tube replacement and general radio set repairing.

(An indication of their opinion concerning tube types was revealed in Sylvania's survey in which 90.5% of the servicemen questioned said they would prefer fewer and simpler tube types.)

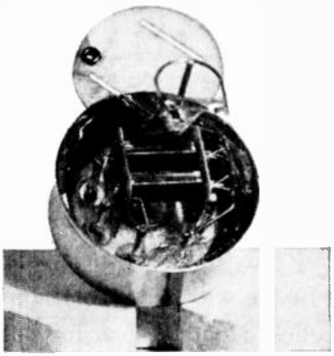
This handy reference chart will help smooth some of the wrinkles of the problem and act as a future guide. Write for it to Sylvania Electric Products Inc., 500 Fifth Ave., New York 18, N. Y.



Double Triode Tube Has Two Uses

Acts As Converter Or Amplifier

Sylvania's new high mutual conductance double triode tube—Type 7F8—is designed for use at frequencies up to 300 or 400 Mc.



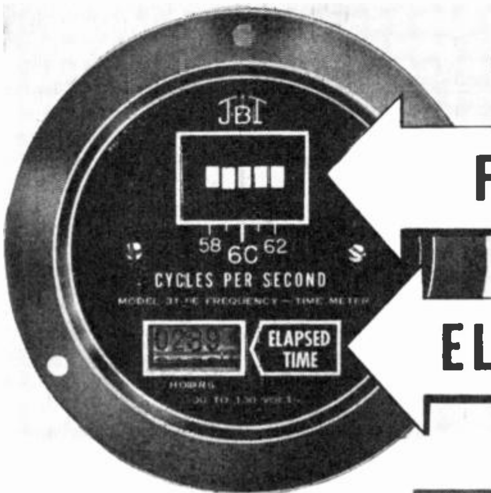
With precautions the two sections may be used separately, saving space and the number of tubes required for a given performance since all the elements except the heaters are independent.

The cascade operation thus made possible is useful in u-h-f grounded grid and cathode follower amplifier service. It may also be used as a push-pull u-h-f amplifier.

SYLVANIA ELECTRIC

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, ACCESSORIES; INCANDESCENT LAMPS

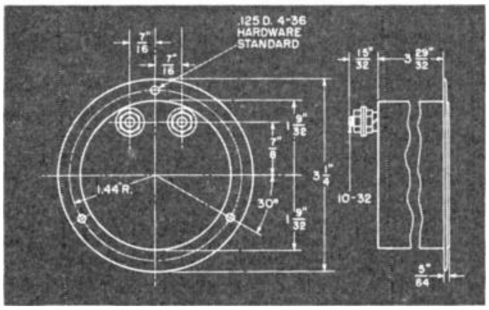
NEW METER *Indicates* BOTH



FREQUENCY

ELAPSED TIME

- Saves panel space and weight – one instrument does the work of two
- Insures operation of equipment at proper speed, within ± 0.3%
- Eliminates breakdowns caused by failure to lubricate, maintain and overhaul—on schedule



Size...3¼" flange diameter. Black metal case for flush-panel mounting. 5 reeds...58-62 cycle range. Accuracy... ± 0.3%. Power consumption...3 watts, 110 volt operation. Weight...1.3 lbs. Also made for 59-61, 48-52, and 49-51 cycle ranges.

This combination running time and frequency meter is just one of the variations J-B-T has pioneered for specific field and laboratory use in measuring speed, temperature and frequency. This and 17 other interesting applications are illustrated in a new bulletin, now ready.

They may suggest ways to attack your own problems...through use of J-B-T's wide engineering "know how," laboratory set-up and production capacity. Ask for Bulletin VF 43-IC.

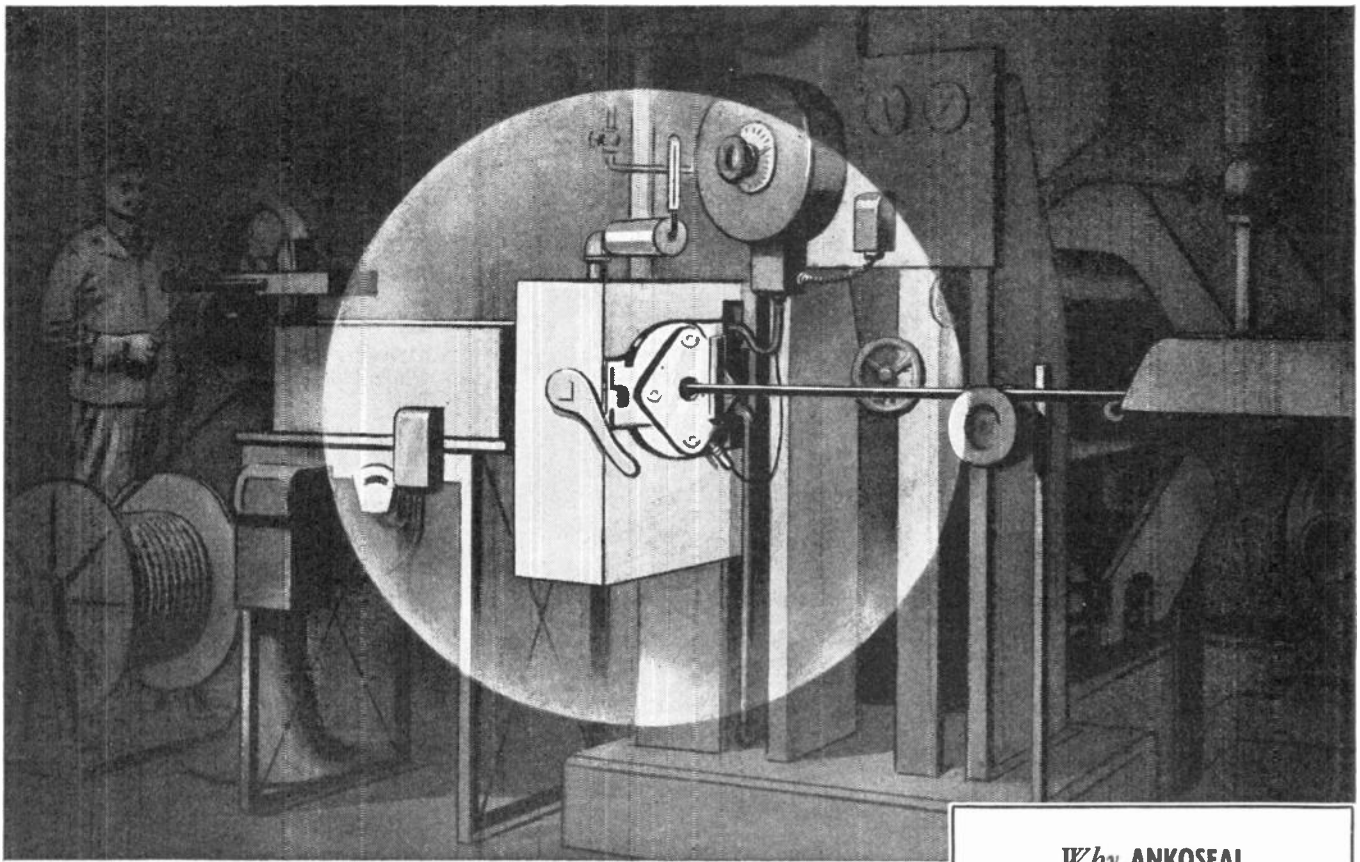
P.S. Perhaps you would also like to have Bulletins VF-43 describing basic Vibrating Reed Frequency Meters and their operation, VF 43-IA on 400 cycle meters and VF 43-IB on the smallest frequency meters made. They're yours for the asking too.

J-B-T INSTRUMENTS, INC.

CHAPEL STREET • NEW HAVEN 8, CONNECTICUT

5-JBT-4

ADVERTISERS INDEX



ENGINEERING SALES

Anthony Acquaviva: The first business loan granted in Pennsylvania under the G.I. Bill of Rights went to Anthony Acquaviva, who will set up a radio store in Philadelphia to handle the Bendix Radio line.

Zenith: New distributors have been appointed in Virginia and North Carolina. Radio Supply Company, Norfolk, operated by partners Hiram B. Bennett and William D. Jenkins, will handle Zenith in Virginia and a few North Carolina counties. Roland B. Nash and Russell E. Steele, owners of Nash-Steele Motor Company, Raleigh, will distribute the line in North Carolina.

Major Henry W. Burwell: Hallicrafters' representative in Atlanta, whose work is being carried on by Mrs. Burwell, has been awarded the Bronze Star for meritorious service in Africa, Sicily, Italy, and France.

Hoffman Radio: Kenneth Sloan is enlarging the quarters of Radio Parts of Arizona, 36 Madison Avenue, Phoenix, in preparation for distributing Hoffman Radio receivers in his State.

Sylvania: J. N. A. Hawkins has been appointed general manager of industrial electronics. He will make his headquarters at 500 Fifth Avenue, New York. A former partner at Eitel-McCullough and later chief transmission engineer of Walt Disney's sound department, he has been engaged since 1941 in Navy research work that has taken him to Central and South America, Europe, Africa, and Asia.

Stromberg-Carlson: Ben Gross, who has been a representative for Stromberg's radio line since 1924, will now act as a distributor for New York City, northern Jersey, Connecticut, and parts of Western Massachusetts. In addition, he will now distribute Premier vacuum cleaners, Pak-A-Way freezers, and Blackstone laundry equipment.

Bendix: T. Frank Dolan, president of Edward Joy Company, Syracuse, N. Y., is setting up a new division to distribute Bendix Radio sets. The radio division will be headed by Floyd A. Piron.

Albany Hardware & Iron Company, of which W. C. Dearstyne is president, will distribute Bendix radios in the eastern portion of upper New York and adjoining counties of Massachusetts and Vermont.

(CONCLUDED ON PAGE 80)

"Here's how Courtney checks up on Courtney!"

Alan Courtney

"...via a PRESTO recorder"

"An announcer must check up on his technique constantly," says Alan Courtney, popular announcer of WOV's *1280 Club* program. "My own way of doing this is to make frequent recordings of my voice on a portable PRESTO recorder. Then, by listening to the records, I can get an idea of how I sound to the radio audience. Naturally, the accuracy of the recording is of the utmost importance. I find a PRESTO recorder ideal for the work, because, even in amateur hands, it produces cuttings of uniformly high fidelity and clarity."

PRESTO sound recording and transcription equipment is used by major broadcasting companies, in industry, in schools and colleges, and by the Armed Forces. Every PRESTO unit, from the largest to the smallest, is a product of high engineering skill and uncompromising manufacturing standards. Write for information.

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

PRESTO

RECORDING CORPORATION

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

Walter P. Downs Ltd., in Canada

"Wait and See!"

Some day you'll see the multiplexing of FM and Finch Facsimile ... five-column newspapers and audio programs sent simultaneously by radio over one channel to mass circulation homes!

Over-eagerness for postwar products can lead to costly errors. It is altogether probable that so long as American armed forces need equipment and supplies, some of the *leading, ablest, most essential* manufacturers will devote their facilities to war rather than civilian requirements. Buying too soon may be a capital blunder. *In matters of facsimile communication, we remind our friends that strong Finch patents cover nearly every phase of the facsimile field. Wait and see!*

SELF SYNCHRONIZING

finch facsimile

Finch Telecommunications, Inc., Passaic, N. J. • New York Office: 10 East 40th Street, New York 16, N. Y.

How electronics helps tell a knock from a boost...

THE MIT-Sperry Detonation Indicator is an engine instrument that discriminates between normal and abnormal combustion.

Through an electronic pickup, it *instantly detects detonation*—popularly called knocking or pinging—in most types of internal combustion engines. And it gives *immediate evaluation of detonation.*

As a result, warning is given at the time trouble *starts* . . . engine life is lengthened . . . mixture may be adjusted so that considerable fuel is saved . . . and the period between engine overhauls is extended.

No piercing of engine cylinders is required. Yet even the slightest detonation is signalled visually, and the faulty cylinder or cylinders spotted.

Use of the MIT-Sperry Detonation Indicator on airplanes results in remarkable fuel savings, longer engine life, greater safety.

The same is true of surface transportation which employs internal combustion engines.

Engine manufacturers find this instrument an invaluable aid in designing and testing. It also permits development of fuels exactly fitted to engine characteristics, thus increasing power output and lowering fuel costs. Also with the Knockometer, a special application of the Detonation Indicator, fuels with superior anti-knock characteristics can be developed and their quality production controlled.

Since 1937, Sperry engineers have been working on the perfection of a detonation indicator. This is but one of the many fields in which Sperry has pioneered in the field of electronic development.

Additional information on the MIT-Sperry Detonation Indicator is available on request.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

★

Division of the Sperry Corporation

LOS ANGELES • SAN FRANCISCO • SEATTLE • NEW ORLEANS
CLEVELAND • BROOKLYN • HONOLULU

GYROSCOPICS • ELECTRONICS • RADAR • AUTOMATIC COMPUTATION • SERVO-MECHANISMS


MARION INSTRUMENTS
GEARED TO EVER-CHANGING NEEDS OF INDUSTRY
War requirements, plus our own design and construction refinements, now provide industry with instruments of heretofore unknown qualities. As new needs arise, we are geared to use our highly specialized, yet diversified, knowledge in solving any measurement problem.
Solid Alnico magnets
Beryllium copper frames
Sintered soft iron pole pieces
Very high torque movements
Our engineering department welcomes inquiries — especially those demanding extra-critical instruments for special applications.
MARION ELECTRICAL INSTRUMENT CO.
MANCHESTER, NEW HAMPSHIRE
Distributed by ELECTRICAL INSTRUMENT DISTRIBUTING CO.
458 BROADWAY · NEW YORK, N. Y.

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.

As you probably know, many of the electronic marvels of this war have been made possible by the successful harnessing of Super High Frequencies. The scientists at Bell Telephone Laboratories have taken a leading part in this work with MICROWAVES.

The devices they have designed have been built in vast quantities by Western Electric. In this work, Western Electric has added greatly to its fund of spe-

AM · BROADCASTING · FM

MARINE RADIO

AVIATION RADIO

MOBILE RADIO

Western Electric has specialized

cialized knowledge and its manufacturing techniques.

These wartime microwave developments hold great promise for the future of communications and television transmissions.

From the audio band and extending through the many services in the radio frequency spectrum up to the frontiers of super high frequencies, count on Western Electric equipment to lead the way!

During the 7th War Loan Drive, buy bigger, extra War Bonds!

SOUND SYSTEMS

TELEVISION

SOUND MOTION PICTURES

COMPONENT PARTS

knowledge in all of these fields

RAYTHEON TUBES RECOMMENDED

FOR POSTWAR *Chris-Craft*

Chris-Craft, world's largest maker of speedboats, cruisers and motor yachts, has a line of new streamlined beauties on the drawing boards that are sure to be seen on every lake and river in the peacetime years to come. Their refinements, as compared with prewar models, are almost too numerous to count . . . and one of the most important available accessories is ship-to-shore radio, for which Chris-Craft will recommend famous Raytheon High-Fidelity Tubes.

Radio equipment for marine use must be able to take plenty of battering abuse, and Chris-Craft's recommendation of Raytheon Tubes is based on their splendid wartime performance under the most gruelling battle conditions on land, sea, and in the air.

The moral of this story for you, the radio service dealer, is that Raytheon Tubes, capable of absorbing the punishment of war, are the ***best*** bet for giving your customers the dependable, rich reception they rely on you to provide. Their consistent performance . . . plus a postwar Raytheon merchandising program that will revolutionize the radio service industry . . . are the two big reasons why you should feature Raytheon Tubes *now!*

Increased turnover and profits . . . easier stock control . . . better tubes at lower inventory cost . . . these 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, Mass. • Los Angeles • New York • Chicago • Atlanta

All Four Divisions Have Been Awarded Army-Navy "E" With Stars

RAYTHEON

High Fidelity

ELECTRONIC AND RADIO TUBES

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

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES FOR THE NEW ERA OF ELECTRONICS

Many Armed Servant

The many arms of the FEDERAL organization are the arms of a versatile servant . . . making war goods now and preparing for the new and greater demands of a world at peace.

* * *

For example, FEDERAL INSTRUMENT LANDING AND RADIO RANGE equipment is pioneering new concepts of faster, safer air travel.

FEDERAL'S MEGATHERM dielectric and heat induction units are revolutionizing production processes in the plastics, metal, food, plywood, textile and other industries.

FEDERAL always *has* made better tubes. Today, as the result of continuous scientific development, FEDERAL'S TRANSMITTING, RECTIFYING AND INDUSTRIAL POWER TUBES are proving even more dependable and long lasting.

To fill a vital war need, FEDERAL developed INTELIN ULTRA HIGH FREQUENCY TRANSMISSION LINE — now is the world's largest manufacturer.

FEDERAL'S MARINE RADIO EQUIPMENT, first in serving America's merchant fleet, includes DIRECTION FINDERS, AUTO ALARMS, packaged TRANSMITTING AND RECEIVING UNITS and LIFEBOAT TRANSMITTERS.

Back of every FEDERAL TRANSMITTER are years of engineering and manufacturing experience which assure the ability to produce any type or power of communications equipment from walkie-talkie to 200 K.W. transmitters.

QUARTZ CRYSTALS, precision cut and mass produced at FEDERAL, are performing many secret military jobs.

SELENIUM RECTIFIERS, introduced by FEDERAL, are accepted as standard for converting alternating to direct current. Power equipment and battery chargers, powered by FEDERAL SELENIUM RECTIFIERS, are known for long life, high efficiency and low cost.

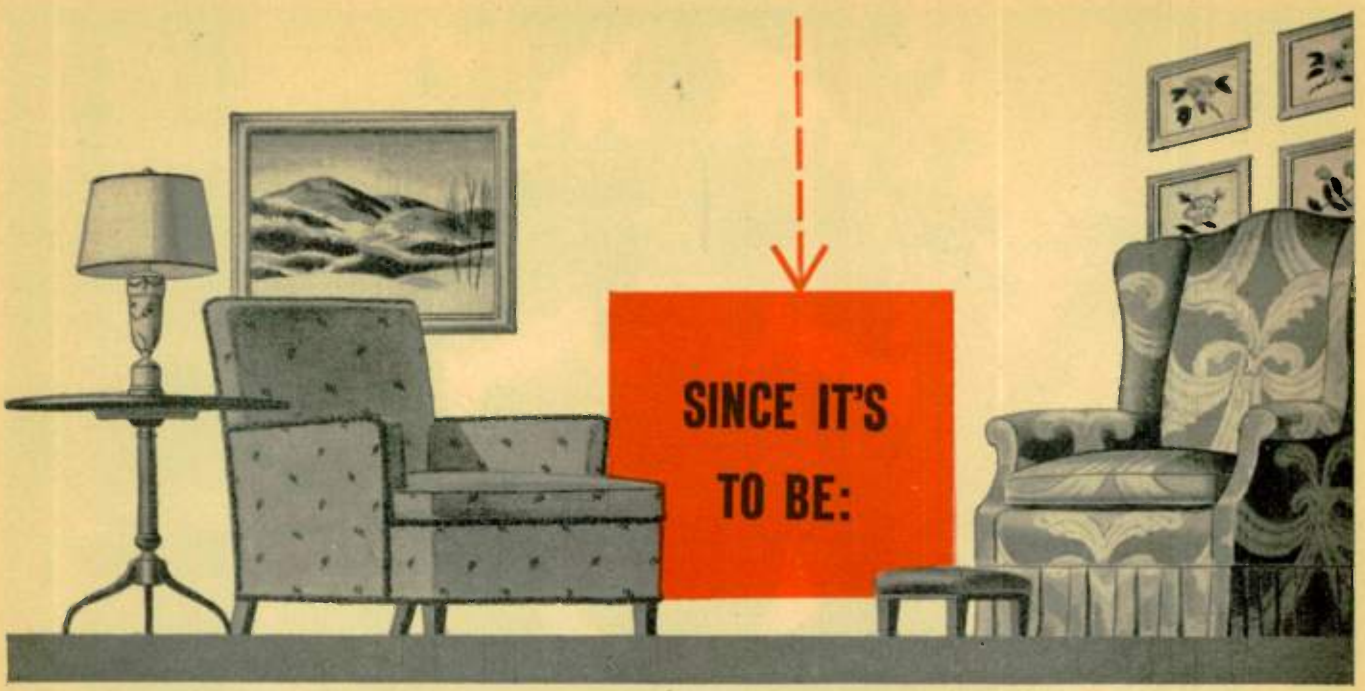
* * *

Yes, FEDERAL'S many arms make many things — all to one high standard. Here some of the world's keenest scientific minds combine their talents with three decades of FEDERAL leadership for developing and producing better communications and industrial electronic equipment.

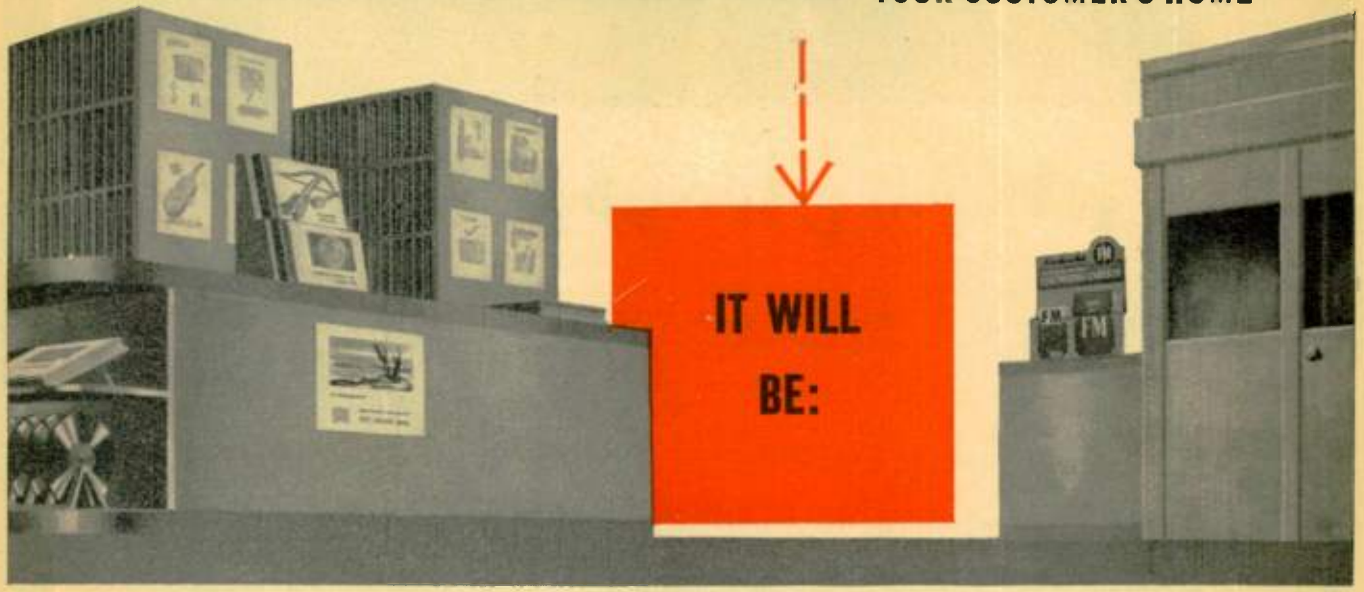
Federal Telephone and Radio Corporation

Newark 1, N. J.

An IT&T Associate



"STROMBERG-CARLSON FOR THE MAIN RADIO IN YOUR CUSTOMER'S HOME"



"STROMBERG-CARLSON FOR THE MAIN RADIO LINE IN YOUR SHOWROOM"

The thought that the main radio in any home should be as fine a radio as its purchaser can buy – a Stromberg-Carlson – is being carried to the radio-purchasing public by over 475,000,000 impressions in thirteen leading magazines. Turn this potent merchandising effort to your own direct service by becoming an authorized Stromberg-Carlson dealer under the very favorable Franchise Agreements now being offered. Get in touch with your local distributor or write us at once.

For Stromberg-Carlson is:

– the important radio unit – the radio unit carrying real profit opportunity – the radio unit with easy-selling public acceptance.

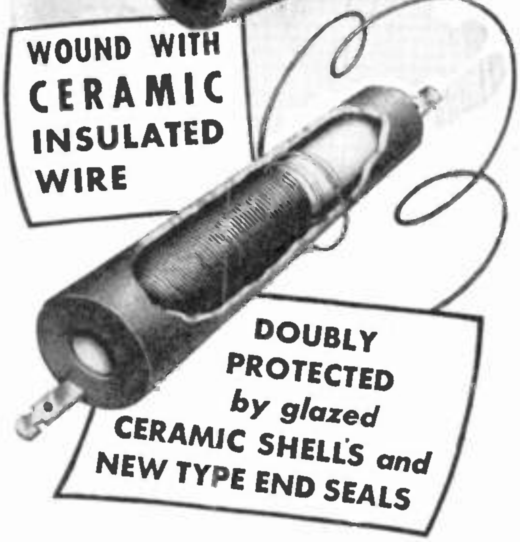
By becoming an Authorized Dealer now, you can organize your post-war business around the Stromberg-Carlson "main radio," a consistent profit maker – whether in an outstanding table model, console, or radio-phonograph combination.

STROMBERG-CARLSON ...ROCHESTER 3, NEW YORK

RADIOS...TELEVISION...TELEPHONES AND SOUND EQUIPMENT

T IS FOR "TROPICALIZED"

. . . . which means that STANDARD Sprague Koolohms now have the same EXTRA HUMIDITY PROTECTION formerly obtainable only on special order.



All Sprague Koolohm Resistors are now supplied with glazed ceramic shells and a *new type of end seal* as standard construction.

These features provide maximum protection against the most severe tropical humidity and corrosive conditions. Extensive tests in the laboratories of the armed forces and prime contractors have proven the ability of the "KT" construction to "take it" under the most brutal air thermal shock, humidity, and corrosive conditions.

Type "KT" Koolohms correspond to characteristic "J" of resistor specification JAN-R-26.

All previous catalog designations remain the same except for the addition of the letter "T" to the old type numbers to designate the new standard construction.

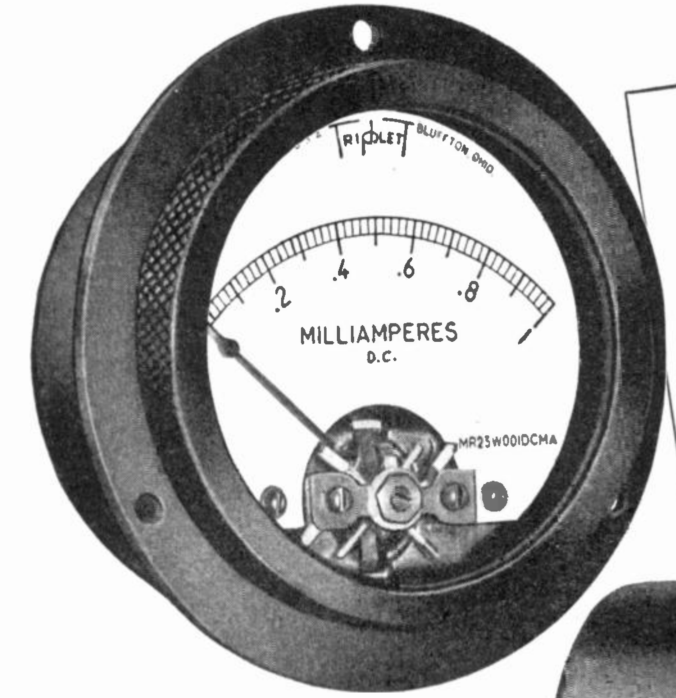
Thus "T" is for "Tropicalized"—and all Sprague Koolohms have it. One type of Koolohm, the *standard* type, does the job—under any climatic condition, anywhere in the world.

SPRAGUE ELECTRIC CO., Resistor Division, North Adams, Mass.
(Formerly Sprague Specialties Co.)

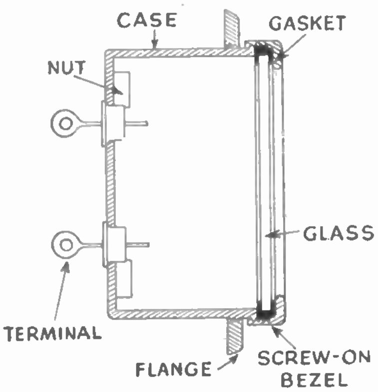
ARMY E NAVY

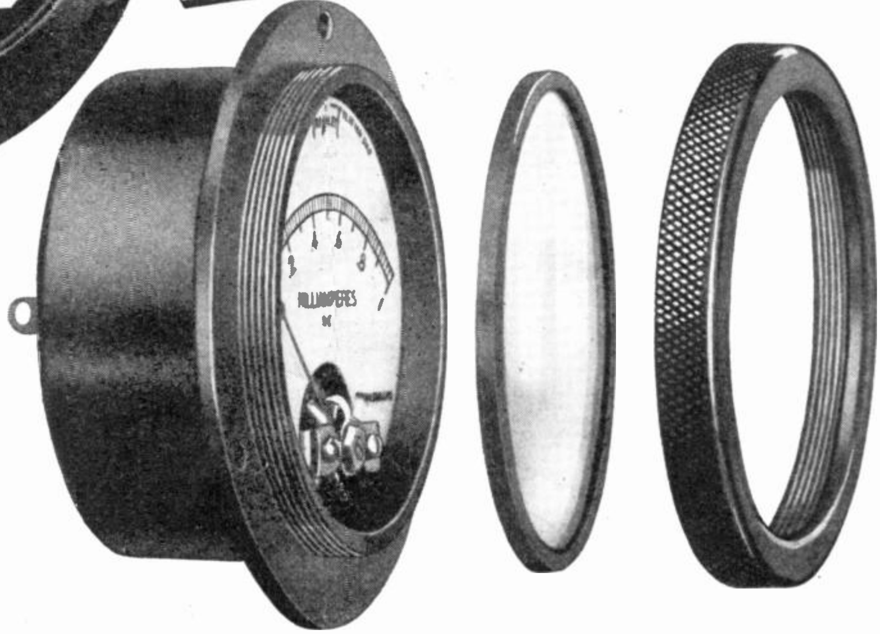
SPRAGUE
KOOLOHM RESISTORS

TRADEMARK REG. U. S. PAT. OFF.



INTRODUCING THE NEW TRIPLETT LINE OF HERMETICALLY SEALED INSTRUMENTS





ALL THE FEATURES of STANDARD INSTRUMENTS RETAINED

Withstands submersion tests at 30 feet

A screw-on bezel provides uniform pressure for hermetically sealing the glass to the case. The gasket is pressed into every crevice around the edge of the glass and the top of the case, where the permanent seal is made.

Tempered glass window and ceramic sealed terminals are used.

The knurled screw type bezel permits servicing when necessary and resealing without replacing a single part or the use of special tools or equipment.

Complete dehydration of the interior is readily accomplished by recognized temperature difference method (the bezel loosely attached for the escape of all moisture, after which the bezel is tightened to make the permanent seal). Interior is completely dry at slightly above atmospheric pressure.

These instruments comply with thermal shock, pressure and vibration tests. They also are resistant to corrosion. Instruments conform to S.C. No. 71-3159 and A.W.S. C-39.2-1944 specifications.

Furnished in 1½", 2½" and 3½" metal cases with 1/16" thick walls, in standard ranges. D.C. moving coil, A.C. moving iron and thermocouple types.

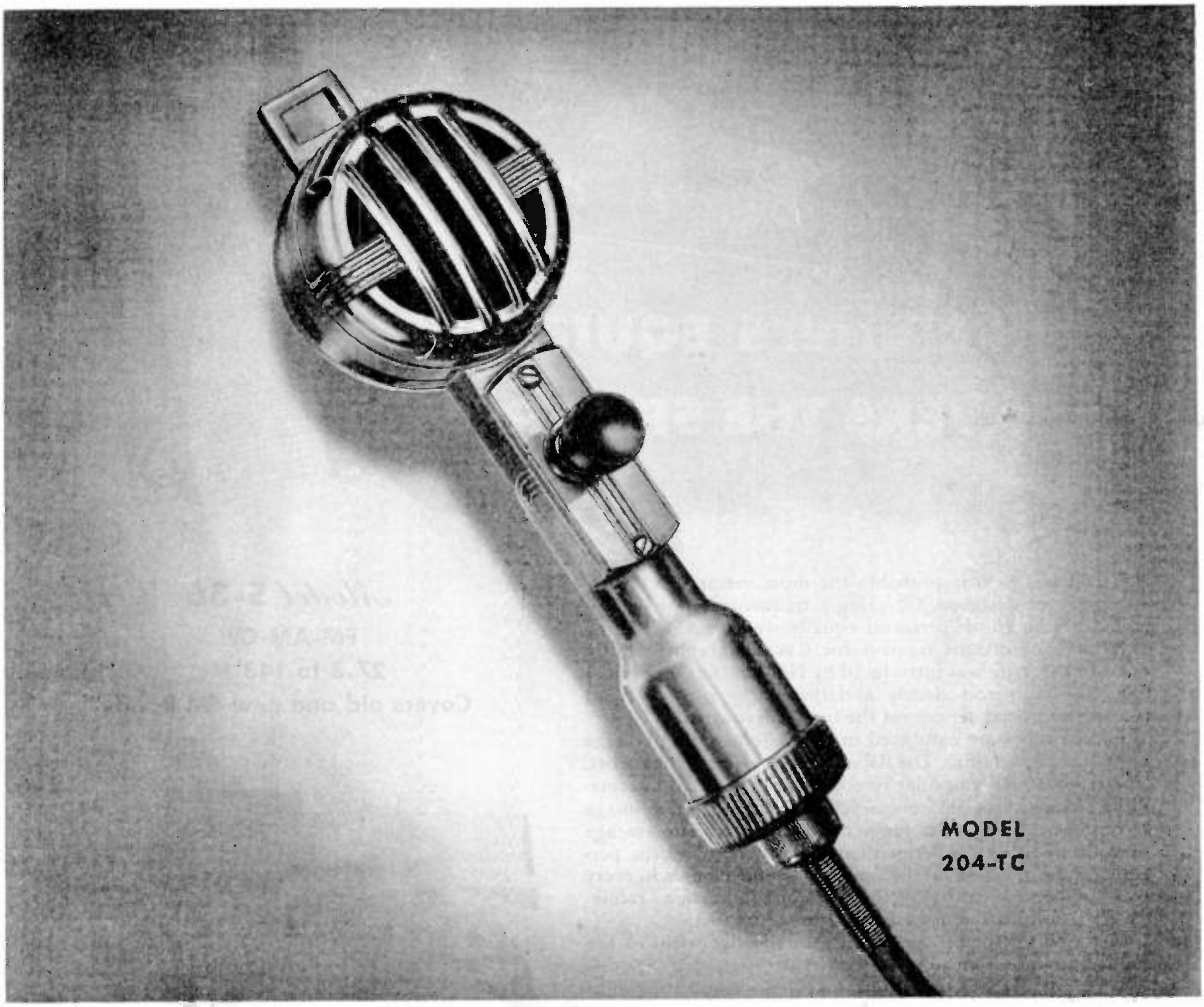
Write for circular

STANDARDS ARE SET BY TRIPLETT

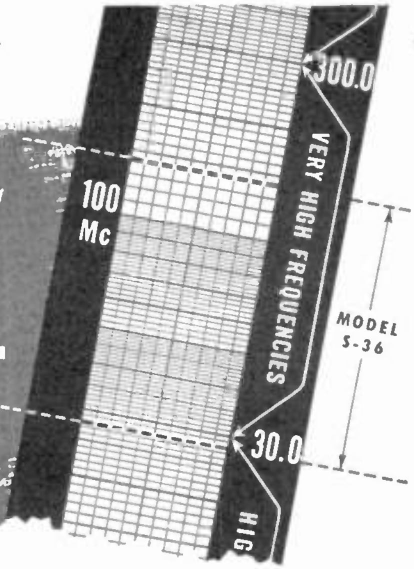
Precision first ... to last

Triplett

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO


MODEL
204-TC

HOW hallicrafters EQUIPMENT COVERS THE SPECTRUM



THE Model S-36 is probably the most versatile VHF receiver ever designed. Covering a frequency range of 27.8 to 143 megacycles it performs equally well on AM, FM, or as a communications receiver for CW telegraphy. Equipment of this type was introduced by Hallicrafters more than five years ago and clearly anticipated the present trend toward improved service on the higher frequencies.

Fifteen tubes are employed in the S-36 including voltage regulator and rectifier. The RF section uses three acorn tubes. The type 956 RF amplifier in conjunction with an intermediate frequency of 5.25 megacycles assures adequate image rejection over the entire range of the receiver. The average over-all sensitivity is better than 5 microvolts and the performance of the S-36 on the very high frequencies is in every way comparable to that of the best communications receivers on the normal short wave and broadcast bands.

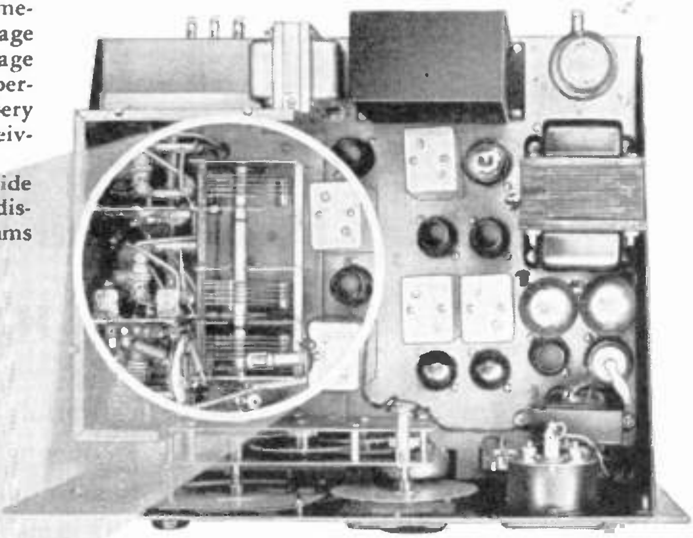
The audio response curve is essentially flat within wide limits and an output of over 3 watts with less than 5% distortion is available. Output terminals for 500 and 5000 ohms are provided.

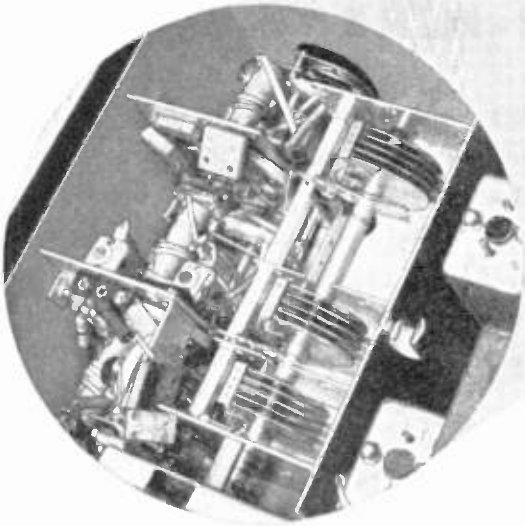
Model S-36

FM-AM-CW

27.8 to 143 Mc.

Covers old and new FM Bands





The RF section is built as a unit on a separate chassis which may easily be removed for servicing and incorporates a three position ceramic band switch. The positive action mechanical bandspread dial turns through more than 2200 divisions for each of the three ranges, 27.8 to 47, 46 to 82, and 82 to 143 megacycles.

For details on the entire Hallicrafters line of precision built receivers and transmitters write for Catalog 36-H.

BUY A WAR BOND TODAY!

hallicrafters RADIO

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

FCC'S FINAL FREQUENCY ALLOCATIONS

For Frequencies of 25 Mc. 30,000 Mc—Released on May 17, 1945

AMATEURS

28–29.7
4 mc. band:
44–108[10]
144–148
220–225
420–450[18]
1145–1245
2300–2450
5250–5650
10000–10500
21000–22000

AVIATION

Airport Control
118–122

Civil Aviation
225–328.6[16]
335.4–400[16]

Flight Test, Schools
7 ch: 25–28

Glide Path
328.6–335.4

Mobile
122–132
1325–1375[22]

Navigation Aids
420–450[18]
1600–1700
2700–2900[23]
3700–3900
5000–5250[24]

BROADCASTING

Experimental
920–940

FM Commercial
14 mc. band:
44–108[10]

FM Educational
4 mc. band:
44–108[10]

Relays
24 ch: 25–28[1]
12 ch: 152–162[15]

S-T Links
30 mc. band:
44–108[10, 11]
196–216[11]
940–960[20]

CITIZENS' RADIO

460–470

COMMUNICATIONS

Fire
15 ch: 30–40
12 ch: 44–108[10]
12 ch: 152–162

Forestry
29 ch: 30–40[6, 7]
8 ch: 44–108[10]
6 ch: 44–108[7]
30 mc. band:
44–108[10, 11]
4 ch: 152–162[13]
12 ch: 152–162[15]
186–216[11]

General H'way Mobile
20 ch: 30–40[4]
20 ch: 42–44[4]

Geophysical
24 ch: 25–28[1]
5 ch: 30–40[5]
5 ch: 42–44[5]
4 ch: 152–162[13]
12 ch: 152–162[15]

Highway Maintenance
10 ch: 44–108[10]

Marine Mobile
5 ch: 30–40[5]
6 ch: 30–40[6]
5 ch: 42–44[5]
8 ch: 152–162

Motion Picture
6 ch: 25–28[2]
12 ch: 152–162[15]

Point-to-Point
30 mc. band:
44–108[10, 11]
186–216[11]

Police
36 ch: 30–40
24 ch: 42–44
36 ch: 44–108[10]
36 ch: 152–162

Power, Petroleum, etc.
12 ch: 25–28
7 ch: 30–40
6 ch: 44–108[10]
6 ch: 152–162

Press Relay
6 ch: 25–28[2]
4 ch: 152–162[13]

44 TO 108 MC.

After further FM propagation tests, the FCC will select one of the three alternative arrangements for the 44- to 108-mc. band:

ALTERNATIVE NO. 1

44–48	Amateur
48–50	Facsimile
50–54	Educational FM
54–68	Commercial FM
68–74	Television
74–78	Fixed and Mobile
78–84	Television[11]
84–90	Television[11]
90–96	Television[11]
96–102	Television[11]
102–108	Television[11]

ALTERNATIVE NO. 2

44–50	Television[11]
50–56	Television[11]
56–60	Amateur
60–66	Television[11]
66–68	Facsimile
68–72	Educational FM
72–86	Commercial FM
86–92	Television
92–98	Television[11]
98–104	Television[11]
104–108	Fixed and Mobile

ALTERNATIVE NO. 3

44–50	Television[11]
50–54	Amateur
54–60	Television[11]
60–66	Television[11]
66–72	Television[11]
72–78	Television[11]
78–84	Television
84–88	Educational FM
88–102	Commercial FM
102–104	Facsimile
104–108	Fixed and Mobile

Railroads
30 mc. band:
44–108[10, 11]
60 ch: 152–162
186–216[11]

Special Emergency
6 ch: 30–40
10 ch: 44–108[10]

Unspecified Non-Gov't Fixed & Mobile
450–460[19]
1325–1375[22]
1750–2100
2450–2700
3900–4400
5650–7050
10500–13000
16000–18000
26000–30000

Urban Mobile
24 ch: 152–162[4, 14]

Urban Transit
6 ch: 30–40[7]
5 ch: 30–40[8]
6 ch: 44–108[7, 10]

FACSIMILE

Broadcasting
2 mc. band:
44–108[10]
470–480

Police Fixed
940–960[20]

GOVERNMENT

25.015–27.185[3]
27.455–28[3]
29.7–30[3]
30–30.5
30.5–32[3]
32–33
33–34[3]
34–35
35–36[3]
36–37
37–38[3]
38–39
40–40.96
41–42
108–118
132–144
148–152
162–174
174–186[12]
216–220
225–328.6[16]
335.4–400[16]
400–420[17]
1375–1600
2100–2300
4400–5000
7050–10000
13000–16000
18000–21000
22000–26000

METEOROLOGICAL

400–420[17]
1700–1750
2700–2900[23]

NAVIGATION AIDS

960–1145
2900–3700

PROVISIONAL & EXPERIMENTAL

10 ch: 25–28
2 ch: 30–40
5 ch: 30–40[8]
2 ch: 30–40[9]
1 ch: 42–44
2 ch: 44–108[10]
2 ch: 152–162

SCIENTIFIC, MEDICAL, INDUSTRIAL

27.185–27.455
40.96–41

TELEPHONE

Rural Subscriber
30 mc. band:
44–108[10, 11]
24 ch: 152–162[4, 14]
186–216[11]

Short Distance Toll
24 ch: 152–162[4, 14]

TELEVISION

Broadcasting
5 ch: 44–108[10, 11]
1 ch: 44–108[10]
174–180[12]
180–186[12]
186–192[12]
192–198[12]
198–204[12]
204–210[12]
210–216[12]
480–920

Relays
1245–1325

[1] Shared by relay broadcast and geophysical
[2] Shared by press relay and motion picture
[3] Shared by Government and fixed and mobile services
[4] For marine, land vehicles, aircraft, etc. 12 of these channels for development on common carrier basis, 4 for trucks, 4 for buses
[5] Shared by marine mobile and geophysical
[6] 6 channels shared by marine mobile and forestry
[7] 6 channels shared by urban transit and forestry
[8] Shared by urban transit and provisional-experimental
[9] Antenna input power limited to 5 watts peak
[10] See proposals for 44–108 mc.
[11] Shared by television and police control and relay circuits, point-to-point, marine control circuits, forestry, rural telephone, studio-transmitter links, and railroad, terminal, and yard operations on mutually non-interfering basis.
[12] Share by Government and television.
[13] Shared by press relay, forestry, and geophysical
[14] Shared by urban mobile, rural subscriber telephone, and short distance toll telephone
[15] Shared by relay broadcast, motion picture, geophysical, and forestry
[16] Shared by Government and civil aviation
[17] Government, including radio sonde
[18] Temporarily for special air navigation aids. To be exclusively for amateurs when no longer required for special navigation aids. Meanwhile, amateur peak power to be limited to 50 watts
[19] Temporarily for special air navigation aids. To be reserved for non-Government services when no longer needed for special air navigation aids
[20] Shared by experimental broadcasting, studio-transmitter links, control circuits, police fixed facsimile, etc.
[21] Shared by meteorological and air navigation aids
[22] Fixed and mobile, including aviation
[23] Shared by meteorological and air navigation aids
[24] Instrument landings

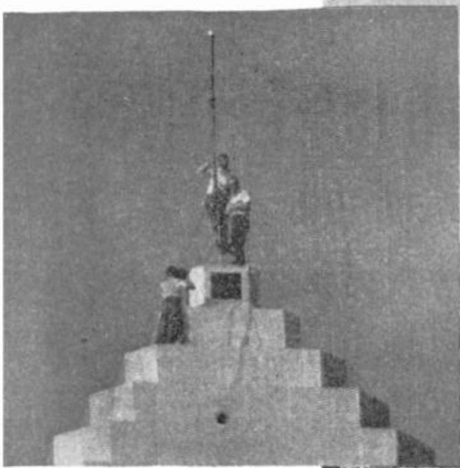


FIG. 1. THE DUAL COAXIAL ANTENNA, ABOVE, IS MOUNTED ON THE COURTHOUSE PEAK, SEEN AT THE RIGHT OF THE WIDE STREET IN THIS BIRD'S-EYE VIEW OF MIAMI

MIAMI POLICE HAVE FIRST 118-MC. SYSTEM

Report on 118-Mc. FM Operation Indicates Higher Frequencies Will Be in Great Demand for Police Service

BY LIEUT. BEN DEMBY*

THE license for our 118-mc. 2-way FM police system was issued on November 1, 1944. Soon after that, an expert on radio communications came to Miami to see how the equipment was performing. When he came back from a trip in one of our patrol cars, he said to me: "Ben, if you'd been a radio engineer, you wouldn't have attempted to put in this system, because radio engineers know it's impossible to get solid coverage at 118 mc."

Why We Wanted 118 Mc. ★ Well, back in March, '44, when we made the first 118-mc. tests with a 15-watt transmitter, I didn't know just what results we would get, but at least I had no reason to believe that solid coverage was impossible. We wanted to replace our 2.442-mc. AM equipment with FM, but we didn't want to have the interference we were experiencing on our 31.5-mc. FM fire department system which we installed in 1941. Just at this time, Norman Wunderlich had announced the results of his 118-mc. tests in Chicago, and that encouraged me to expect the quality of performance on 118 mc. that I wanted in Miami.

Depending upon the time of the year and the time of day, we have interference on 31.5 mc. from sections as far away as California and New England. Worst of all was code interference which we finally traced to a South American press telegraph station HPG, operating on 15.55 mc. We got the second harmonic, and it really cut up our reception.

If it seems surprising that we undertook to pioneer something entirely new and untried, instead of waiting until someone else worked out the answers, there are good reasons for what we did.

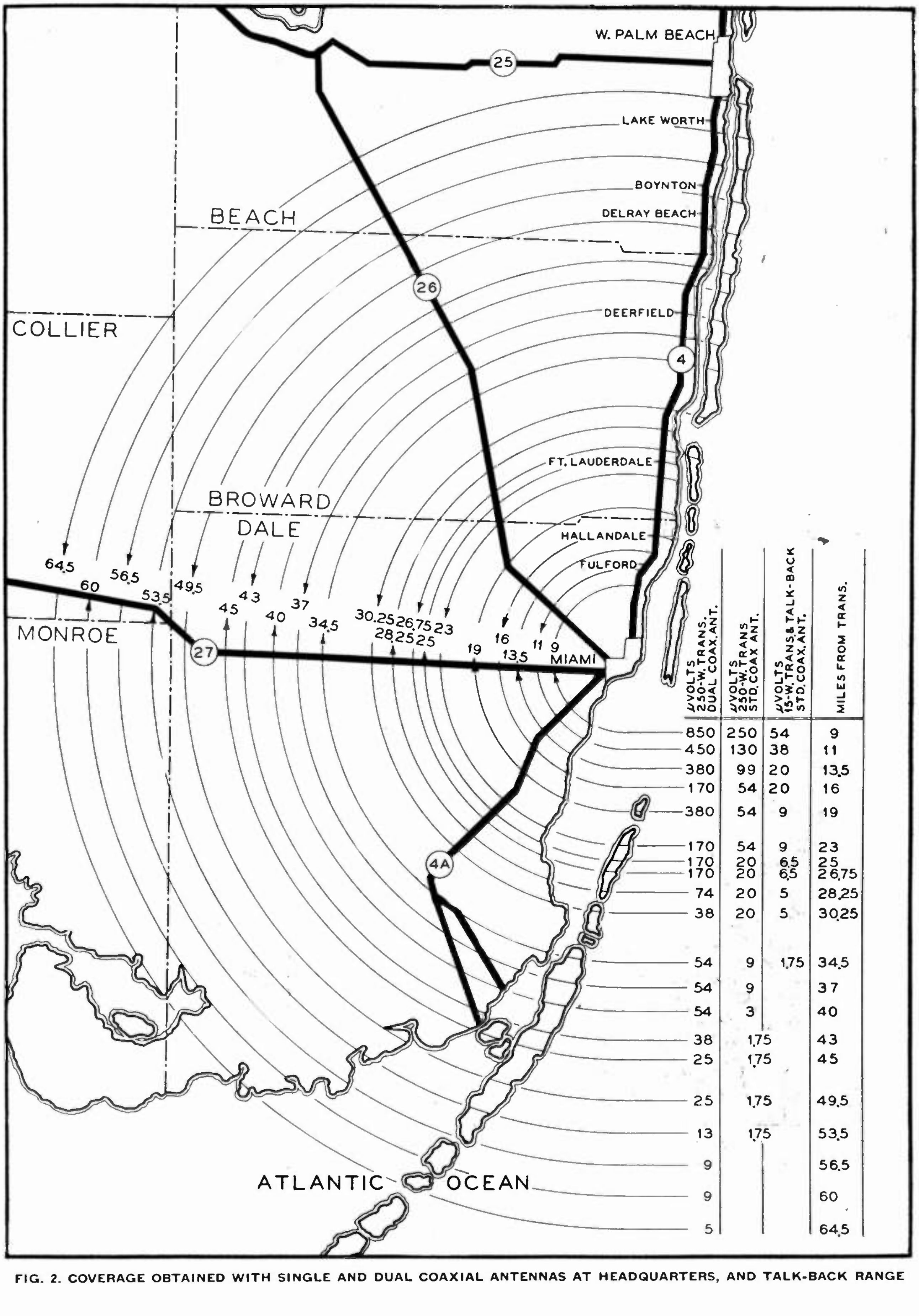
The Miami Police Department is called upon to meet a unique combination of extremely difficult conditions. Our transient population is enormous. In addition to the various wartime services set up by the Army, Navy, and Coast Guard, nearly all of our hotels have been taken over as convalescent homes for soldiers and sailors brought from overseas. They stay for two weeks to a month. While the Municipal Police is not responsible for servicemen, we are called upon to coöperate with Shore Patrol and Military Police operations.

Pan American is bringing in many civilians from the West Indies. Porto Ricans are coming here in great numbers. As fast as one member of a family gets here and finds a job, he sends passage money for the next one.

And, despite all restrictions on travel, people of all kinds still find ways to reach Miami from every part of the United States. Thus a tremendous responsibility of service, as well as maintenance of law and order, is put upon our Director of Public Safety, Dan Rosenfelder, and our Police Department.

Fortunately, we are encouraged by our Director to make use of any means by which we can better meet that responsibility of public service, and probably no one appreciates more keenly than Dan Rosenfelder the value of 2-way police radio communication in police work.

* Supt., Communications Division, Dept. of Public Safety, City of Miami, 3810 N. W. 8th St., Miami, Fla.



μVOLTS 250-W. TRANS. DUAL COAX. ANT.	μVOLTS 250-W. TRANS STD. COAX. ANT.	μVOLTS 15-W. TRANS. & TALK-BACK STD. COAX. ANT.	MILES FROM TRANS.
850	250	54	9
450	130	38	11
380	99	20	13.5
170	54	20	16
380	54	9	19
170	54	9	23
170	20	6.5	25
170	20	6.5	26.75
74	20	5	28.25
38	20	5	30.25
54	9	1.75	34.5
54	9		37
54	3		40
38	1.75		43
25	1.75		45
25	1.75		49.5
13	1.75		53.5
9			56.5
9			60
5			64.5

FIG. 2. COVERAGE OBTAINED WITH SINGLE AND DUAL COAXIAL ANTENNAS AT HEADQUARTERS, AND TALK-BACK RANGE

Description of the Equipment ★ My first efforts to get the equipment did not arouse any enthusiastic response. When I approached the Motorola engineers, they were too busy with their military problems to give me any help and, besides, they didn't think much of the idea of using 118 mc. for 2-way mobile service. Then Norman Wunderlich came to my rescue by practically smuggling out of the plant some Motorola units used for relay installations.

They weren't designed for use in cars, but we rigged up a temporary radiator on the peak of the Courthouse for the main station, and put a toothpick antenna on one of our patrol cars for the mobile unit. Fig. 1 shows the business section of Miami, with the point of the Courthouse, our tallest building, just below the skyline a little to the right of Flagler Street, which runs out the middle of the picture. The dual coaxial antenna shown in the insert was put up later. The car antenna, only 23 ins. long, can be seen in Fig. 5. This, then, was the first 118-mc. police installation.

As for the initial tests using 15 watts output on 118.55 mc., it is enough to say that, from the start, it was certain we were on the right track. Meanwhile, the use of our 31.5-mc. FM system gave us a basis for comparing performance that surely emphasized the advantages of the higher frequency.

FIG. 3. THE AUTHOR WITH MIAMI'S DIRECTOR OF PUBLIC SAFETY, DAN ROSENFELDER, WITH WHOSE ENTHUSIASTIC SUPPORT LIEUT. DEMBY PIONEERED THE USE OF 118 MC.

FIG. 4. PAULINE VARNEDOE AT THE MIKE AT W4XKK CONTROL ROOM, IN MOORE PARK. EXPERIENCE SHOWS THAT WOMEN'S VOICES ARE EASIER TO UNDERSTAND THAN MEN'S

It was not until November 1, 1944 that we were ready to go on the air officially with our new equipment. We put a dual coaxial antenna, shown in Fig. 1, on the Courthouse, and installed a 250-watt, 118-mc. transmitter inside the peak. The elevation at the foot of the antenna is 346 ft. above sea level. Figs. 8 and 9 show the transmitter, with detailed views of the output stage, front and rear. In general appearance, it is similar to the standard 30- to 40-mc. Motorola FM transmitter and receiver assembly. A line to the control room at Moore Park radio headquarters, Fig. 4, carries the voice and control circuits in the conventional manner. The operating procedure is no different from that at the lower frequencies.

The car installations are similar in appearance to conventional types, except for the diminutive size of the antenna. You will see in Fig. 6 that we have a separate 300 A.H. storage battery to operate the radio equipment. In addition, we have a 40-ampere Bosch or Auto-Lite charger under the hood. It is mounted so that the same belt drives both the regular and the added charger. In this way, we have eliminated much of the service work required to keep the regular batteries fully charged at all times when they are used to operate the radio units.

Altogether, in its general appearance and method of use, there is little to distinguish our 118-mc. equipment from that designed to operate on 30 to 40 mc. But the performance is something such as can't be heard now on the lower FM police frequencies.

Coverage ★ The map in Fig. 2 gives the results of a very careful and complete survey we made and was later checked by FCC and FBI engineers. Tests were made in one of our patrol cars, using a calibrated receiver. On the highways marked on the map, the measured signal strength at any given distance was almost absolutely uniform. That is due in part, I suppose, to the fact that the entire area is perfectly flat, but I think the main reason lies in the propagation characteristics at the higher frequencies.

In the table at the left of Fig. 2, the right hand column shows the distance from the transmitter. Next are readings

FIG. 5. MAJOR T. A. WILSON, BRITISH ROYAL CORPS OF SIGNALS, LIEUT. BEN DEMBY, AND CHIEF DISPATCHER R. N. HARWARD, WITH ONE OF THE PATROL CARS

taken with a 15-watt transmitter and coaxial antenna at the Courthouse. These readings are the same as those obtained on the car talk-back measurements.

The third column to the left gives readings taken with the coaxial antenna and a 250-watt transmitter. The last column shows how our signal strength stepped up when we installed the dual coaxial antenna illustrated in Fig. 1.

All those readings are plotted in Fig. 7. Curve A is for the 250-watt transmitter with our dual coaxial antenna. Curve A_1 is for the same transmitter with a conventional coaxial antenna. Curve A_2 is for the 15-watt transmitter and coaxial antenna, and for car talk-back to headquarters. Curve B is shown [1] merely for purposes of comparison. This shows the calculated field strength from a 1 kw. transmitter with a horizontally polarized antenna 1,000 ft. high, working on 100 mc. with a receiving antenna 30 ft. high. It will be noted that the four curves are reasonably similar.

Performance on 118 Mc. ★ Let me take you on a trip in one of our patrol cars. We'll pick out some of the spots where, from your previous experience, you would expect our 118-mc. system to fail. Suppose we take the route selected by Major T. A. Wilson, of the British Army Staff, and Milton Sleeper, editor of *FM* AND TELEVISION, when we spent an afternoon together trying to find adverse conditions that would prevent 2-way communications with headquarters.

We started off from Moore Park where, in a stone building so built as to withstand any future hurricane, we have the radio operating room, Fig. 4, office, and maintenance shop. Driving toward the business section, we took one of the streets lined with high buildings that cut us off from sight of the antenna with walls of steel and stone. I picked up the handset and called, "Seven to W4XKK." And back came the pleasant voice of operator Pauline Varnedoe with, "K, Seven," as clear as if we were in open country.

I called in several times to show my visitors that there was no difference in the signal level as we cruised around the business district, or out in the clear as we headed across McArthur Causeway to Miami Beach. We passed a huge gas storage tank, and I drove close against it on the side away from the transmitter. When I called, "Seven to W4XKK," the operator snapped back, "K, Seven," without the slightest change in the signal.

High-tension power lines cause considerable trouble on the lower frequency. Accordingly, we headed north until we reached a point where 66,000-volt lines run at the side of the road. There wasn't the slightest sound to indicate that we were driving beside such a source of interference.

Twenty miles from the transmitter, we came to a narrow steel bridge. I asked: "Want to hear what this bridge does to the signals?" To show them that the steelwork wouldn't make any difference, I called Headquarters and asked the operator to count slowly from one to twenty-five. That gave me time to approach and cross the bridge while she was talking. They expected that there would be some kind of a break in the signals, but there

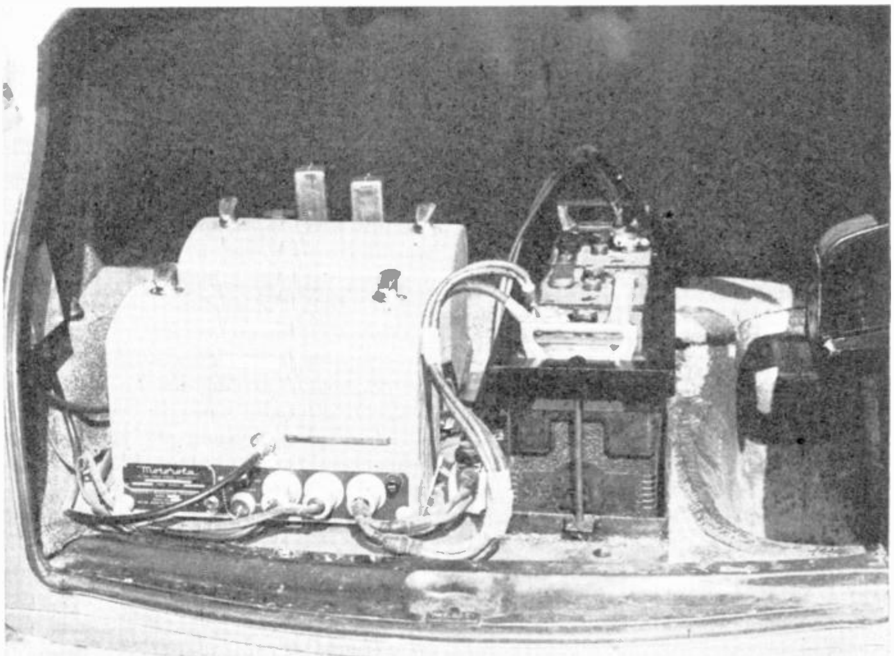
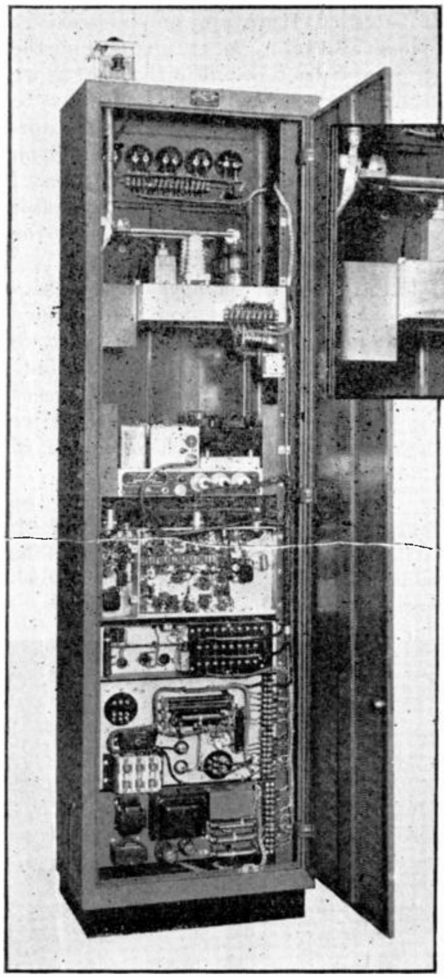


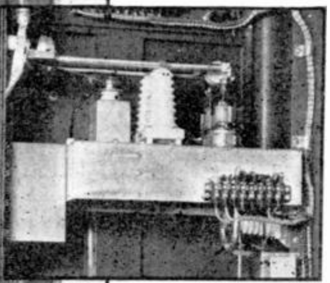
FIG. 6. THE 118-MC TRANSMITTER AND RECEIVER HAVE THE OUTWARD APPEARANCE OF CONVENTIONAL EQUIPMENT, AND ARE INSTALLED IN THE SAME WAY

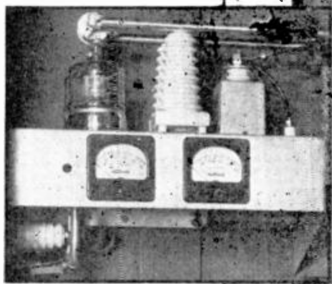
[1] From "FM Broadcast and Communications" by René Hemmes, *FM* AND TELEVISION, April, 1945, page 37.

wasn't. Then Major Wilson had an idea. He said: "Suppose you go back on the bridge and call Headquarters. I'd like to see if the steelwork affects the car transmitter."

So I turned around, stopped on the bridge, and called, "Seven to W4XKK." I knew it wouldn't make any difference, but my passengers were surprised at the







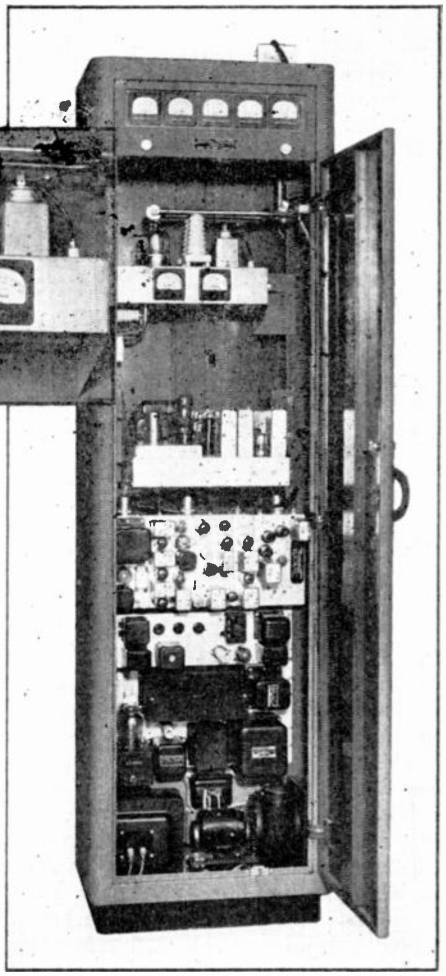


FIG. 8, LEFT. REAR OF 250-W., 118 MC. MOTOROLA TRANSMITTER. FIG. 9, RIGHT. FRONT VIEW, WITH DETAILS OF THE POWER OUTPUT STAGE IN SMALL INSERTS

prompt, "K, Seven," that snapped back to us.

Your Editor had the next stunt for me. He said, "There's a race track on the right. What will the steel construction of the grandstand do to your signals?" It was easy to find out. I was able to drive in at the gate and under the grandstand for, right now, all our tracks are deserted. The 118-mc. signal was no different than it was right in the City, and the operator heard me without any difficulty.

We passed Ft. Lauderdale, nearly 30 miles from the transmitter, before I had any trouble reaching Headquarters. The operator could recognize my call, but I had to repeat my messages. We don't consider that satisfactory communication, even though her voice came in clearly to us.

However, at 30 miles we were not only far from Miami. We were out of Dade County, as you will see from the map in Fig. 2. This is far more range than is required for our system, so that we have an ample margin of safety. A radius of 30 miles represents coverage of nearly 3,000 square miles. That range is more than enough to cover the five boroughs of New York City. In fact it is nearly enough to cover New York metropolitan district which includes parts of New Jersey and Connecticut! The five boroughs of New York comprise only 299 square miles, and the extreme length of the City is only 35 miles.

As a further basis of comparison, the Chicago District covers 1,119 square miles, extending along Lake Michigan for 55 miles, but the City proper contains only 213 square miles, with a Lake front of 26 miles.

These figures are given to indicate the possibilities of using 118 mc. in the largest cities. To be sure, the police will soon have to give up this part of the spectrum and move to 152 to 156 mc., but my experience with these higher frequencies indicates that the performance will be as good as we are getting now in Miami.

Returning from our tests, we tried other stunts, such as driving down into a gravel pit, and stopping close to various steel structures, but nothing affected the performance of the equipment. I had one surprise of my own still up my sleeve. As we approached the Courthouse, I asked the operator to count slowly to one hundred. Then I turned onto the ramp which leads to a parking space under the Courthouse, and below ground level. If there is any space where, from experience with lower frequencies, you would expect the signal level to drop, this is it. But I drove all around the underground area and out to the street again with no more variation in the signal than if the car had been standing at the curb.

In short, both Major Wilson and your Editor agreed that, as a demonstration of solid communications, this was 100%!

Special Notes ★ Engineers and police officials who come to see and hear our radio system seem to expect that we'd have trouble with frequency drift in the mobile units. Our experience with equipment we have had in service for more than six months is that the frequency adjustments require less attention than the 31.5-mc. equipment used by our fire department. It may be due to the design of the 118-mc. circuits. I shan't attempt to explain it, but I can say from my own experience that, with our schedule of checking all car units once a month, we have had no service problem with frequency drift.

The average car-to-car range is 5 miles. That is enough for all conditions where car-to-car communications are required. We do not consider it desirable for any one car to hear all the other cars, nor is it necessary.

On our detective cruisers we use side-mounted antennas. Because of their short length, they look exactly like antennas on private cars. No one can tell the difference. There is no noticeable directional effect at distances under 20 miles.

A feature of our transmitter which deserves special attention from police radio

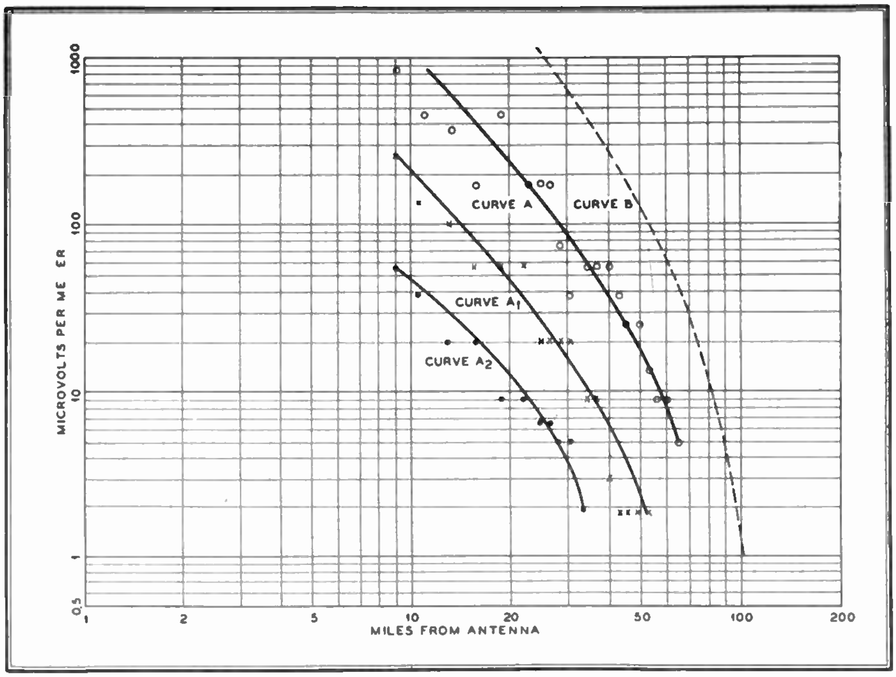


FIG. 7. TALKBACK RANGE AND RANGE OF 250-W. TRANSMITTER WITH SINGLE AND DUAL COAXIAL ANTENNAS, COMPARED TO CALCULATED RANGE OF A 1-KW. TRANSMITTER ON 100 MC. SEE TEXT FOR ADDITIONAL DETAILS

engineers is our dual coaxial antenna. The story of its performance, and the gain over the conventional type of vertical radiator is told by the table in Fig. 2. For example: At a distance of 40 miles, the field strength from the single antenna was 3 microvolts per meter, against 54 from the dual coaxial antenna. That represents the difference between a signal that might be misunderstood, and one of ample signal-to-noise ratio.

This is more important, under most conditions, than increased range. On the other hand, there are many cases where added range is of distinct advantage. On this point, the chart shows a field strength of 9 microvolts up to 37 miles with the standard radiator, against 60 miles for the same field strength with the dual coaxial antenna. That difference of 23 miles has proved mighty useful in special emergencies.

It is interesting to note a dip in the field strength from our dual antenna at 16 miles and again at 30¼ miles. These were not due to obstructions between the car and transmitter. I am inclined to think that they result from interference between the direct wave from our antenna and the ground-reflected wave. It would be easy to tell if that is the case. If it is, raising the car antenna a few feet would bring up the signal strength to a normal value.

However, we haven't made an investigation to determine the cause, and it's not important since the signals at these points are amply strong to operate the limiter. Hence the signals from the loudspeaker are not affected.

Another question we are asked frequently is: "What effects do static or bursts from distant stations have on 118.55-mc. reception?" We have experienced no interference sufficient to open the squelch on our headquarters or car receivers. There are some 40 relay transmitters operating on 118 mc. in various parts of the country, but we have not heard one of them. When the new band from 152 to 156 mc. is put to use in police service, this will provide about 70 channels or twice as many as are now available in the 30- to 40-mc. band. So it looks as if there will be ample room for a great many municipal police systems to operate without co-channel interference.

I know that our Director of Public Safety shares the enthusiasm with which I recommend to other police communications officers the shift which we have made to the higher FM frequencies.

NOTES ON TELEVISION FREQUENCIES

BY JERRY B. MINTER*

There has been considerable expression of opinion recently concerning allocation of the higher frequencies to television. Like most engineers, I have some personal thoughts on this subject which might be of general interest.

In view of the FCC's attitude toward temporary assignments in the lower band, it is my own feeling that it might be better to shift *now* to the higher band, but leave the transmission standards at 525 lines, so that existing studio equipment could be used without change. The assigned channels should be spaced far enough apart to permit improvement of the standards at some future date when iconoscopes, kinescopes, circuits, antennas, etc. are developed to realize any benefit from a change in standards. It might be well to space the sound carrier farther away from the video carrier, since present transmitters seem to have trouble keeping sound carrier out of the picture, and it would not be too difficult to shift the sound carrier on most receivers from 8.25 mc. down to 2.75 mc.

Future television receivers should use much higher IF frequencies to obtain better image ratios and better video detection efficiency. It seems logical to consider 20 mc. for the sound carrier intermediate frequency, and 30 mc. for the video intermediate frequency. This would permit a 9-mc. video bandwidth for single sideband transmission at some time in the future. The high frequency channels should be at least 15 to 20 mc. wide, so that unreasonable requirements are not put on sideband filters at the transmitter. At some future date, when better sideband filters are developed, the transmitted signal can be improved, and better use made of the assigned channel width.

For about 4 years, I have been observing and altering a television receiver in an attempt to utilize fully the present assigned channel width. In order to secure sufficient receiving antenna directivity, I have found it necessary to erect a rhombic antenna occupying a space 20 by 40 ft. Otherwise, multipath effects prevent maximum possible resolution with the present standards. This antenna is necessary in order to cover adequately the entire range from 50 to 300 mc. now assigned to commercial television.

From 450 to 1000 mc., a much smaller rhombic antenna, about 6 by 12 ft., will provide from 3 to 6 times the voltage gain of a half-wave doublet, and sufficient directivity to permit good resolution with the present 525-line standards.

In order to permit the use of one receiving antenna for all assigned channels in a particular area, all the transmitting antennas should be located at the same place. This is obviously much cheaper for listeners than expecting them to erect one antenna for each station to be received. In addition, many metropolitan areas do not provide more than one site that is really suitable for the location of television transmitters.

(CONTINUED ON PAGE 79)

*Chief Engineer, Measurements Corp., Boonton, N. J.

CIRCULAR ANTENNAS FOR FM BROADCASTING

Performance Data on Circular Antennas for 42 to 56 Mc., and Comparisons with Turnstile Types — Part 1

BY M. W. SCHELDORF *

SUMMARY

Power Gain Compared with Turnstile Antenna ★ The horizontal gain from arrays of circular and turnstile antennas are compared on a practical common basis. Difficulties with previously published comparisons are brought out. The results may be summarized in the following table:

GAIN COMPARISONS

	Turnstile		Circular	
Practical Array Length in λ	*Bays*	*Practical Gain*	*Bays*	*Practical Gain*
0.0	1	0.45	1	0.79
0.47	2	1.0		
0.94	3	1.51	2	1.70
1.41	4	2.04		
1.88	5	2.63		
2.35	6	3.12		
2.82	7	3.76	4	3.63
3.29	8	4.36		
4.23	10	5.52		
4.70	11	6.06	6	5.50
6.52	15	8.49	8	7.24

Calculated Field Intensity Contours at Normal Heights ★ Graphical relationships are presented, in order to simplify the determination of contour distances, for all combinations of standard transmitter sizes, standard antenna sizes and transmitting antenna heights. A correction curve for transmitter frequency is shown. Examples of representative calculations are given.

Economic Choice of Antenna and Tower ★ A basis for the economical choice of tower height and antenna size is presented. The net result is made available in simple terms, regardless of the choice of transmitter size.

Calculated Field Intensity Contours at Extended Heights ★ The antenna performance curves are extended to elevated regions up to 10,000 ft., such as are possible in mountainous locations.

ANY discussion of the relative performance of antennas, whether in terms of gain per bay or in terms of gain for a given overall height, requires a common basis for the comparison. It is the purpose of the first part of this article to establish such a basis.

Gain Compared with Turnstile Antenna ★ When an investigator establishes for the first time characteristic curves showing electrical performance, it is to be expected that these curves may be "idealistic" in nature. This is true for curves showing the gain that is achieved when a varying number of antenna bays are stacked in a vertical direction, as is common practice in FM broadcasting. These curves are calculated by the most simple direct method possible, so it is quite probable that the gain values secured in actual practice will deviate from these "ideal" values. The following discussion will serve to demonstrate the necessity for serious attention to these deviations.

In the first paper on the Circular Antenna,[1] a curve was published showing the gain for full wavelength spacings of the bays. This gain curve was calculated from the distribution of energy in solid space compared with the distribution in that same space from the standard vertical dipole. The horizontal distribution from the antenna is not circular and because the choice made no particular handicap, the horizontal gain was calculated on the basis of the average power radiated in the horizontal plane. The result is shown graphically in Fig. 1 at the right hand side. The gain from the circular antenna exceeds the curve first published by 0.8 db in the neutral plane and is less than that curve by 1.0 db in the plane perpendicular to the neutral plane.

Curves of gain for the turnstile antenna with a half wavelength spacing have appeared in several publications. However, none of these publications included a description of the method used to obtain the curves presented. Unfortunately, we have been unable to obtain a fair comparative gain curve in accordance with an accepted method that will agree with these curves.

The simple, direct method referred to is one discussed in detail, with examples, in Case 52201-6 *Notes on Antenna Arrays for High Frequency Broadcasting*, March 25, 1941, prepared by J. F. Morrison as a member of an FCC-sponsored industry committee having the following membership:

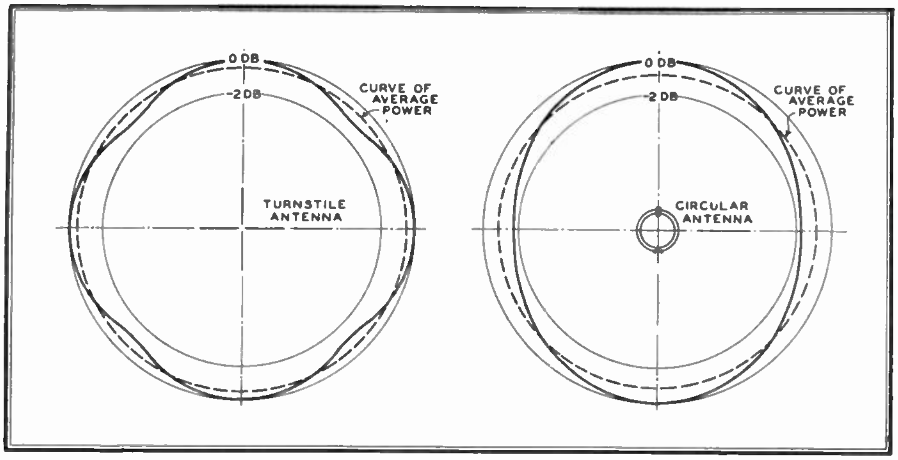


FIG. 1. HORIZONTAL RADIATION PATTERNS, PLOTTED TO THE SAME MAXIMUM REFERENCE LEVELS, FOR TURNSTILE AND CIRCULAR ANTENNAS

Chairman — Lynne C. Smeby — NAB
Members — R. O. Duncan — RCA
H. P. Thomas — GE
C. A. Priest — GE
W. B. Lodge — CBS
F. A. Gunther — Radio Engr. Labs
R. H. Harman — WEM Co.
A. Alford — IT & T Co.
Paul de Mars — Yankee Network
J. F. Morrison — Bell Telephone

This publication includes a graphical representation of the mutual resistance between half-wave dipole elements and describes the necessary steps for the calculation of turnstile gain by the use of the

* Transmitter Division, Electronics Department, General Electric Company, Schenectady, N. Y.

[1] "FM Circular Antenna" by M. W. Scheldorf, *G-E Review*, Vol. 46, page 153, March 1943.

mutual resistance relationships. The mathematical procedure is sound and the results therefore depend entirely upon the mutual resistance curve that is used. In this respect, the curve used agrees well with a similar curve published earlier.[2]

The method just described, using spacings of a half wavelength, will give a curve which, again, is idealized because there are no practical considerations. The curve of course is restricted to antenna arms a quarter wavelength long. However, a curve of mutual resistance for one-sixth wavelength arms, also shown in the paper by Brown,[2] shows that the relative amount of self resistance and mutual resistance is essentially the same, so that the gain curve for this length will be very much the same as for the normal length.

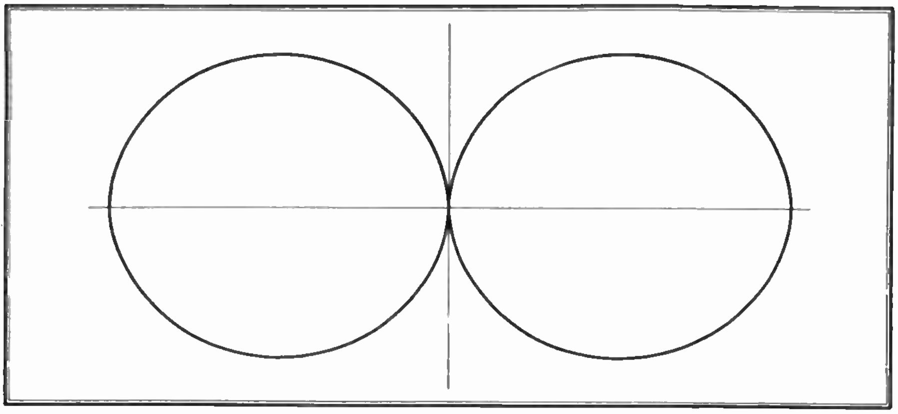


FIG. 2. ACTUAL DISTRIBUTION OF RADIATION FROM ONE HALF-WAVE DIPOLE

Before we can properly compare the gain curves we must establish a common basis with respect to the horizontal pattern and in addition apply a necessary, practical consideration of bay spacing.

When the gain is calculated in accordance with Case 52201-6 outlined above, the result applies to directions in the horizontal plane perpendicular to either one of the half-wave dipoles forming the turnstile. If the horizontal pattern of the turnstile were truly circular, this gain would then be appropriate for comparison, but at forty-five degrees with respect to these two directions, the horizontal pattern is reduced by a value of 1.0 db as shown by the left hand portion of Fig. 1. This is a result of the fact that the pattern of the individual dipoles is not two circles in contact, as has been shown at numerous times but more nearly two ellipses in contact as indicated by the diagram of Fig. 2. The net result is that a correction of −0.5 db must be applied to the idealized curve for the turnstile to make it comparable on this idealized basis with the circular curve originally published.

Next, for the practical spacing considerations: When two or more bays of a given antenna are interconnected with coaxial transmission lines of the rigid conductor type, it is necessary to use lengths of line which are reduced from exact multiples of a half wavelength long, due to the insulating material used to space the two parts of the concentric structure. This reduction amounts to 5.8% for standard ⅞-in. line. The result is that the most practical spacing for the turnstile antenna becomes 47.1% of a wavelength, and for the circular antenna becomes 94.2%. The effect on the gain is shown in a general way by the curves of Fig. 3, where we have chosen to compare the six-bay turnstile and the four-bay circular because these values give approximately the same idealized gain values. Note that the gain for the half-wavelength-spaced units is decreased, while the gain for the wavelength-spaced units is increased.

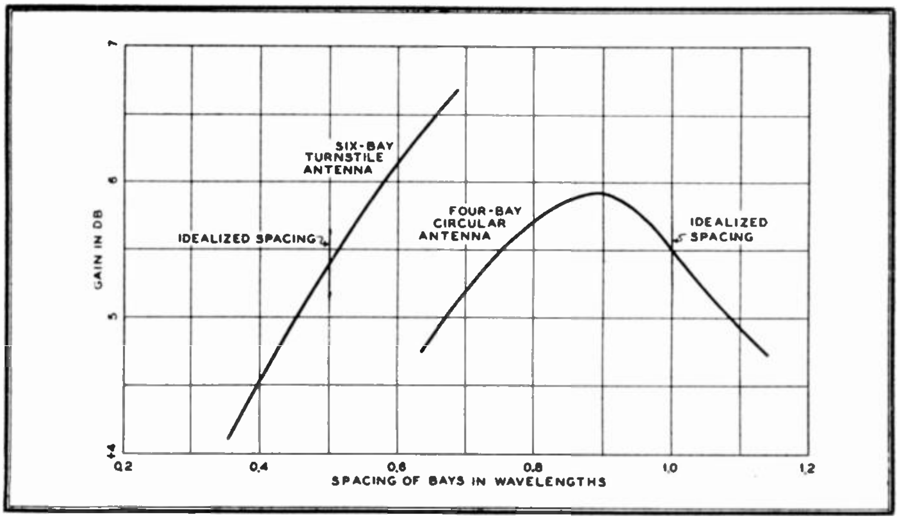


FIG. 3. COMPARISON OF GAIN WHEN SPACING BETWEEN ANTENNA BAYS IS VARIED

The practical results with the circular antenna are shown in Fig. 4, where A is the curve for the idealized full wavelength spacing and B is the curve for a spacing of .942 wavelength.

Similarly the curves of Fig. 5 show at A the gain for the idealized turnstile spacing of a half-wavelength and at B for the practical spacing of .471 wavelength, including the −0.5 db correction for the horizontal pattern.

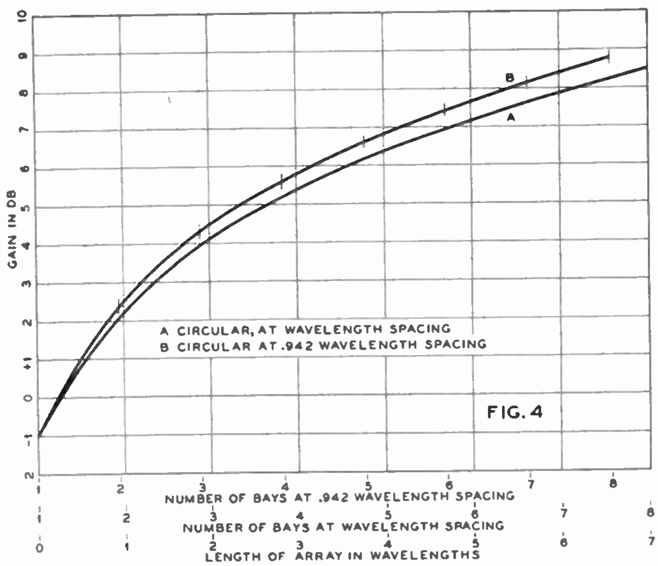
The corrected gain curves are next shown plotted together in Fig. 6. The circular antenna compares very favorably with the turnstile up to the maximum of bays considered practical for the turnstile, namely 10, both in gain per bay and gain for a given height.

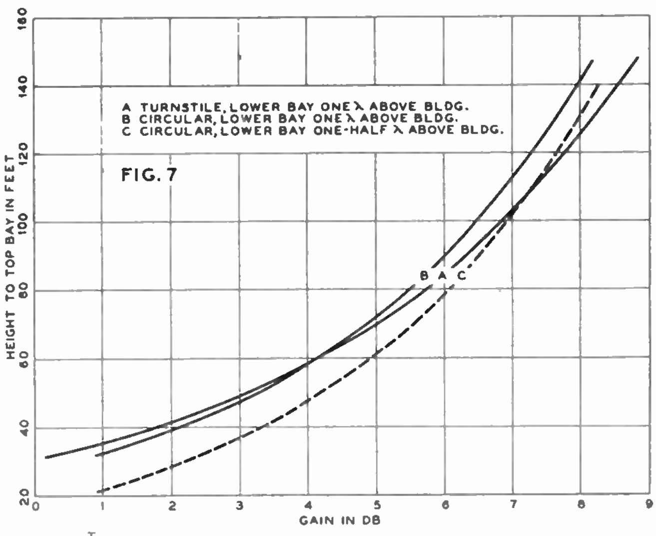
With regard to the latter, some additional studies are desirable, first where the antenna is mounted on a tall building, and second where the antenna is mounted on a tall tower.

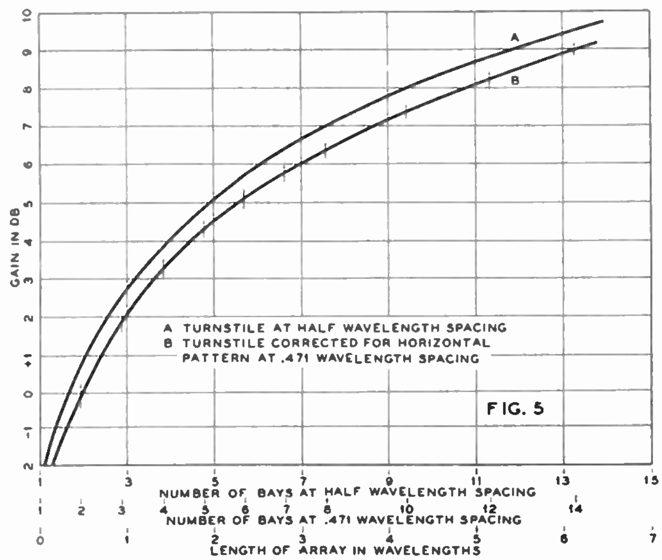
In the first case we can neglect, for simplicity, the change in received field intensity for small changes in average antenna structure height. That is, the field will vary directly as the antenna gain. The important point is: how high must the upper bay be above the top of the building for the same performance? Curves A and B in Fig. 7 show these requirements, based on the same height of the lower bay above the building, namely, one wavelength. But the circular antenna has considerably less radiation vertically than the turnstile, so the limiting height of the lower bay need not be the same as for the turnstile, for the same degree of impedance reaction or for the same degree of disturbance of the radiated field. Curve C shows the effect of placing the lower bay of the circular antenna at only one-half wavelength above the building.

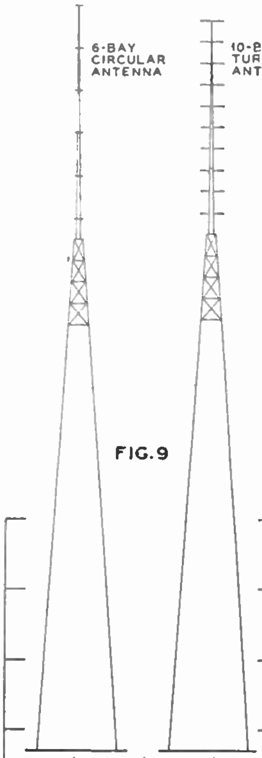
In the second case the importance of the height of the antenna structure proper is very much reduced because the important factor now is: what is the total height to the top bay? For this structure, the center of two antennas of the same gain must be the same height above the ground to give

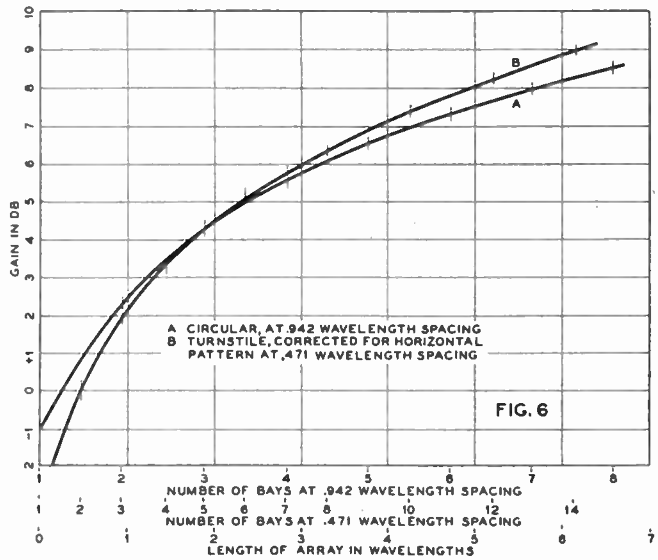
[2] "Directional Antennas" by G. H. Brown, *Proceedings of the IRE*, Vol. 25, page 78, January 1937.

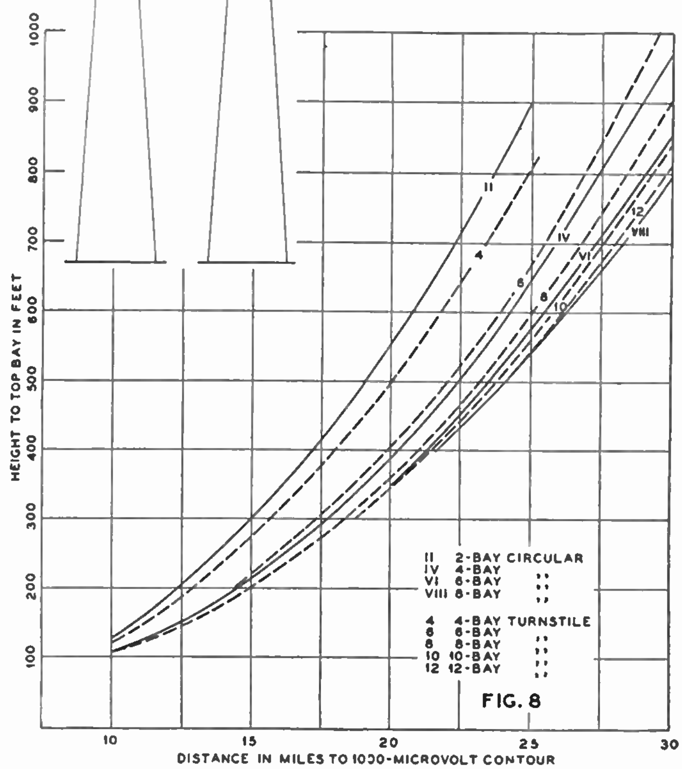




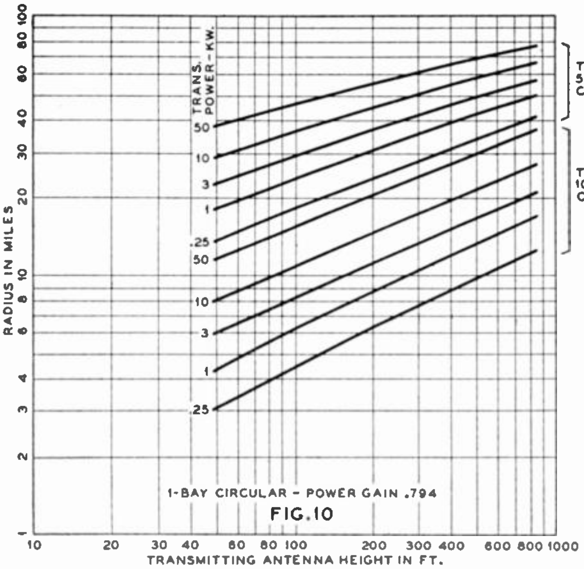


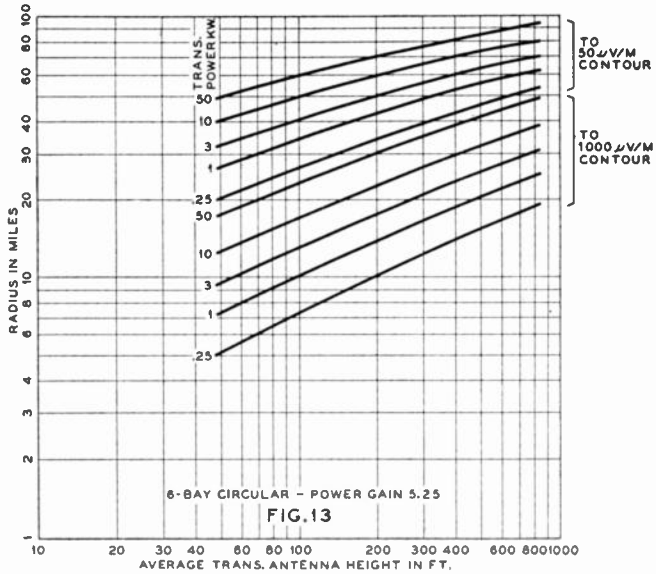


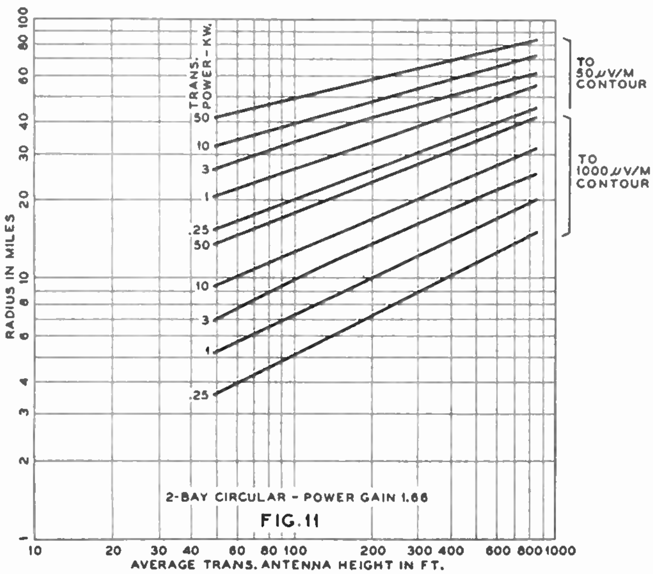


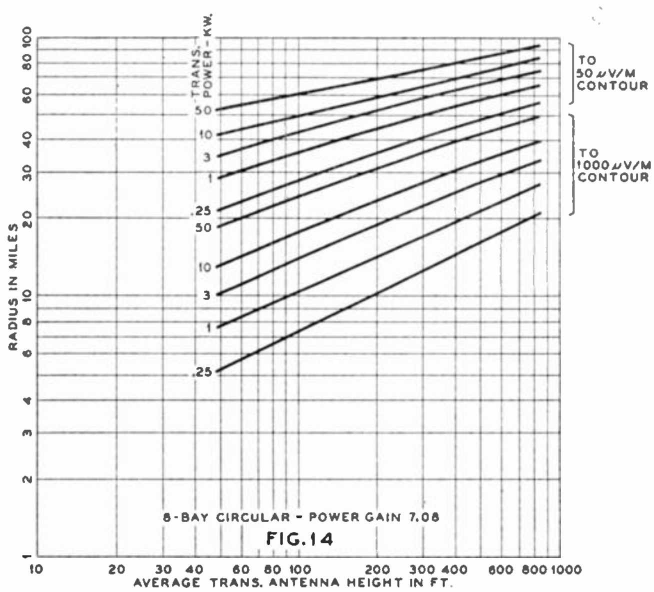


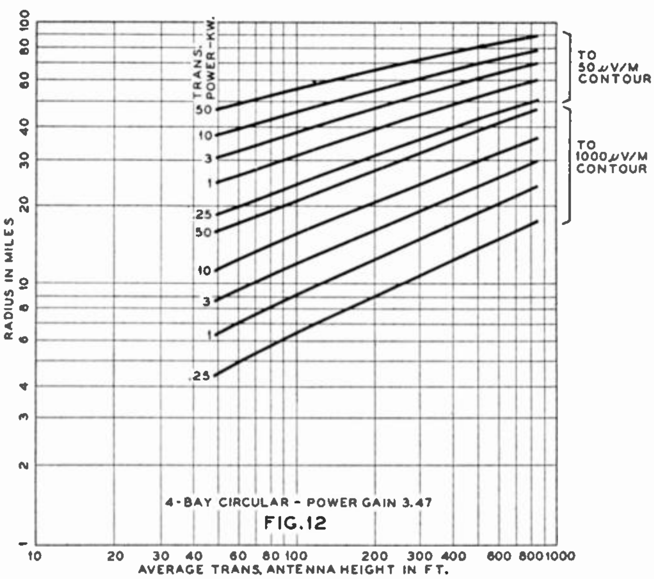
FIGS. 4 TO 9. COMPARATIVE DATA FOR TURNSTILE AND CIRCULAR ANTENNAS SUITABLE FOR FM BROADCASTING

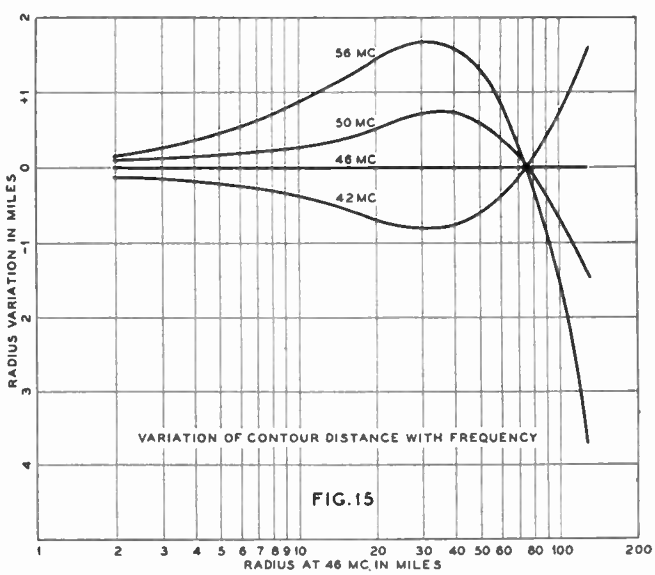












FIGS. 10 TO 14. CALCULATED PROPAGATION FOR CIRCULAR ANTENNAS OF 1 TO 8 BAYS. FIG. 15. CONTOUR DISTANCE CORRECTIONS

the same radiated field for a given power. The result is that any difference in height of the antenna proper appears in the final height by only half that difference. The tower for the highest antenna proper will be shorter than for the lowest antenna proper. Thus, for gain values above the value where the turnstile height is less than the circular height, namely, above +4.2 gain in db, the circular antenna will project higher into space, but the tower will be shorter. In this regard, it is interesting to note that the tower structure costs more per foot at the junction region than the pole, so this is not exactly undesirable. The height of the top bay on a comparative basis is shown in Fig. 8, giving the necessary values for different distances to the 1000 microvolt-per-meter contour for the same transmitter power. This information is not new in a strictly engineering sense, but it presents the information in a form that may be more readily appreciated in its true light, and is most useful to FM engineers.

Consideration must also be given to the number of bays required to do a given job and the general appearance of the structure that results. To do this fairly we have chosen the two arrangements which are the nearest in performance, the six-bay circular and the ten-bay turnstile. Fig. 9 shows an outline of the entire structure for an average height for the center of the antenna proper. It should be clear from these diagrams that a consideration of extreme height alone is not sufficient to establish a choice for a radiator system.

Calculated Field Intensity Contours at Normal Heights ★ In the preceding section, we discussed the relative gain of the turnstile antenna and the circular antenna. In this part we shall apply the information derived for the latter, to make available in the convenient form of curves showing the coverage to be expected from this antenna in different sizes. This information is necessary in order for a prospective FM broadcaster to supply the proper information for a license, as prescribed by the FCC. The FCC has provided most of this information in the form of a set of curves,[3] so that substantially the only unknown is the gain of the antenna system under consideration. However, with a given antenna it is possible to present the information in a much more appropriate manner so that the prospective user will become familiar with the important effects of antenna heights and transmitter power. Accordingly, curves are given for the several standard sizes of circular antennas which the General Electric Company has developed for manufacture after the war.

[3] "Standards of Good Engineering Practice Concerning High Frequency Broadcast Stations", available from the Federal Communications Commission, Washington, D. C.

For each antenna size we have extracted from the FCC curves,[3] the necessary data to plot two new sets of curves, Figs. 10 to 14, showing the radius of the field intensity contours versus average antenna height above the ground. One set of curves corresponds to the 50 microvolt-per-meter contour for suburban coverage and the other corresponds to the 1000 microvolt-per-meter contour for metropolitan coverage. One curve has been drawn for each of the standard transmitter sizes, and a transmission line efficiency of 90% has been assumed.

For any other transmitter power and for any considerable deviation from the assumed 10% power loss in the transmission line, it is possible to determine the contour position by simple interpolation. Normally, this interpolation is not very accurate when the curves are spaced in a logarithmic manner such as these. However, for the relatively low transmitter antenna heights under consideration, there is a practical relationship between the effective radiated power (ERP) and the antenna height which can be used to advantage over small ranges of distance. For a given distance, the product of ERP and the square of the antenna height is a constant. Therefore, for a variation from the specific values used on these curves of either transmitter power, transmission line efficiency, or even antenna power gain, it is possible to choose a modified value of antenna height to determine the correct contour distance. Thus the performance of an FM broadcast transmitter, under any given set of conditions, can be predetermined with considerable accuracy.

Examples ★ 1. Given a transmitter power of 5 kw. and a four-bay antenna connected with a line of 90% efficiency: What is the 50-microvolt-per-meter contour distance for average heights of 50, 100, 150 and 200 ft.? Refer to Fig. 12 and follow the 5-k.w. line in the upper group of curves to its intersection with the vertical antenna height lines of 50, 100, 150 and 200 ft. The contour distances are 32.4, 40.4, 45.5 and 49.6 miles respectively.

2. Suppose that a location on a building is chosen that will give 200 ft. average antenna height. And suppose that it is possible to locate the transmitter near the antenna with a transmission line only 50 ft. long, at the bottom of the building with a line 250 ft. long, or more conveniently in an adjacent building with a line 500 ft. long. Suppose also that the manufacturer of the line gives a value of loss for the line of 0.25 db per 100 ft. What is the change in contour distance that will result from these choices of transmitter location?

First it is necessary to convert the loss in db (values of 0.125, 0.625 and 1.25 db respectively) to percentage of transmitter power available at the antenna, using the familiar relationship:

$$\text{Change in Power in db} = 10 \log_{10}\left(\frac{\text{Power Out}}{\text{Power In}}\right)$$

The result is percentage power values of .972, .866 and .750 respectively. Converting these values of power ratio into new antenna heights we get 207.8, 196.2 and 182.5 ft. respectively. The distances, from Fig. 3, come out 50.0, 49.2 and 48.1 respectively.

It must be added that these curves apply to a transmitted frequency of 46 mc. and, because of the reference, assume average earth constants of a dielectric constant of 15 and a conductivity of 5×10^{-14} electromagnetic units and a receiving antenna height of 30 ft.

This at once brings up a question. What is the effect of operation at other than 46 mc.? This effect is shown in Fig. 15, where the necessary correction in contour distances is indicated when that distance has once been determined at 46 mc. The correction holds very properly up to 500 feet in transmitting antenna height and beyond this has some error, but it is of the second order in magnitude.

3. Suppose that in our considerations of antenna height, it is also found necessary to consider a frequency assignment of 43.1 mc. From Fig. 15 we find that all the corrections are negative, −0.6 for 32.4 miles, −0.5 for 40.4 miles and −0.45 for 49.6 miles or that the net mileages for 43.1 mc. are 31.8, 39.9 and 49.15 respectively. These corrections are not of much significance alone, but it is desirable for the user to know about the general trends, at least.

4. Another point to consider is the matter of horizontal antenna pattern. The contour values are based on the mean horizontal field strength, so that in certain directions the distance will be greater than the curves indicate and in other directions it will be less. The variation is indicated in the right hand curve of Fig. 1, which represents the calculated form. This curve should be used to orient the antenna so as to take advantage of the direction of strongest radiation.

The propagation curves are by no means limited to the circular antenna. On each curve the power gain of the antenna under consideration is indicated. The product of this factor and the power into the antenna gives what is commonly known as effective radiated power or ERP. To use these curves for any other antenna, therefore, it is only necessary to know the power gain of the antenna and contour distances can be determined by interpolation.

The conclusion of this paper will appear in the June issue.

MEMORANDUM ON SPORADIC E INTERFERENCE

Facts Concerning the Extent and Duration of Sporadic E Interference Under Various Conditions, on Which Agreement Has Been Reached with the Engineering Department of the FCC

BY MAJOR EDWIN H. ARMSTRONG *

EDITOR'S NOTE: *Major Armstrong also submitted a memorandum on F2 interference and another on Tropospheric transmission, presumably giving further information on the errors found in Kenneth Norton's testimony, on the basis of which the FCC had proposed to shift FM broadcasting to a higher part of the spectrum. These memoranda, however, deal with discussions at the secret hearing, and have not been released by the FCC for publication.*

THIS memorandum (dated April 25, 1945) is prepared at the request of Commissioner Denny in order to put in more concrete form an agreement reached with the Engineering Department as to the facts concerning the extent of, and duration of, Sporadic E interference under various conditions.

On the occasion of a discussion which I had with the Engineering Department, it was agreed that the figures which I gave in interpreting the Commission's data on the amount of Sporadic E interference, both in my testimony and in the brief, were correct and no exception would be taken to them. No agreement was reached as to the conclusions to be drawn from these figures.

Four conditions of interference based on these figures which have been agreed to will be considered:

1. Interference between two Paxton type transmitters on 44 megacycles.
2. Interference between two Paxton type transmitters at 60 megacycles.
3. Interference between twenty Paxton type transmitters at 60 megacycles, or full channel occupancy.
4. Interference between two local type stations, each capable of covering 40 to 50 miles.

The basis of the analysis of the two Paxton type transmitters will be taken from page 19 of my brief, which quotes a statement made by Mr. Allen during the discussion of his paper (Exhibit 593). Referring to the extent of the interference due to Sporadic E transmission between two Paxton type transmitters located at optimum distances of 500 to 1,000 miles apart, Mr. Allen said:

"How severe is that? Well, of course Sporadic 'E' on a station the size of Paxton, where you started out with 18,000 square miles in the primary area, for one-tenth of 1% of the time you would reduce that area to 9,200 square miles, or almost one-half, if you had a receiver which was capable of rejecting a co-channel station which was half as strong as the desired signal, that is, the Sporadic 'E' interference expected for one co-channel station at a distance, an optimum distance, of 500 to 1,000 miles for one-tenth of 1% of the time" (p. 4697).

Losing one-half the area corresponds to a loss of approximately three-tenths of the range. On the basis of this statement then, seven-tenths of the range would be served perfectly for 99.9% of the time. A man living at the seven-tenths range point would, if he listened eighteen hours a day for one year to the single station in question, receive approximately 6½ hours of interference during the year.

However, if the frequency of the two Paxton type transmitters were changed to 60 megacycles, this interference would be reduced to one-tenth of this value, or approximately 40 minutes for a man who listened 6,570 hours a year. Since this is obviously the practical place to operate stations of the Paxton type, interference conditions will be considered here in more detail.

At a point midway between the seven-tenths range point and the 50-microvolt contour point — or at 85% of the range — approximately four times this amount of interference, or 160 minutes, would be experienced, provided the listener stayed tuned to the station in question for the whole year (18-hour day).

I do not want to be understood as saying that anything in the radio art can be predicted or calculated to an accuracy of minutes such as this. I do, however, say these figures follow inexorably from the measurements which have been made at the four monitoring stations over a period of a year by the Commission's staff and from Fig. 3 of Exhibit 380, which is derived from the data of the Washington Bureau of Standards. These figures do, however, give a general idea of the nature of the effect of Sporadic E.

The figures quoted above represent the interference which may be expected between *two* stations of the Paxton type. For full channel occupancy Mr. Allen has taken a figure of twenty stations and estimates on the basis of probability that the interference time from one station might be increased five-fold (page 19 of my brief). Under such conditions this would increase the interference time at the seven-tenths range point to 200 minutes, and at the 85% range point to 800 minutes. These figures are, of course, also for *the whole year* and an *18-hour* listening day.

It is now in order to see just what this assumption of twenty Paxtons might mean in a practical way. On the basis of a 100-channel assignment to FM, and assuming that 50 of them be allotted to high power stations, full channel occupancy of twenty high power stations to a channel would be arrived at when there were 1,000 Paxton type stations in the United States!

It is needless to add that such a situation could not possibly be brought about within five years, if in fact such a number of stations could be built within that time. If the figures of interference mentioned should ever become of any practical importance as stations are added to a channel (which I do not believe they will), then there will be ample time to meet the situation by automatic boosters. The trend in broadcasting development will be to put these in in any event, so that the whole question will probably be moot long before anything like full channel occupancy is approached.

While the duration of the expected interference has been given in terms of minutes, the percentage value of perfect service rendered gives perhaps a better picture of the factors with which we are dealing. Seven-tenths of the range will be served with full channel occupancy 99.95% of the time perfectly. 85% of the range will be served 99.80% of the time perfectly. For interference between two stations alone, the corresponding percentages of perfect service will be 99.99 and 99.96 percent of the time, respectively.

On page 20 of my brief [1] it is established that interference between two stations capable of covering 55 miles does not occur. The case considered was for operation on 44 megacycles. During the closed hearing it was likewise established that interference between stations having lesser

(CONTINUED ON PAGE 80)

* Department of Electrical Engineering, Columbia University, New York City.

[1] The complete text of Major Armstrong's brief was published in *FM* AND TELEVISION, March, 1945 — *Editor's Note.*

SPOT NEWS NOTES

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

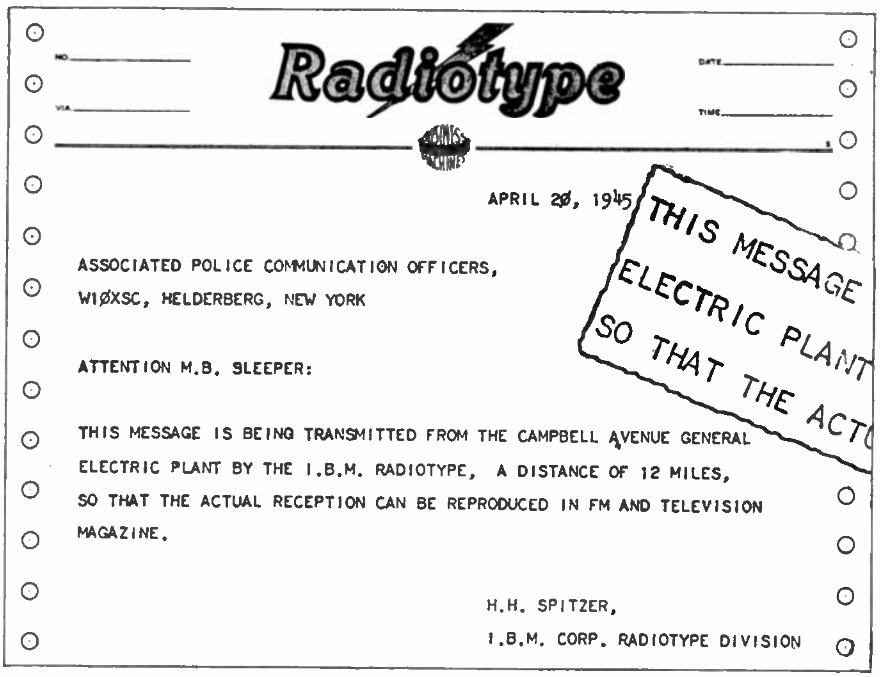
Charles R. Denny, Jr.: Former General Counsel of the FCC was confirmed as Commissioner on March 25th. The youngest man ever nominated to this highly responsible position, Commissioner Denny has a brilliant record in Government service.

Born in Baltimore April 11, 1912, he attended public school in Washington, D. C., was graduated from Amherst in 1933 and from Harvard Law School in 1936. Following two years' association with a Washington law firm, he served in the Lands Division of the Department of Justice first as attorney, then assistant chief, then as chief of the Appellate Section.

As General Counsel of the FCC since October, 1942, he supervised the work of some 60 lawyers in the Law Department. During the Allocations Hearing and the subsequent Oral Argument, the industry saw him in action during his admirable handling of more than 200 witnesses, when he displayed an amazing grasp of the complex problems and the many aspects of frequency assignments. A Democratic member of the FCC, Commissioner Denny's term will expire June 30, 1951.

UERMWA-CIO Contract: The first all-inclusive Uniform Time Study Contract, governing time-study procedures for setting incentive rates, has been signed by representatives of Local 430, UERMWA-CIO and Hammarlund Manufacturing Co., Inc. Labor and management organizations can obtain copies of this contract from the local office at 139 Fifth Avenue, New York City.

30% Price Increase: According to Mort N. Lansing, analyst of the Specialties Unit, Bureau of Foreign and Domestic Commerce, postwar increases in labor and materials costs will up prices of home radio sets 30% over 1941 levels. Of postwar sales: "It is believed that, at least on a short-time basis, FM will be much more important on account of its more general utility and the fact that sound broadcasting techniques have been developed already. As television broadcast techniques are perfected, television sales will become increasingly lower."



Radiotype

NO. ______ VIA ______ DATE ______ TIME ______

APRIL 20, 1945

ASSOCIATED POLICE COMMUNICATION OFFICERS,
W1ØXSC, HELDERBERG, NEW YORK

ATTENTION M.B. SLEEPER:

THIS MESSAGE IS BEING TRANSMITTED FROM THE CAMPBELL AVENUE GENERAL ELECTRIC PLANT BY THE I.B.M. RADIOTYPE, A DISTANCE OF 12 MILES, SO THAT THE ACTUAL RECEPTION CAN BE REPRODUCED IN FM AND TELEVISION MAGAZINE.

H.H. SPITZER,
I.B.M. CORP. RADIOTYPE DIVISION

THIS MESSAGE
ELECTRIC PLANT
SO THAT THE ACT

Consolidation: Jefferson-Travis Radio Mfg. Corporation has filed a certificate of consolidation under which it has merged with the Fonda Corporation, assuming the liabilities and assets of the latter. The two concerns will now be operated under the name of Jefferson-Travis Corporation, 245 East 23rd Street, New York City.

Will Whitmore: Advertising supervisor of Western Electric Company, and widely known to communications and broadcast engineers through the pages of *Pick-Ups* which he originated and edited, has been named advertising manager, to succeed the late H. W. Forster.

A native of the Lone Star State, he attended the University of Texas as a student of electrical engineering, then transferred to the School of Journalism at Northwestern University where he was graduated in 1926. In 1929, he joined the Western Electric organization. Will Whitmore's ardent interest in photography and motion pictures is reflected in the handsome illustrations which characterize Western Electric technical literature and advertising.

Radiotype Demonstration: The message reproduced on this page was transmitted and received by I.B.M. Radiotype machines. A modified I.B.M. electric typewriter is used in this system to type the message and, at the same time, to perforate a tape. The tape is then used to transmit audio frequency impulses. Another electric typewriter, connected to the output of a radio receiver, is actuated directly by the im-

(CONTINUED ON PAGE 65)

NEWS PICTURE

ON April 20th, when General Electric was host to the New York State Chapter of the Associated Police Communications Officers, members were given a demonstration of G.E. 161-mc. 2-way FM equipment. In addition, at the Helderbergs television station, they watched the operation of International Business Machines' Radiotype, receiving messages on 35.46 mc. from Schenectady. The Radiotype, a tone-operated electric typewriter working at 150 words per minute, is suitable for use over any police radiophone system. In this picture, Milton Sleeper, editor of *FM* AND TELEVISION, is looking at the message reproduced on the opposite page. At his right is I.B.M. engineer A. C. Holt. Radiotype printers will be used on the Schenectady-Washington relay G.E. and I.B.M. are preparing to install.

100- TO 165-MC. MOBILE UNITS

New Models Designed for Post-war Police and Railroad Service Reflect New Trends

BY G. A. LEAP*

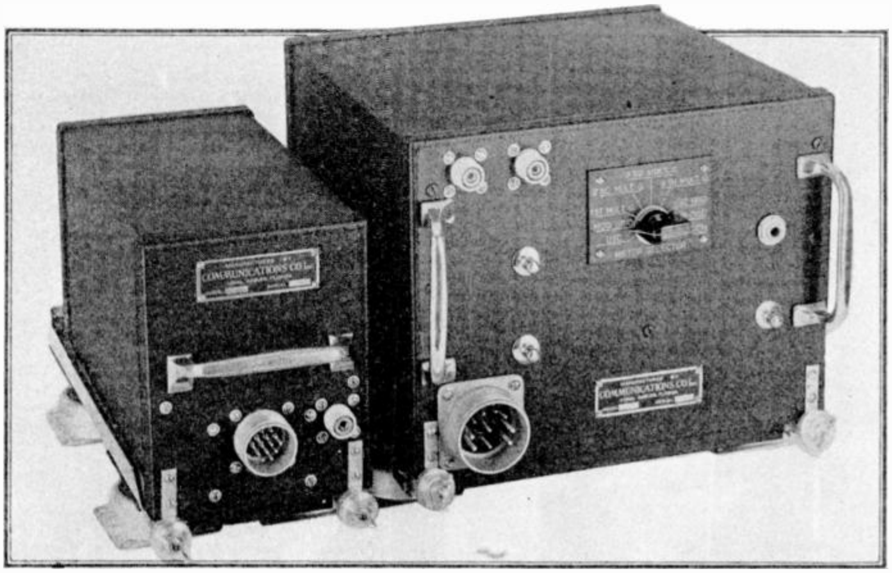


FIG. 1. FM RECEIVER, LEFT, AND TRANSMITTER FOR 15, 25, OR 50W. OUTPUT

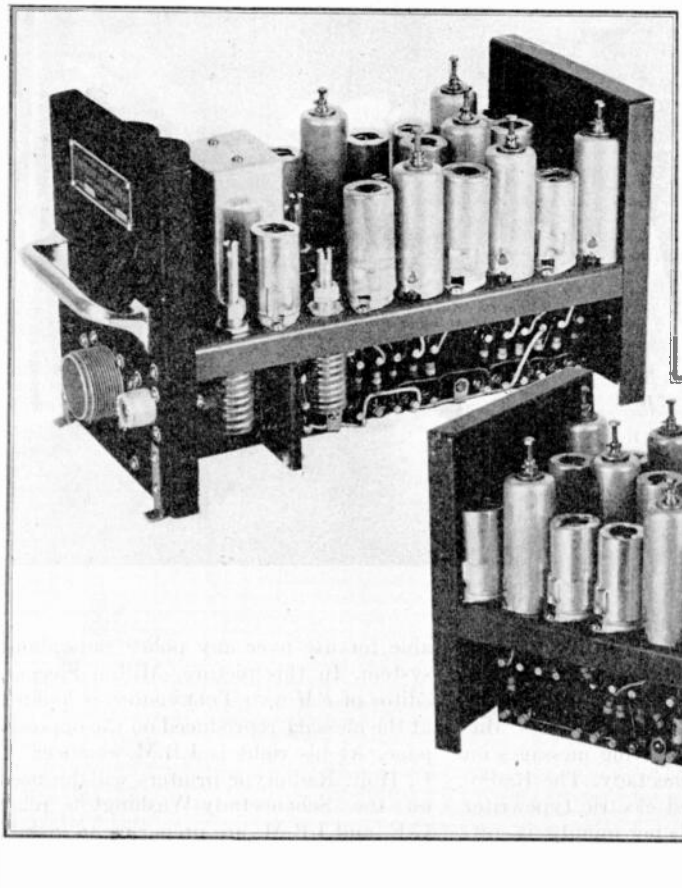
OUR approach to the design of the mobile communications equipment shown in the accompanying illustrations is through our experience with aircraft radio apparatus. This has certain advantages. First and foremost, we have had a long but eventually successful battle against vibration, arch enemy of all aircraft instruments. I think those who have shared our experience will agree that any mobile service on cars or locomotives is easy going for equipment that stands up in commercial and military flying.

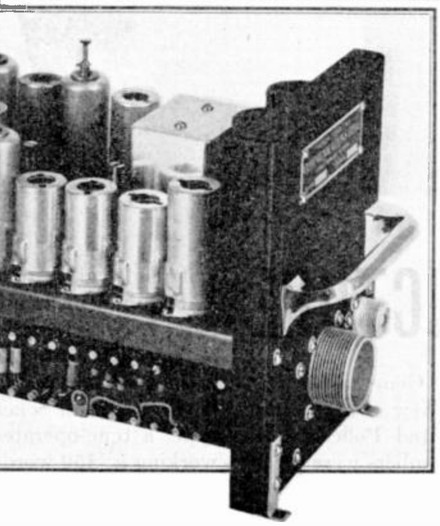
Also, we have employed many tricks which are old to us but new to mobile apparatus design, all drawn from what we have learned in maintaining output and frequency constant under far more severe conditions of temperature, humidity, and mechanical shock and strain than are encountered on the ground. These refinements are built into the FM models illustrated here.

The receiver, shown at the left in Fig. 1 and in Figs. 2 and 3, is intended for operation at any frequency from 100 to 165 mc. In addition, by a simple circuit change, it can be made to operate on 30

*Chief Development Engineers, Communications Company, Inc., Coral Gables 34, Fla.

FIG. 2. BELOW: SIDE VIEWS OF THE 100- TO 165-MC. RECEIVER, SHOWING COMPACT DESIGN MADE POSSIBLE BY THE USE OF MINIATURE TUBES





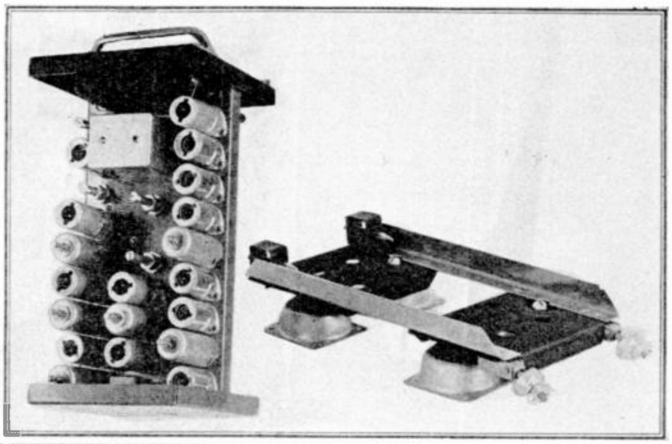


FIG. 3. ABOVE: THE RECEIVER CAN BE DETACHED FROM THIS AIRCRAFT TYPE OF MOUNTING IN A FEW SECONDS, MERELY BY TURNING THE SMALL THUMB NUTS AT THE FRONT

to 40 mc. Thus, it has the advantage that it can be used now in any system operating in the lower band, and changed later if the system is shifted to one of the new frequencies.

On the upper band, the circuit employs dual conversion with a single crystal and triple detection, or single conversion on the lower band. One RF stage and four IF stages at the second IF frequency are used. All 13 tubes are standard A-N miniature types, making it possible to provide accessibility to every part, and yet keep down the size of the case to 5 by 6 ins., with a depth of 10 ins.

As Fig. 1 shows, both the receiver and transmitter are carried on ATR mounts which are now standard for all aircraft equipment. The shock-absorbing effect of these mounts cuts down to a large extent the wear and tear on equipment fastened directly to floor boards of the rear baggage compartment of an automobile, while in railroad service this type of mounting is absolutely essential.

The FM transmitter, shown at the right in Fig. 1 and in Fig. 4, uses crystal-controlled phase-shift modulation. It can be supplied for any one of three output ratings. With an 832-A tube in the final stage, the output is 15 watts, while with an 829-B the output is 25 watts or 50 watts, depending upon the plate supply. Of the 10 tubes used in the transmitter, all but the last two are receiver types.

Accessibility has been stressed in the design of this unit, with the result that any part can be removed quickly and easily without disturbing other components. This is in accordance with the requirements of aircraft radio practice, and is of equal importance to mobile equipment.

When these units are used for police, truck, or taxi service, a vibrator furnishes plate voltage for the receiver, and a 6-volt dynamotor supplies the transmitter. For railroad use and fixed services, power supplies are available for operation from 32, 64, or 110 volts DC, or 110 volts AC. A dynamotor, controlled by a push-to-talk switch, furnishes plate voltage to the transmitter, with a converter to supply volts AC to the receiver power unit.

It is interesting to note that the antenna for 146-mc. operation is only 185 ins. long. Thus it can be mounted on a locomotive or caboose at a position where most efficient operation can be obtained without interfering with bridges, tunnels, signal towers, or other objects along the right of way.

The models shown here are the first of a series of FM units which will cover the requirements of all new communications frequencies made available under FCC allocations above 30 mc.

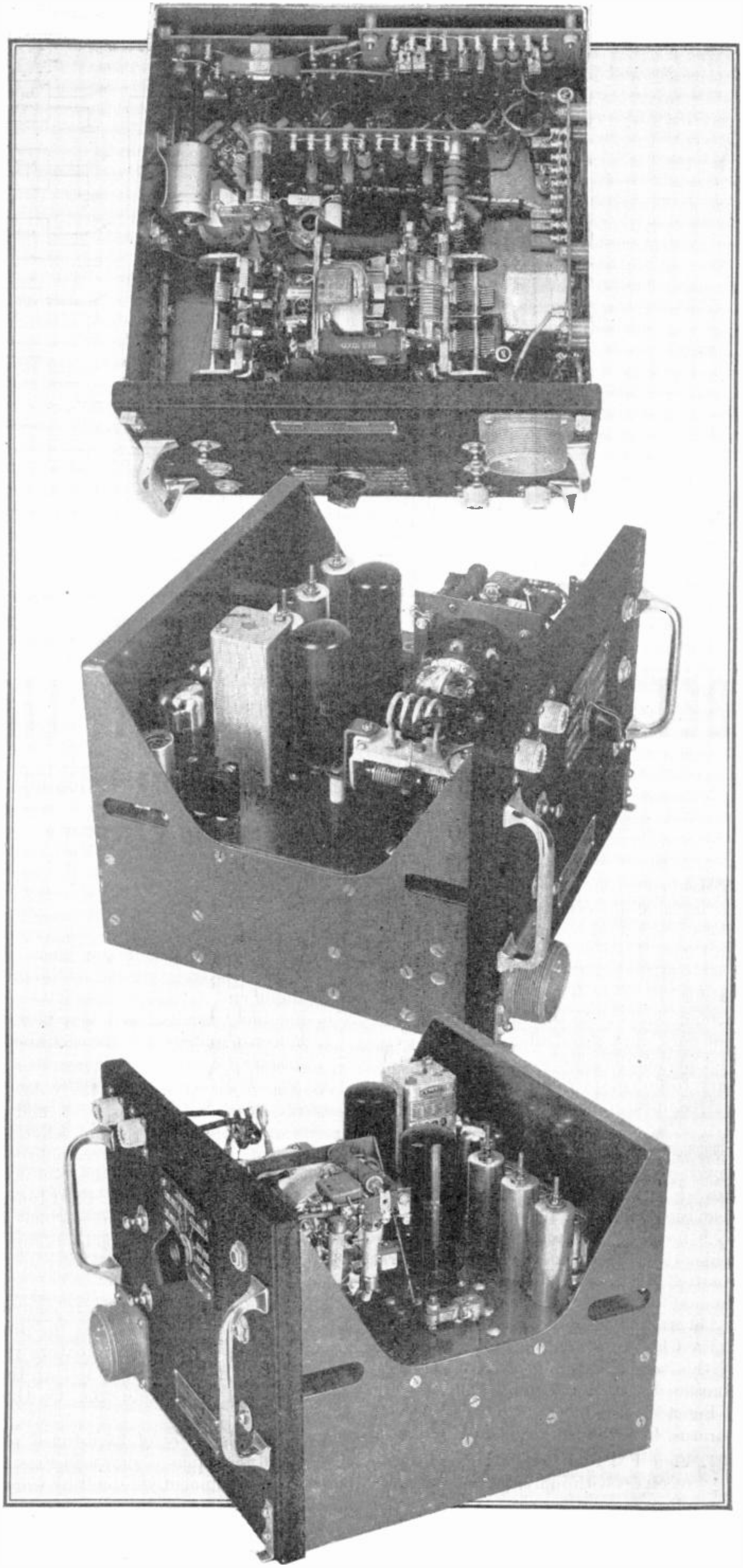


FIG. 4. THREE VIEWS OF THE FM TRANSMITTER. THERE IS NO CROWDING OF PARTS IN THIS COMPACT DESIGN

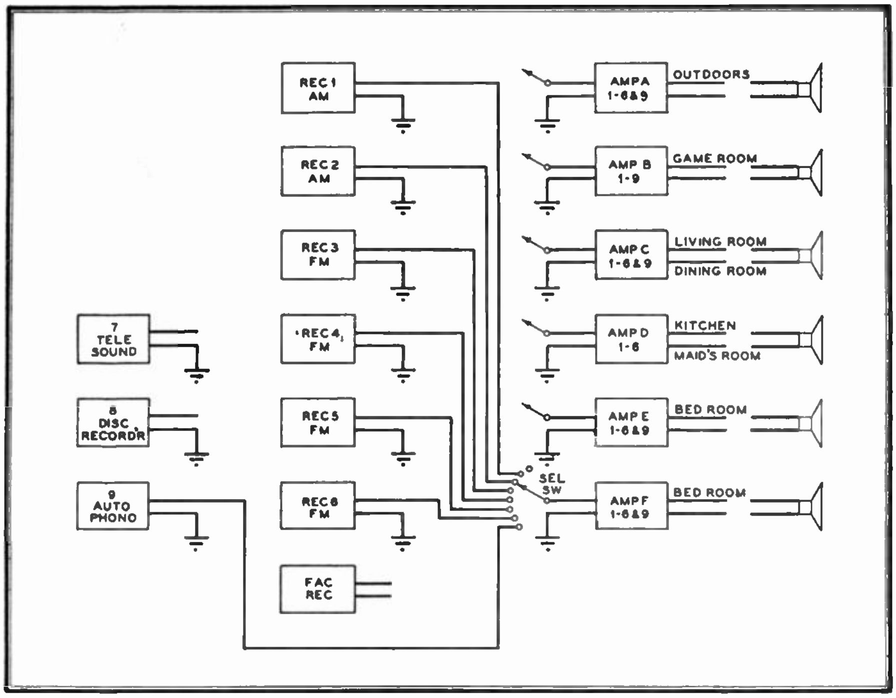


FIG. 4. IN THIS DIAGRAM, EACH AMPLIFIER BLOCK IS MARKED WITH NUMBERS CORRESPONDING WITH THE UNITS TO WHICH IT CAN BE CONNECTED

BETTER WAYS TO MEET LISTENERS' NEEDS

Part 2 — How to Plan a Class 1 Residence Installation

BY MILTON B. SLEEPER

THE first lesson learned from experience in handling expensive radio installations is the need of making sure that the customer knows what he wants, and understands exactly what his sytem will do for him when it is finished. Failure to attend carefully to this initial detail may not only cause dissatisfaction with a perfect installation, but may make it necessary to do considerable extra work without compensation before the bill is paid.

Equipment Required ★ It will be possible to build residence installations that will provide as many of the postwar radio, television, facsimile, and sound services as each member of a household wants, and make them available wherever they are wanted. The only limiting factor is the amount the owner is willing to spend.

Let us analyze the equipment included in the Class 1 installation shown in Part 1 of this series. Later, in Part 3, we can consider the circuit details involved.

Fig. 4 shows a block diagram of the apparatus. It is divided as follows:

1. Four FM and two AM fixed-tuned receivers with individual power supplies.
2. Automatic phonograph and pre-amplifier.
3. Wire recorder.
4. Disc recorder and pre-amplifier.
5. Television receiver and audio-pre-amplifier.
6. Facsimile receiver and amplifier.
7. Power amplifiers, one for each loudspeaker.

As Fig. 4 shows, each of the 6 loudspeakers illustrated in Figs. 1, 2, and 3 has its own amplifier. Program selection at each control is, therefore, accomplished by connecting the corresponding speaker and amplifier to one of the fixed-tuned receivers or to the pre-amplifier of one of the sound units. This selection is obtained by stepping switches, actuated by telephone-type dials.

There are a number of ways to control the volume at each speaker, but the preferred method is to use a miniature reversing motor at the amplifier to turn the rheostat and to actuate the ON-OFF switch.

A typical assembly of fixed-tuned receivers and amplifiers is shown in Figs. 5 and 6. This equipment was built by Communications Company, Inc., Coral Gables, Florida. The FM and AM units in the rack illustrated in Fig. 5 are interchangeable in size, so that any number of each can be employed. Space is provided above the receivers for the stepping relays.

Three controls on each receiver permit adjustment of sensitivity, squelch, and output. With the latter control, the same signal level can be obtained from each receiver, regardless of the initial signal strength. A phone jack at the front is provided so that the performance of each receiver can be checked.

The second rack, Fig. 6, carries the amplifiers and volume controls. Each amplifier has an individual gain control, so as to limit the output in accordance with the requirements of its corresponding speaker. This prevents blasting if the remote-controlled volume control is turned to maximum.

Also located in the amplifier rack is a selenium rectifier which supplies DC to the stepping relays, and the volume control motors.

Here, then, is the overall picture of what is required in a system of this sort. Details of the circuits and components, and suggestions as to arrangements suitable for meeting special conditions will be presented in Part 3. But first we must consider the problems of planning to meet the individual owner's requirements. Until those are known, circuit details cannot be worked out.

Planning an Installation ★ In a Class 1 installation, where the system is not strictly limited as to cost, the owner can have whatever he wants, but it is first necessary for him to decide *what* he wants. The first thing, then, is to list the rooms which are to be equipped, and to list the services to be provided in each room. In the typical case illustrated in Part 1, these are:

LIVING ROOM
- Services from Speaker:
  - 4 FM channels, 2 AM channels
  - Automatic phonograph
- Special Equipment:
  - Loudspeaker
  - Wire recorder at piano
  - Automatic phonograph
  - Record cabinet
  - Facsimile recorder
  - 2 Control boxes

DINING ROOM
- Served by speaker located between living room and dining room
- Special Equipment:
  - 1 Control box

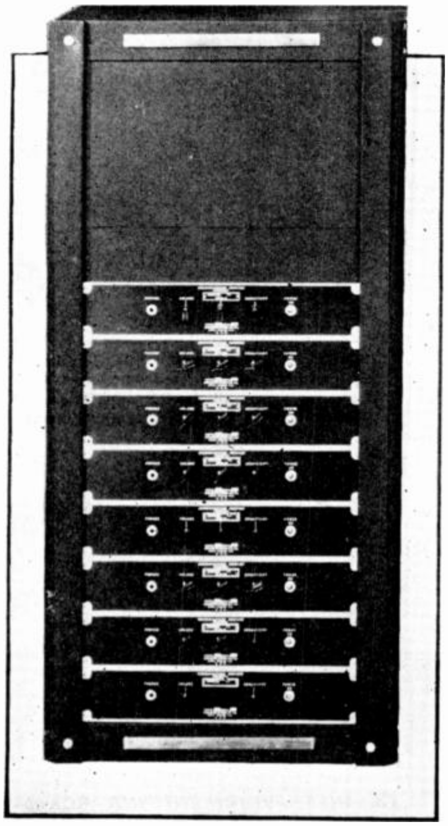


FIG. 5. THIS RACK CARRIES THE PRE-TUNED FM AND AM RECEIVERS

THE THREE INSTALLATIONS

AS explained in Part 1 of this series, three types of radio installations, adaptable to the requirements of individual owners and their homes, will be described in detail. These types will be:

Class 1 — An installation which includes all radio services, planned to meet the most modern thinking of architects, decorators, and radio engineers, without limitation as to cost.

Class 2 — An installation providing all radio services, but scaled down as to cost.

Class 3 — An installation comprising high-quality radio, phonograph, and facsimile to cost under $400, with provisions for adding television reception.

Part 3 will present the circuit and installation data on the Class 1 equipment, and will explain the use of stepping relays for program selection.

KITCHEN-MAID'S ROOM
- Services from Speaker:
  - 4 FM channels, 2 AM channels
- Special Equipment:
  - Loudspeaker between the rooms
  - 1 Control box, shared by both rooms

GUEST ROOM
- Services from Speaker:
  - 4 FM channels, 2 AM channels
  - Automatic phonograph
- Special Equipment:
  - Loudspeaker
  - 2 Control boxes

MASTER BEDROOM
- Services from Speaker:
  - 4 FM channels, 2 AM channels
  - Automatic phonograph
- Special Equipment:
  - Loudspeaker
  - 2 Control boxes

GAME ROOM
- Services from Speaker:
  - 4 FM channels, 2 AM channels
  - Automatic phonograph
  - Television sound
  - Disc recorder sound
- Special Equipment:
  - Loudspeaker
  - Television projector
  - Disc recorder and playback
  - 2 Control boxes

OUTDOORS
- Services from Speaker:
  - 4 FM channels, 2 AM channels
  - Automatic phonograph
- Special Equipment:
  - Loudspeaker
  - 1 Control box

All the units required for such a system are included in the block diagram, Fig. 4.

The only piece of equipment not listed above is a separate facsimile receiver, for which provision is made in case this service is not duplexed on FM broadcasting.

Writing Specifications ★ When the plan of the system has been laid out in such a list as above, and the owner has an exact understanding of what he wants and the services which will be performed by the installation, a set of specifications must be drawn up and presented for the owner's approval and signature. These specifications must set forth:

1. Services to be furnished in each room:
   Number of FM and AM stations selected, phonograph, television, facsimile, etc.
2. Type and mounting of each loudspeaker:
   This should include reference to use of permanent magnet or electro-dynamic speakers, and power connections if speakers are to have built-in field-supply units.
3. Design of control boxes and functions of controls and number of boxes and outlets in each room:
   Description of case for each control box, and what each box will control.

(CONTINUED ON PAGE 82)

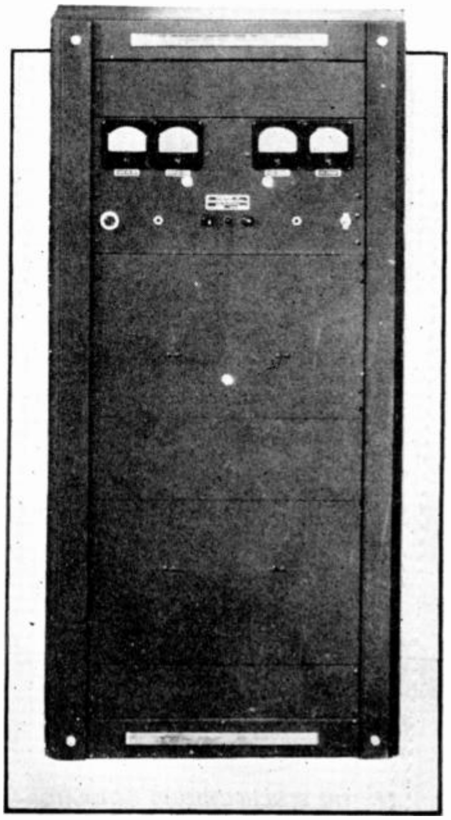


FIG. 6. AMPLIFIERS FOR THE INDIVIDUAL SPEAKERS ARE ON THIS RACK

Electronic Television is

This is a story of leadership—as clean-cut, unassailable and complete as any industry can show.

It's the story of RCA's development, in all of its basic essentials, of the electronic television system in use today. For RCA engineers contributed ALL of the essential elements of this system—including *tubes and circuits.*

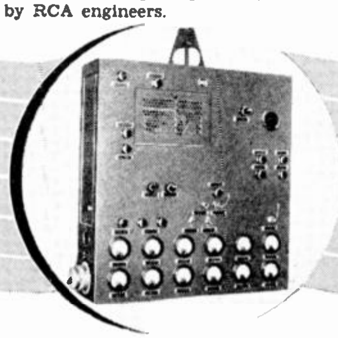
RCA factories built the first transmitters and the first receivers of the type now almost universally used. The Radio Corporation of America through its broadcasting service—the National Broadcasting Company—installed the *first commercial television station*—a station whose operating and programming technique has set a standard of performance in the television broadcasting field.

ELEMENTS OF THE TELEVISION SYSTEM

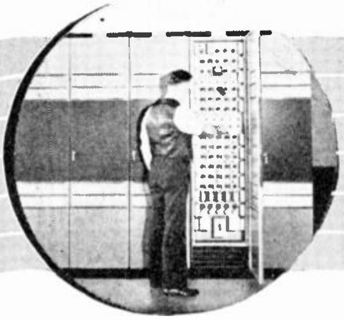
1. THE ICONOSCOPE—The "electric eye" of the television camera. Developed by Dr. V. K. Zworykin, RCA scientist, and brought to a high degree of perfection by RCA engineers.

5. THE FIELD CAMERA — The RCA field pickup camera shown here is the first camera to use the "orthicon" pickup tube—by far the most satisfactory for "outside" pickups.

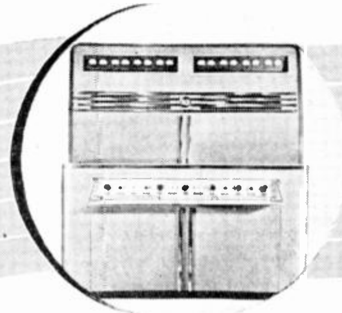
6. REMOTE PICKUP EQUIPMENT — RCA engineers built the first television equipment for field pickups—and the first such equipment (shown here) for use with the "orthicon" camera.



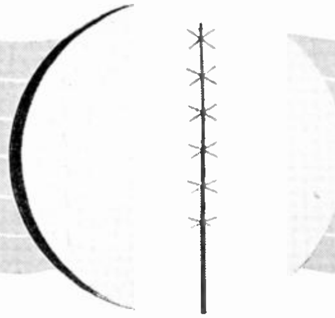
7. THE RELAY TRANSMITTER — The first transmitters to be used for television relaying were built by RCA engineers—the one shown here is for relaying from a remote pickup point.



11. THE SYNCHRONIZING GENERATOR—Furnishes the signals that key transmitter and receiver together. This type of synchronizing, now almost universally used, was developed by RCA.



12. THE VIDEO TRANSMITTER — The first commercially produced video transmitter, the 4 KW model shown here, was designed and manufactured before the war by RCA.



13. THE TELEVISION ANTENNA—RCA engineers have designed a large number of antennas for television. The turnstile antenna, shown here, was developed by Dr. G. H. Brown of RCA Laboratories.

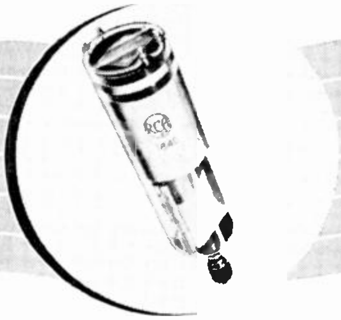
an RCA Development

RCA and NBC engineers, working together, established the *first television relay system*, put on the first outdoor program, the first "theatre" television, the first Broadway play, the first baseball game, the first television from an airplane.

Consider, for instance, the elements of the television system as presented on these pages. Note that RCA engineers played a big part in developing *every one of them*. Add to this the fact that these same engineers have been working *100% of their time* on radio, radar and other electronic equipment of the *most advanced types* for the Army and Navy, and you can well understand the basis for RCA television leadership.

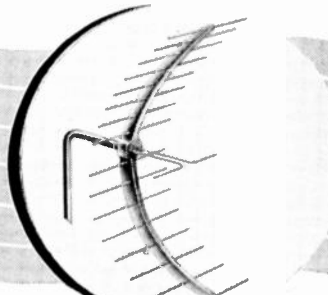
You can expect the best of all kinds of television transmitting and receiving equipment from RCA—the leader from start to finish.

2. THE KINESCOPE — The reproducing tube used in all present-day receivers. Developed by Dr. V. K. Zworykin of RCA Laboratories as part of his "all-electronic" television system.

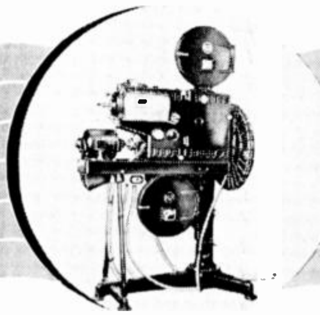


3. THE "ORTHICON" — The high-sensitivity pickup tube, which requires much less light and hence makes outside pick-ups practical. Developed by Dr. Rose and Dr. Iams of RCA Laboratories.

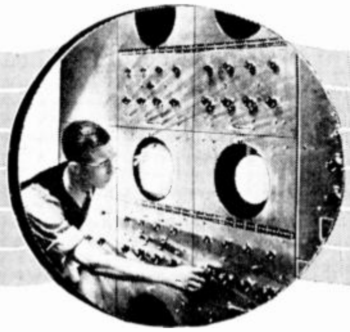
4. THE STUDIO CAMERA — Deluxe-type studio cameras shown here were first designed and built by RCA. Cameras of generally similar design are now used in nearly every television studio.



8. BEAM ANTENNAS — Beam antennas such as the one shown here, which may be used with the relay transmitter shown at left, are largely based on original RCA research.

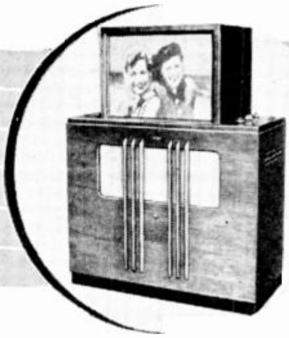


9. THE FILM SCANNER — The arrangement which allows standard motion picture films (24 frames) to be televised over a 30-frame, interlaced system was devised by RCA engineers.



10. THE MONITOR EQUIPMENT—The system of monitoring several video channels by means of a picture tube and an oscilloscope for each channel was first used by RCA engineers.

BUY MORE WAR BONDS



14. "BIG SCREEN" RECEIVERS — RCA engineers designed and RCA factories built the first home television receivers. Their newest contribution, shown here, is the home receiver with a built-in, large-size screen for comfortable viewing from any point in an average-sized living room. Picture is unretouched.

For Everything in Television

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION · CAMDEN, N. J.

FM BROADCASTING & COMMUNICATIONS HANDBOOK

Chapter 4: Introduction to FM Transmitter Circuits and Discussion of Reactance-Tube Modulators

BY RENÉ T. HEMMES

THE preceding chapters have described the differences that exist between FM systems operating at very high carrier frequencies and AM systems operating at frequencies of a much lower order. It was noted that FM has a number of distinct advantages over AM, the most important being the inherent ability of a well-designed FM system to reduce greatly the effects of interference and noise, provided that the strength of the desired signal at the limiter of the FM receiver is two or more times the strength of the disturbances.

Other important advantages of FM were also explained, such as the improved efficiency obtainable in the FM transmitter, and the greater realism of reproduction found in a properly engineered FM receiver. Moreover, it was shown that at the very high frequencies employed with FM, better and more consistent coverage is obtained within the intended service area than with AM, and that the FM service area is the same after nightfall as during the daylight hours.

It is proposed next to describe the actual methods whereby FM signals can be generated, transmitted, and detected. While the discussion to follow will give primary attention to the basic principles of different methods, additional details of circuit arrangements will be given in later chapters, where the features of commercial transmitters and receivers will be described. The present Chapter and Chapter 5 will deal exclusively with methods for generating FM signals.

FM Transmitter Design Considerations ★ In order to obtain the full benefits of the FM system and to minimize the possibility of interference between stations, it is necessary that the FM transmitter output have a wide frequency deviation during modulation and a stable center frequency. Specifically, the output of the FM transmitter must have the following characteristics:

1. The amplitude of the output must remain constant during modulation.

2. The radio frequency of the output must be varied at a rate corresponding to the frequency of the audio modulating voltage.

3. The frequency deviation of the output must be proportional to the *amplitude* of the audio modulating voltage, but independent of the *frequency* of the audio modulating voltage.

4. The accepted compromise value for maximum frequency deviation of the output, occurring at the highest peaks of audio modulating voltage, is five times the highest modulating frequency. In FM broadcast service, where the highest modulating frequency is 15,000 cycles, the FCC specifies a maximum frequency deviation of 75,000 cycles and, in communications services, where the highest modulating frequency used in speech transmission is 3,000 cycles, the specified maximum frequency deviation is 15,000 cycles. If the maximum frequency deviation is less than five times the highest modulating frequency, the channel assigned by the FCC is not entirely utilized, and full advantage is not taken of the noise and interference reduction made possible by the FM system. On the other hand, if the deviation exceeds five times the highest modulating frequency, there is danger of creating interference with stations on adjacent channels.

5. The frequency deviation must be symmetrical about the assigned carrier frequency and the center frequency stability must meet the following FCC requirements: For FM broadcasting the center frequency of the transmission shall at all times be within 2,000 cycles of the assigned carrier frequency of the station. For mobile communications transmitters, the maximum permissible drift of the center frequency from the assigned value is ± .02%, and for fixed communications transmitters, ± .01%.

In view of the fact that Frequency Modulation involves a continual variation of the frequency of transmission, the center frequency stability requirements mentioned above are quite exacting. However, an equally high degree of frequency stability is necessary with FM as with AM, in order that interference will not be created in adjacent channels, and that receivers, once they are tuned, will give satisfactory reception continuously, without requiring readjustment to compensate for center-frequency drift at the transmitter.

There are a number of methods whereby frequency-modulated signals can be generated. The methods in common use, however, may be divided into two distinct systems. The first, which involves the use of the reactance modulator, will be described in this Chapter. The frequency stability of this system in its most simple form is relatively poor, but the stability can be improved greatly by the use of auxiliary frequency-correction circuits. The second system employs the Armstrong phase-shift modulator, and will be described in Chapter 5. The Armstrong system has inherently good stability, since the center frequency is established by a crystal-controlled oscillator.

Reactance Modulation ★ In the reactance modulation method of generating FM signals, the frequency of the oscillator is varied by the direct action of an associated tube and circuit called the reactance-tube modulator. Before considering the manner in which the variation of the oscillator frequency is effected by the modulator, it is advisable to review briefly the factors which govern the natural frequency of an RF oscillator.

Strictly speaking, the operating frequency of an oscillator is not exactly the resonant frequency of its tuned circuit. However, there is only a slight difference between the resonant frequency of the oscillator tank and the actual frequency generated by the master oscillator circuit of a transmitter, where low-loss coils and condensers are used in the tank and where the load of the following buffer stage is relatively light.

It is customary, therefore, to speak of the inductance and capacity of the oscillator tank as comprising the *frequency-determining circuit*, and to regard the oscillator frequency as being the resonant frequency of the oscillator tank.

The resonant frequency of the oscillator tank depends on the product of the tank inductance and the tank capacity. If either the inductance or capacity is increased, the *LC* product is increased, and the period of oscillation is made longer, so that the oscillator operates at a lower frequency. On the other hand, if either *C* or *L* is decreased, the *LC* product is decreased, and the oscillator operates at a higher frequency.

The exact manner in which the resonant frequency is related to the *LC* product will now be examined, with a view toward finding a way in which the frequency of the oscillator can be varied without changing the inductance of the tank coil and without readjusting the capacity of the tank condenser.

At the resonant frequency, the opposition to the flow of alternating current offered by the tank coil, called the *inductive reactance*, is equal to the opposition to the flow of alternating current offered by the tank condenser, called the *capacitive reactance*.

Inductive reactance, the opposition found in coils, has the effect of limiting the current flow and causing the current to *lag behind* the voltage applied to the coil by 90°. Inductive reactance varies directly as the frequency and directly as the inductance of the coil, according to the relation:

$$X_L = 2\pi FL \qquad (1)$$

in which X_L represents the inductive reactance in ohms, F the frequency in cycles, and L the inductance in henrys.

Capacitive reactance, the opposition found in condensers, also limits the current for any applied voltage, but causes the current to *lead* the applied voltage by 90°. Capacitive reactance varies inversely as the frequency and inversely as the capacity, as shown by the expression:

$$X_C = \frac{1}{2\pi FC} \qquad (2)$$

in which X_C represents the capacitive reactance in ohms and C the capacity in farads.

At the resonant frequency, the inductive and capacitive reactances are equal. That is, at the resonant frequency:

$$2\pi FL = \frac{1}{2\pi FC} \qquad (3)$$

or

$$X_L = X_C \qquad (4)$$

The resonant frequency, in terms of L and C, is found by solving equation (3) for F, which gives the familiar relation:

$$F = \frac{1}{2\pi\sqrt{LC}} \qquad (5)$$

Thus, for any given values of circuit inductance L and capacity C, there is but one resonant frequency, regardless of whether large L is used with small C or small L with correspondingly large C.

Consider now the oscillator circuit of Fig. 32. The inductance of the tank coil in this particular case is 15.92 microhenrys (.00001592 henry) and the tank capacity is 1,592 micromicrofarads (.000000001592 farad). By the use of equations (1), (2), and (5), it is found that the resonant frequency of the tank is 1,000 kc., and that the values of capacitive and inductive reactance offered by the tank coil and condenser are 100 ohms each, as noted in Fig. 33.

Therefore, if voltage at a frequency of 1,000 kc. is present across the tank, the current in the inductive branch will be equal to the current in the capacitive branch of the tank. However, the current in the capacitive branch will lead the voltage by 90° while that in the inductive branch will lag by 90°, as shown by the small vector diagrams in Fig. 33.

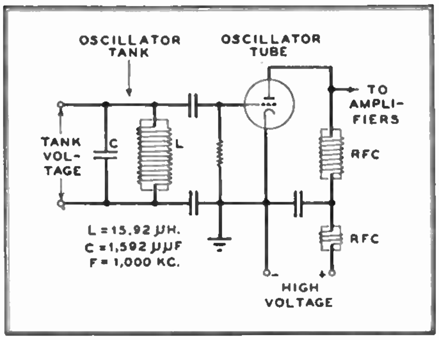


FIG. 32. CIRCUIT OF CONVENTIONAL UNMODULATED OSCILLATOR

Now suppose that a variable capacitive reactance of 1,000 ohms at 1,000 kc. is connected in parallel with the tank condenser, as shown in Fig. 34 at the left. The *net* capacitive reactance offered by two capacitive reactances in parallel can be determined by

$$\text{net capacitive reactance} = \frac{X_C \times X_{C_1}}{X_C + X_{C_1}} \qquad (6)$$

This is similar to the procedure employed

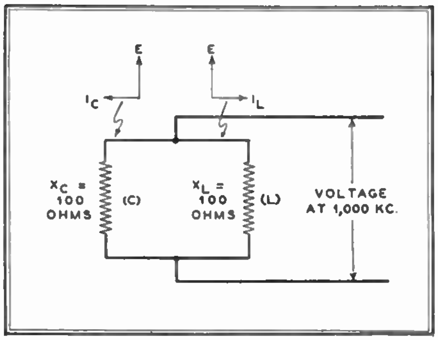


FIG. 33. REACTANCE RELATIONS OF CIRCUIT SHOWN IN FIG. 32

to find the net resistance offered by two resistors in parallel. It is found in this case that the equivalent capacitive reactance of 1,000 ohms in parallel with 100 ohms is 90.9 ohms.

Thus at 1,000 kc., the net capacitive reactance of the variable capacitive reactance in parallel with the tank condenser (90.9 ohms) is less than the inductive reactance of the coil (100 ohms). Also, the 90° leading current in the capacitive branch will be greater than the 90° lagging current in the inductive branch by the amount of current flowing in the extra path provided by the variable capacitive reactance. In short, when the variable capacitive reactance is connected across the oscillator tank condenser, the resonant frequency is no longer 1,000 kc., and the oscillator adjusts itself to a new frequency.

The frequency to which the oscillator adjusts itself in this case is 953 kc. At this frequency, the inductive reactance of the tank coil, which varies directly as the frequency, is decreased from 100 ohms at 1,000 kc., to 953/1000 × 100 or 95.3 ohms at 953 kc. The combined capacitive reactances, which offer a net capacitive reactance of 90.9 ohms at 1,000 kc., vary inversely as the frequency and therefore assume a value of 90.9 × 1000/953, or 95.3 ohms at 953 kc.

Thus the oscillator, by adjusting itself to a lower frequency, brings the capacitive and inductive reactances into equilibrium, as shown in the right-hand diagram of Fig. 34. The total 90° leading current will equal the 90° lagging current and operation as the resonant frequency is maintained.

If the value of the variable capacitive reactance in parallel with the tank condenser is changed to less than 1,000 ohms at 1,000 kc., the oscillator will adjust itself to a frequency lower than 953 kc. to restore operation at the resonant frequency. On the other hand, if the value of the variable capacitive reactance is greater than 1,000 ohms at 1,000 kc., the oscillator will shift to a frequency higher than 953 kc.

Now, if the capacitive reactance shunted across the tank condenser is varied at an audio rate, the oscillator frequency will also vary at the same rate in order to maintain continuous operation at resonant frequency. In this manner frequency modulation of the oscillator output can be obtained.

The shunted capacitive reactance varying at an audio rate can be in the form of a condenser microphone upon whose diaphragm sound waves are impinging. Such an arrangement was mentioned in Chapter 1, but it is hardly practical for most applications because the microphone must be part of the oscillator circuit.

The effect of varying capacity can be produced artificially, without actually varying a condenser, by introducing a variable capacitive reactance across the oscillator tank condenser, as shown in the preceding paragraphs. Such a variable capacitive reactance can be furnished by the reactance-tube circuit, which is shown connected to the oscillator in Fig. 35.

The tube used in the reactance-modulator stage is of the variable-mu type, whose gain can be varied by changing the grid bias. The tank voltage of the oscillator is applied to the series network RC and also to the cathode and plate of the reactance tube. The capacitive reactance of C at the oscillator frequency is very much greater than the resistance of R. Hence the current through RC leads the tank voltage of

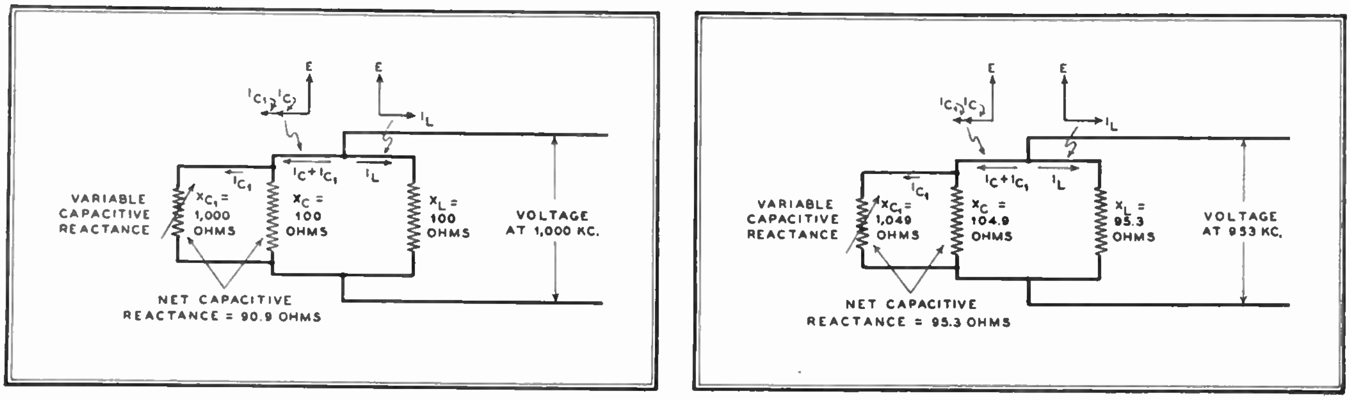


FIG. 34. EFFECT OF PUTTING VARIABLE CAPACITIVE REACTANCE ACROSS OSCILLATOR TANK CONDENSER. LEFT: NON-RESONANT CONDITION AT ORIGINAL FREQUENCY. RIGHT: CONDITION AFTER OSCILLATOR HAS SHIFTED FREQUENCY

the oscillator by 90°. The voltage across R, in phase with the current through it, also leads the tank voltage by practically 90°. Thus the grid of the reactance tube receives an excitation voltage from R that leads the tank voltage applied to the plate and cathode of the tube by practically 90°.

If the reactance tube were biased so negatively that no plate current whatever could flow in the tube, the frequency of the oscillator would be unaffected by the presence of the reactance-tube circuit. (The impedance of the voltage-dividing phase-shift network RC is too high to affect the oscillator frequency appreciably.) Thus, the oscillator frequency would be determined by the tank coil inductance and the tank condenser capacity.

If the negative bias should be reduced sufficiently to permit a small plate current to flow in the reactance tube, *and if there were no RF voltage on the grid of the tube,* the effect would be that of shunting the plate resistance of the tube across the oscillator tank. Since the plate current of the pentode is relatively insensitive to small changes in *plate* voltage, the RF resistance shunted across the oscillator by the tube would be of relatively high order. The frequency of the oscillator would not be affected appreciably.

Actually, however, the resistor R of the RC network furnishes an excitation to the *grid* of the reactance tube at the frequency of the oscillator, but leading the oscillator tank voltage by 90°. Since the plate current is much more sensitive to a change in grid voltage than in plate voltage, the tube permits the flow of a 90° leading current through it with much greater ease than an in-phase current. Thus, with respect to the oscillator tank voltage, the reactance tube of Fig. 35 provides a capacitive reactance across the oscillator tank condenser, the effect of which is to cause the oscillator to adjust itself to a lower frequency in order to maintain resonant operation.

Moreover, the magnitude of the 90° leading current allowed to flow in the reactance tube depends on the mutual conductance of the tube, that is, on the sensitivity of the plate current to a change in grid voltage. When the negative bias is reduced, the mutual conductance of the tube is increased, and a larger 90° leading current flows in the tube, so that the effective reactance of the tube is reduced. This causes the oscillator to adjust itself to a still lower frequency. Conversely, when the bias is made more negative, the 90° leading current is reduced and the effective reactance is increased.

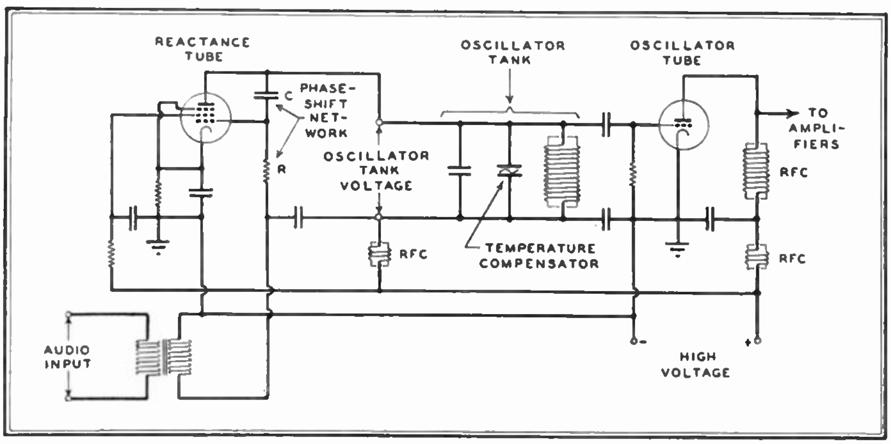


FIG. 35. THE VARIABLE CAPACITIVE REACTANCE SHOWN IN FIG. 34 IS HERE REPLACED BY A REACTANCE TUBE TO VARY THE OSCILLATOR FREQUENCY

It is feasible, therefore, to vary the reactance of the tube at an audio rate simply by introducing an audio voltage in the grid bias of the reactance tube from the output of an audio amplifier, as shown in Fig. 35. The varying reactance, in turn, causes the oscillator frequency to shift at an audio rate, giving frequency modulation of the oscillator output equivalent to actually varying the capacity of an auxiliary condenser across the tank condenser.

By a simple circuit rearrangement, the reactance tube circuit can be made to furnish a variable *inductive* reactance across the tank circuit for reactance-modulating the oscillator frequency. For example, suppose that the positions of R and C in the RC network are interchanged, and that the resistance of R is made very much greater than the capacitive reactance of C at the oscillator frequency. The current in RC would then be nearly in phase with the tank voltage of the oscillator. The current in C would lead the voltage across C by 90°. In other words, the voltage across C will lag the oscillator tank voltage by 90°, thus giving a 90° lagging current in the tube. The tube will therefore look like an inductive reactance to the oscillator tank voltage.

Whatever the type of reactance furnished by the reactance-tube circuit, the carrier frequency of the oscillator, in the absence of modulation, depends upon the constants of the oscillator tank, and the amount of reactance shunted across the tank by the reactance tube. The amount of reactance offered by the tube, in the absence of modulation, depends in turn upon the DC grid bias. Thus the center frequency of the FM signal generated by the oscillator can be adjusted to the assigned carrier frequency simply by an adjustment of the DC bias on the grid of the reactance tube.

The center frequency stability of the simple reactance modulator circuit of Fig.

35 is relatively poor. In the first place, the center frequency cannot be crystal-controlled. The natural frequency of the oscillator, even in the absence of the reactance tube, is affected by variations of the voltages on the oscillator tube elements, by the effects of temperature changes upon the inductance and capacity of the tank, and by the resistance reflected from the coupled load.

When the reactance tube is connected to the oscillator, the oscillator frequency also becomes dependent upon the gain of the reactance tube, since it determines the magnitude of the RF component of plate current that is allowed to flow in the tube at a 90° angle of lead. The gain of the tube in turn depends upon its mutual conductance, upon the characteristics of the associated circuits, and especially upon the voltages applied to the tube elements. Thus the center frequency of the generated wave is affected by such factors as the constants of the reactance tube and the voltage regulation of the power supply. In particular, a very slight variation in the grid bias of the reactance tube causes a considerable shift of the oscillator frequency.

In general, therefore, the primary difficulty that arises in the use of a reactance-tube modulator for the generation of FM signals is that the center frequency of the generated wave depends upon the voltages on the reactance tube as well as upon the constants of the oscillator. The frequency stability can be improved by the use of a voltage-regulated power supply for the reactance modulator. However, even with this precaution, the drift at the very high frequencies is too great to meet the stability requirements of the FCC.

It is necessary, therefore, to employ auxiliary circuits to maintain the center frequency at the assigned value. The principle commonly employed is to compare the center frequency of the transmitter output to that of a crystal oscillator. When the center frequency departs from its correct value, the stabilization circuits operate upon the reactance tube or the oscillator to bring the center frequency back to its correct value.

The Crosby System ★ The circuit diagram of a transmitter employing the frequency stabilization circuit developed by Murray G. Crosby is shown in Fig. 36. The oscillator in this particular case operates at one-ninth of the assigned transmitting frequency. In the circuit of Fig. 36 the 4.7-mc. oscillator frequency is passed through two tripler stages to produce a frequency of 42.3 mc. The oscillator is frequency-modulated by the reactance tube, a frequency deviation of 75/9 or 8.33 kc. being required at the oscillator for full modulation of the transmitter.

In the frequency stabilization circuits, a crystal oscillator operates at a frequency that differs from the correct center frequency of the reactance-modulated oscillator by a known amount. For example, the frequency of the crystal oscillator may be 4.5 mc. which, after being tripled twice, gives a reference frequency of 4.5 × 9 or 40.5 mc.

The reference frequency of 40.5 mc. is applied to a mixer tube along with a voltage at the transmitter output frequency, taken from the intermediate power amplifier stage. If the center frequency of the transmitter output is correct, a beat frequency of 42,300 − 40,500 or 1,800 kc. will appear at the output of the converter. If the center frequency of the transmitter output is greater or less than 42,300 kc., the beat frequency will be greater or less than 1,800 kc. by the same amount.

The converter output is applied to a discriminator [1] having a temperature-compensated circuit very accurately tuned to 1,800 kc. The discriminator, in the absence of modulation, produces a DC voltage whose *magnitude* is proportional to the amount by which the frequency applied to the discriminator differs its resonant frequency. For example, if the discriminator produces 20 volts when the applied frequency is 1,820 kc., it will produce 50 volts when the applied frequency is 1,850 kc.

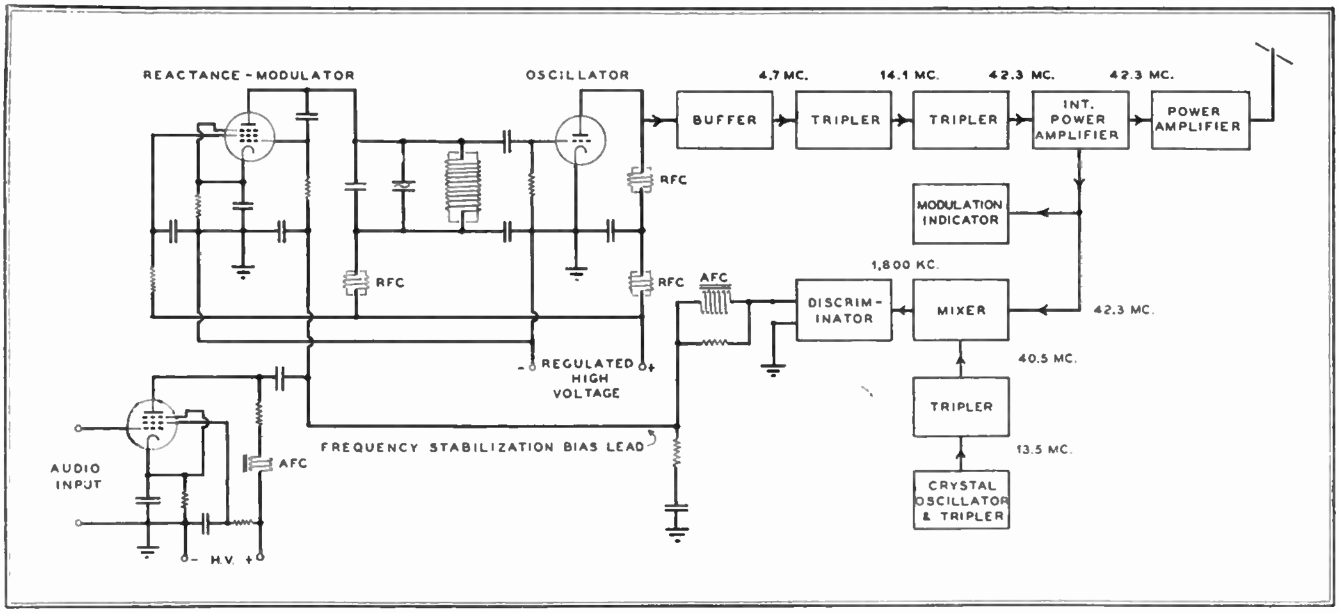


FIG. 36 FM BROADCAST TRANSMITTER EMPLOYING BIAS-CONTROL METHOD OF MINIMIZING FREQUENCY DRIFT

The polarity of the voltage at the discriminator output depends on whether the applied frequency is greater or less than the frequency of the discriminator circuit. Thus, when the applied frequency is 1,750 instead of 1,850 kc., the same voltage is produced but in opposite polarity.

The voltage output of the discriminator is used for frequency correction and is applied to the grid of the reactance-modulator tube in addition to the bias contributed by the cathode resistor of the modulator tube. If the transmitter output frequency is exactly correct, the DC output voltage of the discriminator is zero, and the bias on the reactance tube is that developed by the cathode resistor alone. When the transmitter output frequency differs from the correct value, the discriminator produces a DC voltage of such polarity that the bias of the reactance tube is varied in a

[1] The operating principle of the discriminator will be explained in a later chapter.

direction to shift the output frequency toward its correct value. When the frequency is very nearly correct, and only a very small correction voltage remains at the discriminator output, the frequency correction action ceases.

In the above explanation of the frequency stabilizing action, it has been assumed that no modulation is present. Actually, of course, a frequency-modulating audio voltage is being applied to the grid of the reactance tube during most of the time that the transmitter is on the air. Since the discriminator is responsive to change in frequency, whether in the form of a slow drift or a rapid variation, an audio voltage appears across the discriminator output during modulation in addition to the DC voltage. However, the *average* value of the voltage across the discriminator output will be proportional to the drift of the center frequency of the output, and the polarity of the average voltage will depend on the direction of frequency drift.

An example will serve to make this action clear. Suppose that the transmitter, having an assigned frequency of 42,300 kc., is actually operating at a center frequency of 42,350 kc., and that the frequency deviation during modulation is 75 kc. The transmitter output frequency is varying between 42,425 kc., and 42,275 kc. The voltage applied by the mixer in the frequency correction circuit to the discriminator will vary in frequency between 42,425 − 40,500 or 1,925 kc., and 42,275 − 40,500 or 1,775 kc. This is 125 kc. above and 25 kc. below the 1,800 kc. reference frequency to which the discriminator is tuned. The voltage across the discriminator output will vary, therefore, between +125 and −25 volts, the average of which is +50 volts, the same voltage that would be obtained for an unmodulated transmitter output frequency of 42,350 kc. Thus the center frequency of the output during modulation can be corrected as easily in the absence of modulation, by employing the DC component of the discriminator output voltage.

Actually, the audio voltage of the discriminator is sometimes only partially filtered at the lower audio frequencies, in order to obtain some degenerative feedback at these frequencies. This gives the transmitter a pre-emphasis characteristic that improves the signal-to-noise ratio at the higher audio frequencies.

The stability of the carrier frequency in the circuit of Fig. 36 depends on: 1) the stability of the reference crystal oscillator; 2) the gain of the mixer tube, and 3) the stability of the tuned circuits of the discriminator. Also, the frequency stabilization circuit does not remove all the drift of the output frequency, although the drift can be reduced by as much as 100 to 1 as compared to the drift of an unstabilized reactance-modulated transmitter.

Western Electric System ★ A different frequency stabilization system, developed by J. F. Morrison of Bell Laboratories, is employed in Western Electric transmitters. In this system, drift of the center frequency is automatically corrected by means of a small, reversible motor that readjusts the settings of variable condensers in the oscillator tank circuit. This motor, and the compensating condensers which it adjusts, are shown in Fig. 37.

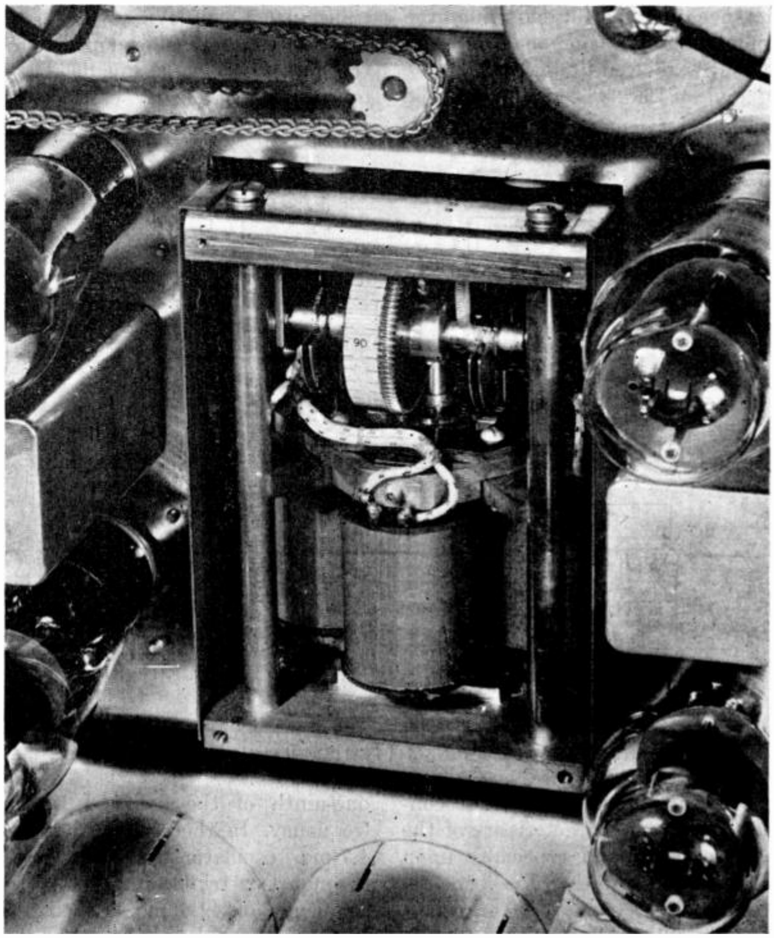


FIG. 37. CLOSE-UP OF WESTERN ELECTRIC FREQUENCY COMPENSATING CONTROL

A simplified diagram of the oscillator and reactance-tube modulator appears in Fig. 38. The oscillator is of the push-pull type, employing two tubes. Energy is fed back to the grids from the plate circuits through small coupling condensers C_C in such polarity as to sustain oscillation. The reactance-modulator also employs two tubes, the plates being connected in push-pull to opposite ends of the oscillator tank. The grids of the tubes in the modulator are connected in parallel, and are excited by a voltage taken from the oscillator tank through a 90° phase-shifting network.

Since the plates of the reactance tubes are connected to opposite ends of the oscillator tank, the direction in which the oscillator frequency will be shifted by the modulator depends on which of the tubes in the modulator passes the greater reactive current. By applying the audio voltage to the control grids of the reactance tubes in push-pull, during the first alternation of the audio voltage, the bias on one tube is reduced while the bias on the other tube is increased. Thus one tube is made to pass a greater reactive current than the other, so that the oscillator frequency is shifted. During the next alternation of the audio voltage, the grid biases are unbalanced in the opposite direction. The tube which passed the greater reactive current in the first alternation now passes the lesser current, and the oscillator frequency is shifted in the opposite direction.

As the audio voltage alternately favors the flow of reactive current first in one tube and then in the other, the oscillator frequency is increased and decreased at the same audio rate. Thus frequency modulation of the oscillator output voltage is obtained.

The balanced reactance-tube modulator

circuit employed here has the advantage over single-tube modulators of balancing out the effects of ripples and fluctuations in the grid bias and plate voltages which are applied in parallel to the reactance-tubes.

The oscillator tank capacity consists of fixed condensers C_F and variable condensers C_V. The variable condensers are ganged and mechanically linked to a synchronous motor, controlled by the frequency stabilization circuit. When the center frequency of the transmitter drifts away from the assigned carrier frequency, the motor rotates in the proper direction and to the extent necessary to readjust the tank capacity of the oscillator to the correct center frequency.

Fig. 39 shows, in block diagram form, the arrangement of this system of frequency stabilization. The frequency of the reactance-modulated oscillator in this case is 1/8 of the transmitter output frequency. For example, if the assigned carrier frequency is 42.3 mc., the oscillator operates at 5.2875 mc. The oscillator output is passed through a buffer and three doubler stages to give the assigned carrier frequency. It is then amplified to give the required power output.

A portion of the output voltage of the reactance-modulated oscillator is applied to the input of a chain of ten frequency dividers, each of which gives an output having one-half the frequency of its input. Thus the center frequency at the output of the last frequency divider is 1/1,024 of the frequency of the modulated oscillator. Hence, if the reactance-modulated oscillator is furnishing the correct frequency of 5.2875 mc., the frequency at the output of the frequency-divider chain is 5,287,500/1,024 or 5,163.5 cycles. This is the frequency at which the reference crystal oscillator is designed to operate.

The output of the reference crystal oscillator and the output of the frequency-divider chain are combined in the motor-control circuit. This circuit determines the magnitudes of the currents that flow in the four windings of the synchronous motor that adjusts the oscillator tuning condensers.

If the output frequency of the transmitter has the correct value of 42.3 mc., the frequencies applied from the reference oscillator and the frequency-divider chain are the same. The resultant magnetic field set up between the poles of the motor by the currents in the windings is stationary, so that the armature of the synchronous motor does not rotate.

Suppose, however, that the output frequency of the transmitter drifts to 42.4 mc., so that the frequency at the output of the frequency-divider chain becomes 5,175.7 cycles. When this frequency is applied to the motor control circuits along with the reference frequency of 5,163.5 cycles from the crystal oscillator, the magnetic field set up between the motor poles is made to rotate at the difference frequency of 12.2 electrical cycles per second. Accordingly, the armature of the motor rotates and increases the capacity of the variable condensers, C_V, Fig. 38, thereby lowering the oscillator frequency toward the correct value. As the amount of the frequency drift is reduced, the difference frequency at the motor-control circuit is reduced, and the magnetic field rotates more slowly. The armature likewise revolves at a slower rate, in keeping with the field, and comes to rest when the field is stationary, that is, when the transmitter drift has been corrected, and the frequency at the output of the frequency-divider chain is exactly equal to that furnished by the reference oscillator.

If the transmitter output frequency should drift to a value *lower* than the assigned carrier frequency, then the rotation of the magnetic field is in the opposite direction.

In this way, the transmitter output frequency drifts, no matter how slowly, the magnetic field of the motor starts to revolve and the armature of the motor turns with the field, applying a correcting adjustment to the oscillator tank capacity.

The question naturally arises as to whether or not the frequency variations occurring during modulation will disturb the operation of the motor. Also, as explained in Chapter 1, in frequency modulation the center frequency component varies in amplitude and even disappears at certain percentages of modulation. What will be the effects of such variations in the center frequency component of the modulated oscillator output upon the operation of the motor-drive circuits?

Neither of these factors affects the operation of the motor. Each of the frequency-dividing stages halves the frequency deviation as well as the frequency of the voltage applied at the input. In the present case, when the transmitter output frequency is being fully modulated, the frequency deviation is ± 75 kc. The frequency deviation of the reactance-modulated oscillator is 1/8 of the output deviation, or ± 9.375 kc. The frequency deviation at the output of the frequency-divider chain is 9,375/1,024 or ± 9.14 cycles. At the lowest audio frequency, say 30 cycles, the modulation index is 9.14/30 or about 0.3. Reference to the table of Bessel factors (Chapter 1) shows that, with this modulation index, the frequency-modulated voltage is composed of a center frequency component having 97.7% of the amplitude of the unmodulated carrier and only one important pair of sidebands, having an amplitude of less than 15% of the unmodulated carrier.

At modulating frequencies greater than 30 cycles, that is, over the entire audio range, the modulation index is still smaller, and the center frequency component is greater than 97.7%, while each of the two sideband components has an amplitude of less than 15%. Thus the process of frequency division concentrates the energy of the frequency-modulated

(CONTINUED ON PAGE 51)

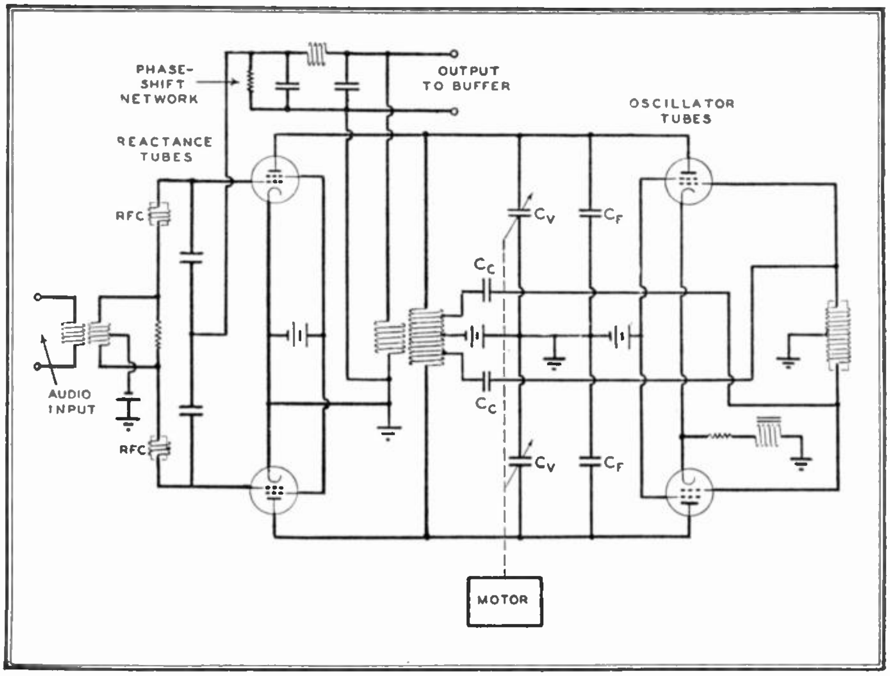


FIG. 38. REACTANCE-MODULATED OSCILLATOR OF WESTERN ELECTRIC FM TRANSMITTER, USING MOTOR-DRIVEN FREQUENCY-CORRECTION CONDENSERS

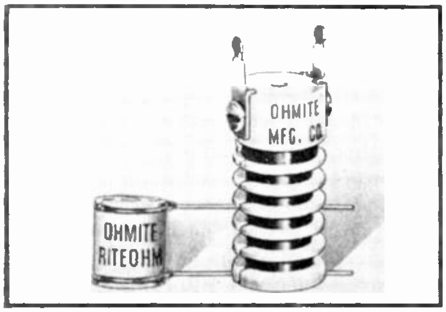


FIG. 3. CERAMIC-BOBBIN RESISTORS

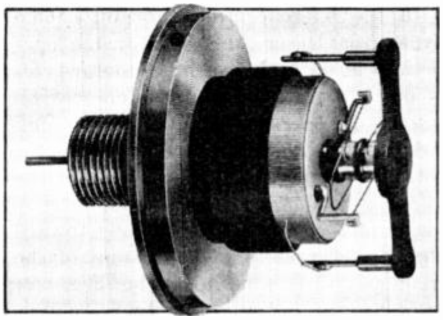


FIG. 4. SENSITIVE VARIABLE RESISTOR

RADIO DESIGNER'S ITEMS

Notes on Methods and Products of Importance to Design Engineers

Walnut Condensers: So-called because of small, light, and compact shape illustrated in Fig. 1, are being manufactured by Jen-

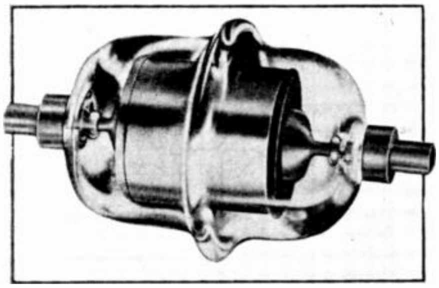


FIG. 1. JENNINGS WALNUT CONDENSER

nings Radio Mfg. Company, 1098 East William Street, San Jose 12, Calif. Specially designed for high frequency circuits, they are self-healing in case of flashover. Maximum current is 20 amps. peak, maximum voltage 30 kv. peak, capacities 6 to 50 mmf.

Precision Resistors: The hermetically sealed resistor shown in Fig. 2 of a new design introduced by Daven Company, 191 Central Avenue, Newark 4, N. J. The non-inductive resistor element, wire-wound to any value up to 1.6 megohm, is sealed in a drawn brass case, with leads brought out through glass seals. Size is 1 9/16 by 7/8

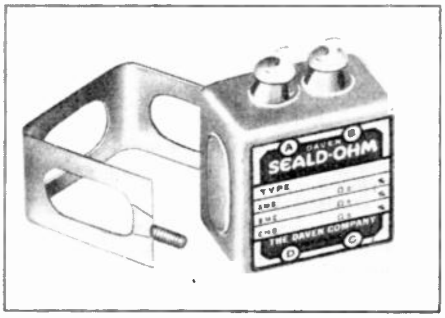


FIG. 2. HERMETICALLY SEALED RESISTOR

by 21/16 in. high over the terminals. Accuracy is ± .1 to 10%, according to requirements.

Field Strength Meter Needed: Among the items listed in a Government bulletin describing much-needed inventions is a small, portable field strength meter "about the size of a walkie-talkie." It must be simple to use and accurate to ± 10%, with a frequency range of .1 to 20 mc. Field intensity must be 10 to 1,000 millivolts per meter.

Approved Pilot Lights: Underwriters' Laboratories have recently approved a number of the pilot lights designed and manufactured by Gothard Manufacturing Company, Springfield, Ill.

Ceramic-Bobbin Resistors: Two new series of precision resistors which feature the use of ceramic bobbins are being produced by Ohmite Manufacturing Company, 4835 Flourney Street, Chicago 44. Series 83, shown at the left in Fig. 3, is wound for values of 10 ohms to .4 megohm. Bobbins are 1/2 in. in diameter and 7/16, 5/8, or 1 in. long. The larger type, series 82, is wound for values of .1 ohm to 1. megohm. Bobbins are 11/16 in. in diameter, and 1 1/8, 1 7/16, or 1 3/4 ins. long. Accuracy is ± 1%. The windings, of enameled wire, are vacuum-impregnated, and can be further protected with anti-fungus varnish.

Hermetically-Sealed Instruments: A complete series of AC and DC voltmeter, ammeters, milliammeters, and microammeters in 2 1/2, 3 1/2, and 4-in. sizes is offered by Hickok Electrical Instrument Company, 10530 Dupont Avenue, Cleveland 8. Hermetic sealing is obtained by the use of glass-sealed terminals and a case construction which employs a clamping mechanism to maintain a permanent closure.

VHF Doping Varnish: Technical data has been released by American Phenolic Corp., Chicago 50, on Polyweld 912. This material is pure polystyrene in solution. Thus its electrical characteristics are excellent for coating, impregnating, or sealing radio windings and components. Air-drying time is 4 to 8 minutes. Polyweld does not support fungus growth. When used to join polystyrene parts, it forms a welded joint. A bulletin showing electrical characteristics up to 10,000 mc. is available on request.

Variable Resistor: The variable resistor shown in Fig. 4 can be turned by delicate devices providing as little torque as 2 gram-milliameters or less than 2 inch-ounces. Resistance values are 100 to 1,500 ohms, 4 to 15 watts. These units, produced by G. M. Giannini & Company, Inc., 161 E. California Street, Pasadena, Calif., afford a new answer to designs

FIG. 5. JENSEN LOUDSPEAKER

which have required photo-electric cells and other elaborate methods of current control.

Loudspeaker: Jensen Radio Mfg. Company, 6601 S. Laramie Avenue, Chicago 38, has announced a new speaker NF-300 designed to reproduce speech under conditions of high ambient noise. The speaker is shown in Fig. 5. Voice-coil impedance is 12 ohms, and maximum capacity 10 watts.

Neutralizing Condenser: Two new neutralizing condensers, Fig. 6, are offered by

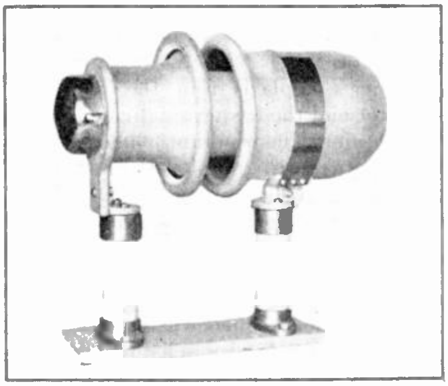


FIG. 6. E. F. J. NEUTRALIZING CONDENSER

E. F. Johnson, Waseca, Minn. The larger is rated at 45 kv. peak breakdown with a range of 33.1 to 12.6 mmf., while the smaller is rated at 35 kv. peak with a range of 26.0 to 7.2 mmf. Construction is of spun and cast aluminum.

Panel Pump: To meet the needs of special high-frequency equipment, a panel-mounted dry-air pump, Fig. 7, is now available from Andrew Company, Chicago 19. This device can be made an integral part of the

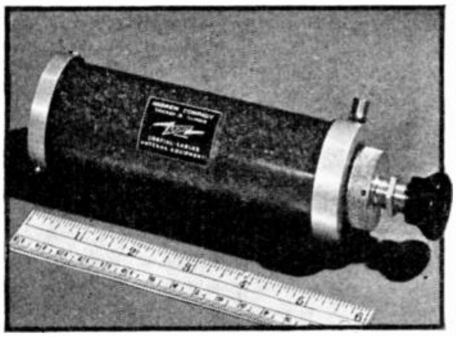


FIG. 7. ANDREW DRY-AIR PUMP

equipment for which it supplies pressure. Dimensions are 6 ins. long behind the panel and 2 ins. in diameter. Weight is

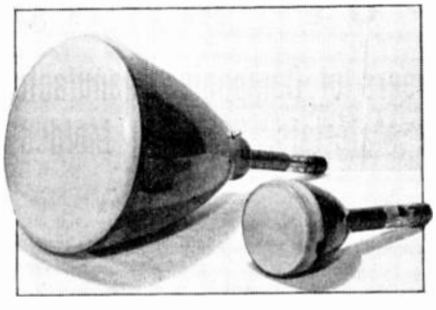


FIG. 8. OLD AND NEW TUBE DESIGNS

10 oz. The drying agent, contained in a transparent plastic cylinder, is blue, turning pink when it requires replacement.

Smaller Television Tubes: Fig. 8 shows the 12-in. prewar cathode-ray tube and the 5-in. developmental type designed by RCA for their projection television receivers. The smaller tube operates at 27,000 volts, nearly 4 times the voltage used on the 12-inch tube, and produces a much brighter spot on the fluorescent green.

Fixed Ceramic Condensers: A-N JAN-C-20 fixed ceramic condensers in a wide range of temperature coefficients, capacities, and sizes are now being produced by Micamold Radio Corporation, 1087 Flushing Avenue, Brooklyn 6. Samples are available to manufacturers.

Outdoor Horn: The exponential horn shown in Fig. 9 is manufactured by Langevin Company, 37 W. 65 Street, New York 23, for outdoor use. It is weatherproofed with a new vitreous finish capable of withstanding high corrosion conditions. Bell diameter is 25 ins. overall length 38 ins., and width 26 ins. One or two driver units can

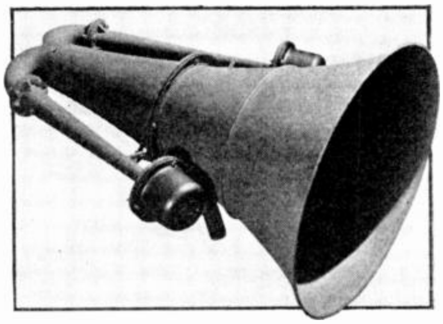


FIG. 9. LANGEVIN OUTDOOR SPEAKER

be used on each side, for an input of 50 or 100 watts. Frequency response is rated at 110 to 6,500 cycles.

FM HANDBOOK

(CONTINUED FROM PAGE 49)

wave into the center frequency component. At the output of the frequency-divider chain, the amplitude of the center frequency component during modulation is never less than 97.7% of the amplitude of the carrier in the absence of modulation. Large variations in the amplitude of the center frequency component at the transmitter *output* during modulation, therefore, do not affect the operation of the motor-control circuits.

The FM voltage from the frequency-dividing chain, which has been described as having a frequency deviation of 9.14 cycles at full modulation, will cause a slight oscillation of the motor field at the modulating frequency. The angle in radians of alternate advancement and retardation of the field in the motor at the modulating frequency of 30 cycles per second would be equal to the modulation index, that is, to .3 radian or about 17°. In other words, the rotating or stationary field of the motor has a superimposed oscillation over a range of ± 17° when the transmitter is fully modulated at 30 cycles. That represents the most extreme condition of oscillation. When the modulating frequency is higher than 30 cycles and the transmitter is being modulated at less than 100%, the oscillation range is less than ± 17°.

For all the modulating frequencies from 30 to 15,000 cycles, the inertia of the armature element and the friction in the motor is sufficient to prevent any response to the slight, rapid oscillations of the motor field at the modulating frequency. The motor is only responsive to slow rotation of the mean position of the motor field, which occurs when the transmitter output frequency starts to drift from the correct value.

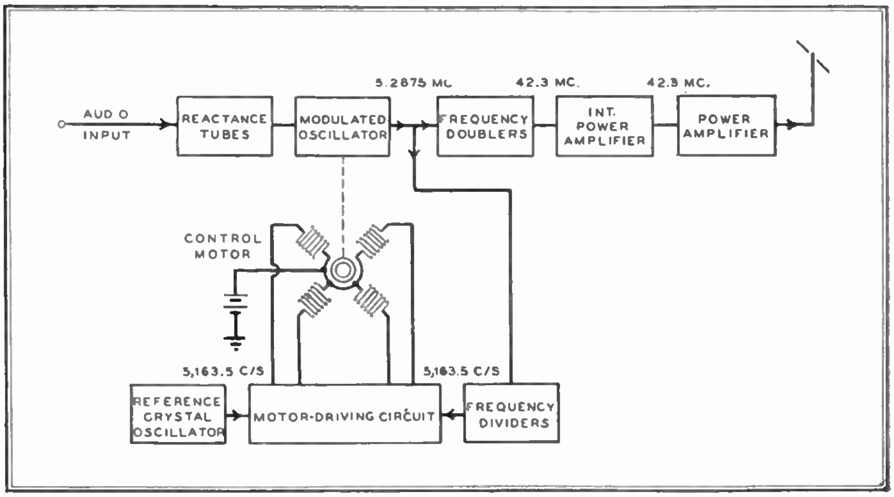


FIG. 39. BLOCK DIAGRAM OF W.E. SYNCHRONIZING MOTOR CONTROL CIRCUIT

Since positive synchronism is maintained between the subharmonic of the transmitter output frequency and the reference crystal oscillator, the carrier frequency stability is that of the crystal oscillator. The stability is not affected by fluctuations of power supply voltages, nor does it depend on the maintenance of the constants of a tuned circuit, nor upon the stability of gain in any tube.

The frequency correction is applied in the oscillator by electro-mechanical means so that the design of the reactance-tube modulator does not involve considerations of frequency stabilization, and failures in the frequency stabilization circuit cannot affect the process of modulation. If the frequency stabilization circuits fail, the motor ceases to revolve and the transmitter frequency will drift slowly. There will not be a sudden change in the transmitter output frequency as would be the case where frequency stabilization is obtained by means of bias applied to the reactance-tube modulator.

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The name of the General Manager appears at the left; the name of the Chief Engineer is at the right.

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American Communications Corp 306 B'way N Y C
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E V Amy
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R Kimball — R Kimball
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Continental Elec Co 903 Merchandise Mart Chicago Ill
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A W Peterson — G E Petterson
Continental Radio & Telev Corp 3800 W Cortland St Chicago Ill
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Copperweld Steel Co Glassport Pa
W J McIlvane — C H Jensen
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Corning Glass Works Corning N Y
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T S Wood Jr Lamp Dept
Cornish Wire Co Inc 15 Park Row N Y C 7
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Corry-Jamestown Mfg Corp Corry Pa.
Cosmic Radio Corp 699 E 135 St N Y C 54
S Fishberg
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Cover Dual Signal Systems Inc 5215 Ravenswood Av Chicago 40
J J Bailey — W R Schum
Creative Plastics Corp 963 Kent Av Brooklyn
Crescent Industries Inc 4140 W Belmont Av Chicago 41 Ill
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Crescent Ins Wire & Cable Co Trenton N J
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"WE USE EIMAC TUBES EXCLUSIVELY IN ALL OUR LARGER GROUND STATIONS"

Says Robert F. Six

PRESIDENT, CONTINENTAL AIR LINES

CONTINENTAL AIR LINES, INC.
MUNICIPAL AIR TERMINAL
Denver 7 Colorado

January 9, 1945

Chief Engineer
Eitel-McCullough, Inc.
870 San Mateo Avenue
San Bruno, California

Dear Sir:

An airline must have a communication system which is absolutely dependable. For that reason, we scrutinize with great care the records we keep on the performance of the various components used in our transmitting and receiving equipment.

Included among these records are those on Eimac transmitting tubes--used exclusively in all of the larger ground stations operated by Continental Air Lines. I am pleased to tell you that these records show that your transmitting tubes are averaging well over 20,000 hours of service in our stations.

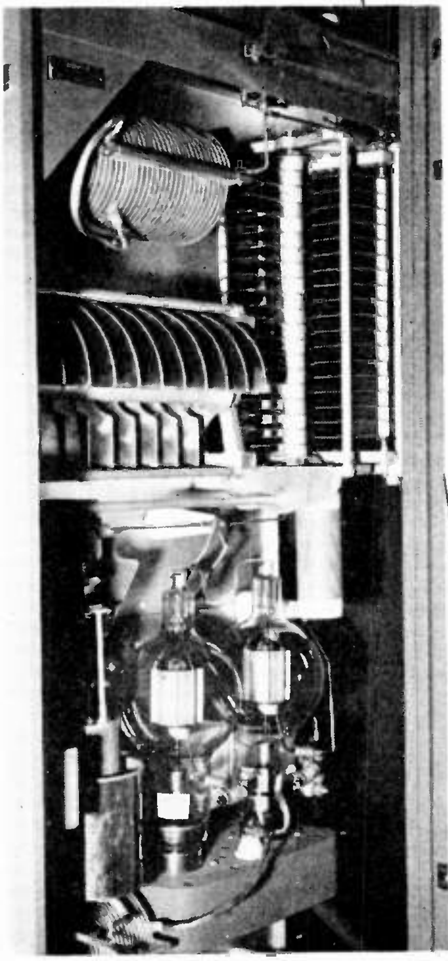
Sincerely yours,

Robert F. Six
President

RFS/lad

ROBERT F. SIX
President
Continental Air Lines

Below... a pair of Eimac 450-T tubes in the panel of Continental ground station transmitter built by Wilcox.



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Plants located at: San Bruno, California and Salt Lake City, Utah
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1029

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

Dejur-Amsco Corp 6 Bridge St Shelton Conn
H Blye
Delco Appliance Rochester N Y
H C Jones
Delco Radio Div General Motors Corp 303 N Buckeye Kokomo Ind
B W Cooper B A Schwarz
Detroit Power Screwdriver Co 2801 W Fort Detroit 16 Mich
R H Gladfelter
Detrola Corp 1501 Beard Detroit Mich
R M Daugherty
Deutschmann Corp Tobe Canton Mass
De Vry Herman A 1111 W Center Chicago
DeWald Radio Corp 440 Lafayette St N Y C
M Glaser
Dial Light Co of America Inc 900 B'way N Y C
Diamond Inst Co Wakefield Mass
Dictaphone Corp 375 Howard Av Bridgeport Conn
Diehl Mfg Co Somerville N J
P H Trickey
Dinion Coil Co Caledonia N Y
F S Eberts I W Armstrong
Dixon Crucible Co Jersey City N J
Dolph John C Newark N J
Dongan Elec Co 74 Trinity Pl N Y C
Doolittle Radio Inc 7421 S Loomis Blvd Chicago 36 Ill
D Gray D Gray
Dow Chemical Co Midland Mich
W H Dow L J Richards
Drake Mfg Co 1713 W Hubbard St Chicago 22
A J Foute H K Foute
Driver-Harris Co Harrison N J
F L Driver F E Bosh
Dumont Elec Co 34 Hubert St N Y C
J Katzman
Du Mont Labs Allen B Passaic N J
A B DuMont P S Christaldi
Du Pont De Nemours & Co Arlington N J
Durez Plastics & Chemicals Inc North Tonawanda N Y
R M Crawford G Loomis
DX Crystal Co 1200 Claremont Chicago
D-X Radio Prods Co 1200 N Claremont Ave Chicago 22
M P McLean L J Patla

— E —

Eagle Elec Mfg Co 23–10 Bridge Plaza S Long Island City N Y
G I Hamond
Eagle Metals Seattle Wash
Eastern Air Devices 585 Dean St Brooklyn 17
H G Hamilton L C Pratt
Eastman Kodak Co 343 State St Rochester N Y
A K Chapman F E Tuttle
Eby Inc H H 18-A W Chelton Av Phila
F Holmstrom L R Wanner
Echophone Radio Co 540 N Mich Chicago 11
W J Halligan R E Samuelson
Eckstein Radio & Telev Co 1400 Harmon Pl Minneapolis 3 Minn
E A Eckstein E A Eckstein
Eclipse-Pioneer Div Bendix Aviation Corp Teterboro N J
R P Lansing R Sylvander
Edwards Co W H 94 B'way Providence R I
E Gervais W H Edwards
Elcor Inc 1501 W Congress Chicago 7
Eisler Eng Co 7518 13 St Newark N J
Eitel-McCollough Inc San Bruno Calif
G F Wunderlich G Howes
Elastic Stop Nut Corp of America 1060 Broad St Newark 2 N J
L H Atkinson H Karlby
Electra Voice Corp 5215 Ravenswood Av Chicago Ill
W R Schum
Electrical Industries Inc 42 Summer Av Newark 4 N J
W H Fredericks
Electrical Prods Supply Co 1140 Venice Blvd Los Angeles 15 Calif
L A Rice
Electrical Prod Corp 950 30 St Oakland Calif
G W Thunen
Electrical Research Labs Inc 2020 Ridge Av Evanston Ill
O F Taylor W J Schnell
Electric Auto-Lite Co Port Huron Mich
J A Minch F H Wetzel
Electric Indicator Co Stamford Conn
Electric Motors Corp Racine Wis
Electric Soldering Iron Co Deep River Conn

Electric Specialty Co 211 South St Stamford Conn
D G Shepherd E W Borggrafe
Electrolux Corp Old Greenwich Conn
A F Murray F C Doughman
Electro Motive Mfg Co Willimantic Conn
J A Flanzer M Cohn
Electronic Communications Co 36 N W B'way Portland Ore
Electronic Corp of America 450 W 18 St N Y C 11
S J Novick F Lester
Electronic Enterprises Inc 656 Av N Y C
Electronic Labs Inc 122 W New York St Indianapolis 4 Ind
W W Garstang R H Frye
Electronic Laboratory 306 S Edinburgh St Los Angeles Calif
Electronic Mechanics Inc 70 Clifton Blvd Clifton N J
F B DuVall D E Replogle
Electronic Specialty Co 3456 Glendale Blvd Los Angeles Calif
D A Marcus S K Babcock
Electronic Transformer Co 207 W 25 St New York 1 N Y
A Cezar A Cezar
Electro Tech Prod Inc Nutley N J
Electro-Voice Corp 1239 S Bend Av South Bend Ind
A R Kahn L R Burroughs
Emerson Radio & Phonograph Corp 111 8th Av N Y C
B Abrams D D Israel
Endurette Corp of America Cliffwood N J
Erco Radio Labs Inc 231 Main St Hempstead New York
F Ruth E Ruth
Erie Resistor Corp 640 W 12 St Erie Pa
J M Allen B B Minnium
Espey Mfg Co Inc 33 West 46 St N Y C 19
N Pinsley J Rosenbaum
Essex Specialty Co Inc Broad St Newark N J
Etched Prod Corp 39–01 Queens Blvd Long Island City N Y
Eureka Vacuum Cleaner Co 6060 Hamilton Detroit 2 Mich
H W Burritt F L Pierce
Ever-Ready Label Corp 141 E 25 St N Y C
Extruded Plastics Inc Norwalk Conn

— F —

Fada Radio & Electric Co Inc 30–20 Thomson Av Long Island City N Y
J R Swikard G Mountjoy
Fansteel Metallurgical Corp North Chicago
R J Aitchison F L Hunter
Farnsworth Telev & Radio Corp 2701 E Pontiac Fort Wayne Ind
B R Cummings J Ferguson
Fast & Co John E 3109 N Crawford Av Chicago 41 Ill
L Kopinski W S Franklin
Federal Engineering Co 37 Murray St N Y C 18
M J Kirsch M J Kirsch
Federal Mfg & Eng Corp 199–217 Steuben St Brooklyn 5 N Y
D H Engelson M Kaplowitz
Federal Recorder Co Elkhart Ind
Federal Screw Prods Co 224 W Huron St Chicago Ill
J M Levine
Federal Telephone & Radio Co 200 Mt Pleasant Newark 4 N J
E G Ports
Felker Mfg Co Torrance Calif
M N Felker M W Hinshaw
Fenwal Inc Ashland Mass
J M Storkerson J Taplin
Ferranti Elec Inc 30 Rockefeller Plaza N Y C
Ferris Inst Co Boonton N J
Ferrocart Corp of America Hastings on Hudson New York
Finch Telecommunications Inc Passaic N J
Fisher Research Lab 1961–63 University Av Palo Alto Calif
E Smith G R Fisher
Follansbee Steel Corp Pittsburgh Pa
Ford Radio & Mica Corp 538 63 St Brooklyn
Formica Insulation Co Cincinnati O
Franklin Mfg Corp 175 Varick St N Y C
A W Franklin
Freed Radio Corp 200 Hudson St N Y C
A Freed M Weinstein
Freed Transformer Co 72 Spring St N Y C
L Freed D Gurevics

— G —

Galvin Mfg Corp 4545 W Augusta Blvd Chicago Ill
F J O'Brien D H Mitchell

Garden City Lab 2744 W 37 Pl Chicago Ill
Gardiner Metal Co 4820 S Campbell Av Chicago 32 Ill
R A Gardiner A F Sternad
Gardner Elec Mfg Co 4227 Hollis St Oakland Calif
W W Wahlgren W W Wahlgren
Garner Co Fred E 43 E Ohio St Chicago
Garod Radio Corp 70 Washington St Brooklyn
B S Trott
Gates Radio Co 220 Hampshire Quincy Ill
L I McEwen F Grimwood
Gavitt Mfg Co Inc Brookfield Mass
Gear Specialties 2635 W Medill Av Chicago
E H Johnson C B Hale
General Aniline Wks 435 Hudson St N Y C 14
C F McKenna
General Armature Corp Logan & Prospect Sts Lock Haven Pa
A C Potratz T Ramsey
General Cable Corp 420 Lex Av N Y C
J R McDonald I T Faucett
General Ceramics & Steatite Corp Keasbey N J
General Communication Co 530 Commonwealth Boston Mass
T M Hastings Dr M C Bloom
General Control Co 1200 Soldiers Field Rd Boston 34 Mass
W J Kelleigh E B Farmer
General Electric Co Eng Receiver Div Electronics Dept 1285 Boston Av Bridgeport Conn
I J Karr C G Fick
General Electric Co Lamp Dept Hoboken N J
General Electric Co Pittsfield Mass
General Electric Co Schenectady N Y Transmitter Div
C A Priest J J Farrell
General Electronics Inc 101 Hazel St Paterson 3 N J
D E Replogle E J Oberle
General Industries Co Elyria Ohio
D L Boyd
General Inst Corp 829 Newark Av Elizabeth 3 N J
B N Fisher
General Insulated Wire Corp 53 Park Pl N Y C
General Radio Co 275 Massachusetts Av Cambridge 39 Mass
H B Richmond M Eastham
General Scientific Corp 4829 Kedzie Av Chicago Ill
General Telev & Radio Corp 1240 N Homan Av Chicago 51 Ill
H R Rose W Kroening
General Transformer Corp 1250 W Van Buren Chicago Ill
L J Seelig C E DeHorn
General Winding Co 420 W 45 St N Y C
W A Barlow
Gentleman Prods Div of Henney Motor Co 1702 Cuming St Omaha 2 Nebr
A E Bennett
Gibbs & Co Thomas B Div George W Borg Corp Delavan Wisc
P Morrison P Wickham
Gibson Co Wm D 1800 Clybourn Av Chicago
Gibson Elec Co 8350 Frankstown Av Pittsburgh
Gilfillan Bros Inc 1815 Venice Blvd Los Angeles 6 Calif
S W Gilfillan F C Wolcott
Girard-Hopkins 1000 40 Av Okland 1 Calif
J C Hopkins
A R Stack C Lasswell
Girdler Corp Thermex Div Louisville Ky
P D Zottu
Gits Molding Corp 4600 Huron St Chicago
G-M Laboratories Inc 4300 N Knox Av Chicago
A J McMaster A J McMaster
Globar Div Carborundum Co Niagara Falls N Y
Goat Metal Stampings Inc 314 Dean St Brooklyn N Y
E F Staver
Gothard Mfg Co 1300 N 9 St Springfield Ill
R W Gothard G W Frost
Gould-Moody Co 395 B'way N Y C
Granite City Steel Co Granite City Ill
Graybar Electric Co Inc 420 Lexington Av New York City 17
C S Powell J W La Marque
Gray Mfg Co Hartford Conn
Gray Radio Co West Palm Beach Fla
G H DeShazo F E Gray
Green Elec Co Inc 130 Cedar St N Y C
Grenby Mfg Co Plainville Conn
C A Gray L H Whitney

Greyhound Equip Co 1720 Church Av Brooklyn
Guardian Elec Mfg Co 1400 W Washington Blvd Chicago Ill
F F Rowell Jr M Nelsen
Guided Radio Corp 6161 Av N Y C
F W Nickerson H C Dalrymple
Guthman & Co Edwin I 15 S Throop St Chicago

— H —

Hadley Co R M 707 E 61 St Los Angeles Calif
R M Hadley H H Hill
Halldorsen Co 4500 Ravenswood Av Chicago Ill
Hallicrafters Co 2611 Indiana Av Chicago Ill
W J Halligan R E Samuelson
Halstead Traffic Communications Corp 155 E 44 St Rm 804 New York City
J A Curtis E V Thatcher
Hamilton Radio Corp 510 6 Av N Y C 11
A A Juviler J Raydin
Hammarlund Mfg Co Inc 460 W 34 St N Y C
J K Johnson
Harco Steel Constr Co Inc 1180 E Broad Elizabeth N J
E Schaefer
Hardwick Hindle Inc Newark N J
Harper Co H M 2609 Fletcher Chicago
Harrison Radio Corp 12 W B'way N Y C
W E Harrison
Harvey Machine Co Inc 6200 Avalon Blvd Los Angeles 3 Calif
L A Harvey H Harvey
Harvey Radio Labs Inc 447 Concord Av Cambridge 38 Mass
F Lyman Jr A L Quirk
Harvey Wells Electronics Inc Southbridge Mass
R A Mahler C A Harvey
Hartman Corp of America 6417 Dale Av St Louis Mo
L H Matthey Jr
Harwood Co Div of Los Angeles Corp 540 N LaBrea Av Los Angeles 36 Calif
G J Levingston A C Pearson
Haskelite Mfg Corp 208 W Washington St Chicago Ill
Hatry & Young 203 Ann St Hartford Conn
N T Young L W Hatry
Haydon Mfg Co Inc Forestville Conn
R A Conover C M Reed
Hazard Ins Wire Wks Wilkes-Barre Pa
Hazeltine Electronics Corp 58–25 Little Neck P'kway Little Neck N Y
D E Harnett
H-B Electric Co 6122 N 21 St Philadelphia 38
W E Girard
Heintz & Kaufman Ltd So San Francisco Calif
R H Andersen G Lebedeff
Herbach & Rademan Co 522 Market St Phila
Herzog Miniature Lamp Wks 12–19 Jackson Av Long Island City N Y
Hewlett-Packard Co 395 Page Mill Rd Palo Alto Calif
G Zieber B Bauer
Hexacon Electric Co 161 W Clay Av Roselle Park N J
A L Johnson A L Johnson
Hickok Electrical Inst Co 10514 Dupont Av Cleveland 8 Ohio
R D Hickok Jr W A Weiss
Higgins Industries Inc 2221 Warwick Av Santa Monica Calif
F E Dine Trustee
Hilo Varnish Co Brooklyn N Y
Hilton Engineering Labs Redwood City Calif
Hipower Crystal Co 2035 W Charleston Chicago
Hoffman Radio Corp 3330 S Hill St Los Angeles Calif
Hofstatter's Sons Inc 42–53 24 St L I City N Y
W Schier
Hollywood Electronics Service Dept 1223 Venice Blvd Los Angeles 6
J Gunter H Schaffer
Holyoke Wire & Cable Corp Holyoke Mass
Hopp Press Inc 460 W 34 St N Y C 1 N Y
Hopp P
Howard Pacific Corp 923 N Western Ave Los Angeles Calif
Howard Radio Co 1731 Belmont Av Chicago
J M Muniz W James
Hoyt Elec Inst Wks Boston Mass
H R S Products 5707 W Lake St Chicago
H R Sieniers D Zmuda
Hubbard Spring Co M D Pontiac Mich
Hudson American Corp 25 W 43 St N Y C
R Young A Haas
Hunt & Sons G C 133 N Hanover St Carlisle Pa
T D Burnett
Hunter-Hartman Corp St Louis Mo
Hunter Pressed Steel Co Lansdale Pa
Hygrade Sylvania Corp Salem Mass
Hytron Corp & Hytronic Labs Salem Mass

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Ideal Commutator Dresser Co Sycamore Ill
I D Applegate
Illinois Condenser Co 1160 N Howe St Chicago Ill
J J Kurland
Ilsco Copper Tube & Prods Inc Cincinnati O
A H Stubbers A J Pauly
Imperial Molded Prods Corp 2925 W Harrison Chicago 12 Ill
L H Amrine R E O'Neill
Indiana Steel Prod Co 6 N Mich Chicago
Induction Heating Corp 389 Lafayette N Y C
W E Rudd
Industrial & Com Electronics P O Box 296 Belmont Calif
R C Shermund D G Clifford
Industrial Condenser Corp 1725 W North Av Chicago 22 Ill
K D Engle H L Sklar
Industrial Filter & Pump Mfg Co 1621 W Carroll Av Chicago Ill
J W MacAllister
Industrial Instruments Inc 17 Pollock Av Jersey City 5 N J
P M Gotthold N Schnoll
Industrial Molded Prods Co 2035 Charleston Chicago Ill


one step
Nearer...

Industrial Synthetics Corp 60 Woolsey St Irvington N J A A Kaufman

Industrial Timer Corp 115 Edison Pl Newark N J

Instrument Resistors Co Little Falls N J A H Melick

Instrument Specialties Co Inc 224 Bergen Blvd Little Falls N J R W Carson F S Stickney

Insulation Mfgrs Corp 565 W Wash Blvd Chicago 6 Ill A S Gray B F McNamara

Insuline Corp of America 36-02 35 Av Long Island City N Y J R Carpenter

Intl Detrola Corp Beard & Chatfield Sts Detroit 9 Mich

Intl Prods Corp Baltimore 18 Md

International Resistance 401 N Broad St Philadelphia 8 Pa J Marsten

International Screw Co Detroit Mich

Irvington Varnish & Insulating Co Irvington N J

Isolantite Inc Belleville N J G W Hawkins

— J —

Jackson Electrical Inst Co Dayton O

Janette Mfg Co 558 W Monroe Chicago Ill A E Klunder J Kotchevar

J-B-T Instruments Inc 441 Chapel St New Haven 8 Conn R M Bixler D E Andersen

Jefferson Elec Co Bellwood Ill A E Tregenza L Maurer

Jefferson Inc Ray 40 E Merrick Rd Freeport N Y W Griffin R Jefferson

Jefferson-Travis Corp 245 E 23 St New York City 10 E E Ellinger Jr W B Wilkens

Jelliff Mfg Corp Southport Conn

Jensen Radio Mfg Co 6601 S Laramie Av Chicago Ill T A White H S Knowles

Johnson Co E F Waseca Minn E F Johnson L W Olander

Jones Co Howard B 2460 W George St Chicago Ill

— K —

Kaar Engineering Co 619 Emerson St Palo Alto Calif J M Kaar N C Helwig

Karadio Corp 1400 Harmon Pl Minneapolis

Kato Engineering Co Mankato Minn C H Jones C H Jones

Kellogg Switchb'd & Supply Co 6650 Cicero Chicago Ill

Kemlite Labs 1809 N Ashland Av Chicago J V Daniels O H Floyd

Ken-Rad Tube & Lamp Corp Owensboro Ky G W Bain

Kenyon Transformer Co Inc 840 Barry St N Y C 59 R B Shimer

Kester Solder Co 4209 Wrightwood Av Chicago

Keuffel & Esser Hoboken N J

Kirkland Co H R Morristown N J H R Kirkland

Knapp-Monarch Co Bent & Potomac Sts St Louis 16 Mo C W Clemons

Knights Co James Sandwich Ill L A Faver M A A Druesne

Kold-Hold Mfg Co 446 N Grand Av Lansing Mich

Kollsman Inst Div of Square D Co 80-08 45 Av Elmhurst N Y V E Carbonara W Angst

Krueger & Hudepohl 3rd & Vine Sts Cincinnati Ohio F G Krueger F H Hudepohl

Kulka Elec Mfg Co Inc 30 South St Mt Vernon N Y W Kulka E R Kulka

Kurtz Kasch Inc 1421 S B'way Dayton O M H Kasch

Kux Machine Co 3930 W Harrison Chicago J J Kux A S Kux

— L —

Lafayette Radio Corp 901 W Jackson Blvd Chicago 7 Ill S W Berke A Rattray

Lamson & Sessions Co Cleveland O

Langevin Co 37 W 65 N Y C 23

Lapp Insulator Co Leroy N Y

Lavoie Laboratories Morganville N J S D Lavoie A M Schmeling

Lear Inc 1480 Buchanan Av S W Grand Rapids Mich E R Crane L G Woycke

Lectrohm Inc 5123-5131 W 25 St Cicero 50 Ill J J Cerny

Leeds & Northrup Co Philadelphia Pa J C Hess J W Harsch

Lehigh Structural Steel Co 17 Battery Pl New York City

Leland Electric Co 1501 Webster St Dayton O W F Lisman E B George

Lenz Electrical Mfg Co 1751 N Western Av Chicago 47 Ill R G Zender

Lepel Labs 39 W 60 St N Y C S L Teitler H Peterson

Lewis Electronics Los Gatos Calif M Shaw G W Lewis

Lewyt Corp 60 B'way Brooklyn N Y R McGlinn A Wolf

Lingo & Son John E Camden N J J E Lingo W Thompson

Link Radio Corp 125 W 17 St N Y C 11 F M Link F T Budelman

Littelfuse Inc Box 150 El Monte Calif E V Sundt

Litton Engineering Labs Redwood City Calif J G Copelin W C Wagener

Locke Insulator Corp P O Box 57 Baltimore Md R G Bellezza R L McCoy

Lord Mfg Co Erie Pa

Louthan Mfg Co 2000 Harvey Av E Liverpool O H S Russell C W Gerster

L-R Mfg Co Torrington Conn

— M —

Maas & Waldstein Co Newark N J

Macallen Co Boston Mass

Magnavox Co Fort Wayne 4 Ind L E Quinnell R H Dreisbach

Magnetic Windings Co Div of Essex Wire Corp 16 & Butler Sts Easton Pa N R Donohoe A Rittenhouse

Majestic Radio & Telev Corp 2600 W 50 St Chicago Ill F Pacholke

Mallory & Co Inc P R 3029 E Washington St Indianapolis 6 Ind J E Cain L Robbin

Mall Tool Co 7708 S Chicago Av Chicago

Mangold Radio Parts & Stamping Co 6300 Shelbourne St Philadelphia 11 Pa F Strobel F Strobel

Manufacturers Screw Prods 216-222 W Hubbard Chicago 10 Ill N R Sackheim W A Mosow

Marken Machine Co Keene N H

McClintock Co O B 139 N Lyndale Av Minneapolis Minn L G Pattee E J Boucher

McElroy Mfg Corp 82 Brookline Av Boston T R McElroy T R McElroy

Measurements Corp Boonton N J H W Houck J B Minter

Meck Industries John Plymouth Ind J S Meck C Wexler

Megard Corp 1601 S Burlington Av Los Angeles 6 Calif J D Funderburg A Troup

Meissner Mfg Co 7 & Belmont Sts Mt Carmel Ill G V Rockey E J Stanmyre

Mercold Corp 4201 Belmont Av Chicago 41 Ill H C Courteol I E McCabe

Merit Coil & Transformer Corp 4427 N Clark Chicago 40 Ill C C Koch H Jones

Metals & Controls Corp General Plate Div Attleboro Mass

Metaplast Co 205 W 19 St New York J Stein M A Prince

Mica Insulator Co 200 Varick St N Y C M A Chapman R H Spry

Micamold Radio Corp 1087 Flushing Av Brooklyn 6 N Y F A Whiting A DiGiacomo

Micarta Fabricators Inc 5324 Ravenswood Av Chicago Ill E Metzger L Nordlie

Micro Switch Div Freeport Ill A L Riche P A Celander

Midwest Radio Corp 909 B'way Cincinnati 2 A G Hoffman P Smith

Millen Mfg Co Malden Mass J Millen R W Caywood

Miller Co J W 5917 S Main St Los Angeles P O'Connor

Minneapolis-Honeywell Regulator Minneapolis Minn

Minn Mining Co 155 6 Av New York City

Mitchell Rand Insulation Co 51 Murray N Y C 7 W B Stevens J J Finn

Mobile Refrigeration Div Bowser Inc 38-32 54 St Woodside N Y C Passman E Lodwig

Molded Insulation Co 335 E Price Phila Pa V Zelov A Zillger

Monitor Piezo Prod Co South Pasadena Calif H E Blasier H E Blasier

Monowatt Electric Corp 66 Bissell St Providence 7 R I G B Behander

Monsanto Chemical Co Springfield Mass

Mossman Inc Donald P 612 N Michigan Av Chicago 11 D P Mossman Sr C A Koerner

Muehlhausen Spring Corp Logansport Ind J R Gustafson

Mueller Electric Co 1583 E 31 St Cleveland S Mueller E H DeConingh

Murdock Mfg Co Chelsea Mass

Muter Co 1255 S Mich Av Chicago 5 Ill L F Muter K E Rollefson

Mycalex Corp of Amer Clifton N J J Talshoff A J Monack

— N —

National Co Inc 61 Sherman St Malden Mass W A Ready D H Bacon

National Electronic Mfg Co 22-78 Steinway Long Island City N Y E Friedlander

National Fabricated Prods W Belden Ave Chicago Ill W M Charney H Ritsch

National Screw & Mfg Co Cleveland Ohio

National Union Radio Corp 15 Wash Newark N J Dr L G Hector

National Varnished Prod Corp Woodbridge N J

Ntl Vulcanized Fibre Co Wilmington Del J K Johnston

Newark Transformer Co 17 Frelinghuysen Av Newark 5 N J M J Herold O A Keefe

New England Mica Co Waltham Mass C G Plimpton W R Mansfield

New England Screw Co Keene N H

New Wrinkel Inc Dayton O

New York Transformer Co 26 Waverly N Y C 3 J C Hindle Z Burzycki

Noblitt Sparks Ind Inc 13th & Big 4 RR Columbus Ind Q G Noblitt A E Silva

Noma Electric Corp 55 W 13 St N Y C C W Otis J E Funk

No. American Philips Co 145 Palisade St Dobbs Ferry N Y E J Kelly H G Boyle

Northern Labs Ltd. 3-01 27 Ave L I City N Y J Zaleski

Northern Industrial Chem Co Boston Mass

Northam Warren Corp Stamford Conn

Norwalk Transformer Corp South Norwalk Conn

Nothelfer Winding Labs Trenton N J

— O —

Oak Mfg Co 1260 Clybourn Av Chicago 10 E Sandstrom E J Mastney

Ohio Carbon Co Cleveland O A K Moulton L L Stoffel

Ohio Electric Co 74 Trinity Pl N Y C

Ohio Nut & Bolt Co 600 Front St Berea O R A Reich Jr

Ohmite Mfg Co 4835 W Flournoy St Chicago J S Howe H Levy

Onan & Sons, D W 43 Royalston Av Minneapolis 5 C W Onan J C Holby

Operadio Mfg Co St Charles Ill G R Haase J F McCraigh

Owens-Corning Fiberglas Corp Toledo O

Oxford-Tartak Radio Corp 3911 S Mich Av Chicago Ill G Rusher

— P —

Pacific Metals Co Ltd San Francisco Calif

Packard Bell Co 1115 S Hope St Los Angeles H D Thomas Jr A R Ellsworth

Palnut Co 92 Cordier St Irvington N J J R Hotchkin E Hill

Panoramic Radio Corp 245 W 55 St N Y C H L M Capron J I Heller

Parisian Novelty Co 3510 S Western Av Chicago Ill L J Komorous

Parker Co Charles Meriden Conn

Parker-Kalon Co 198 Varick St N Y C

Par-Metal Prod Corp L I City N Y

Patton-MacGuyer Co 17 Virginia Av Providence 5 R I J Teeden R C Patton

Pawtucket Screw Co Pawtucket R I

Peck Spring Co Plainville Conn

Peerless Electrical Prod Co 6920 McKinley Los Angeles Calif J Jauch

Perkins Machine & Gear Co Springfield Mass

Permoflux Corp 4916 W Grand Av Chicago W E Gilman

Peterson Radio Council Bluffs Ia

Pheoll Mfg Co 5700 W Roosevelt Rd Chicago 50 E M Whiting F P Tisch

Philco Corp Tioga & C Sts Philadelphia 34 J Ballantyne P Craig Radio F J Bingley Telev

Philharmonic Radio Corp 528 E 72 St N Y C A R Fisher V Brociner

Philmore Mfg Co 113 Univ Pl N Y C 21 P Schwartz R Burke

Phosphor Bronze Smelting Co Phila Pa

Photobell Corp 116 Nassau St N Y C A Edelman

Pierce-Roberts Co Trenton 6 N J H W Roberts

Pilot Radio Corp 37-06 36 St L I City N Y I Goldberg L C Shapiro

Pioneer Gen-E-Motor 5841 W Dickens Av Chicago Ill

Plax Corp Hartford Conn

Polymet Condenser Co 701 E 135 St N Y C S Fishberg

Porter Metal Prod Co 490 Johnson Ave Bklyn

Potter & Brumfield Co Princeton Ind

Potter Co 1950 Sheridan Rd N Chicago Ill E F Potter W F Potter

Power City Radio Co 209 South 1st St Sioux Falls S Dak W B McKenzie G Hering

Powers Electronic & Comm. Co New St Glen Cove N Y A J Sanial

Precision Fabricators Inc Rochester N Y

Precision Piezo Serv 427 Mayflower St Baton Rouge La C E Pearce

Precision Tube Co 3824 Terrace St Phila Pa N H Jack E Turney

Premax Prods Div Chisholm-Ryder Co Inc Niagara Falls N Y G O Benson

Premier Crystal Labs Inc 63 Park Row N Y C A A Glass H M Bach

Premier Metal Etching Co 21-03 44 Av Long Island City N Y

Press Wireless Inc 1475 Broadway N Y C A Warren Norton E E Eldredge

Press Wireless Inc Hicksville N Y P D Zurian

Presto Elec Co New York Av Union City N J

Presto Recording Corp 242 W 55 St NYC 19 R C Powell G J Saliba M M Gruber

Printloid Inc 93 Mercer St N Y C 12 G Margolish

Pyroferric 175 Varick St N Y C

— Q —

Quaker City Gear Wks Inc N Front St Phila

Quam-Nichols Co 33 Pl Av Chicago 16 J P Quam H F Breit

Quartz Labs 1512 Oak St Kansas City Kans H Bowman O Jenkins

— R —

Racon Electric Co Inc 52 E 19 St N Y C 3 A I Abrahams A I Abrahams

Radell Corp Guilford Av Indianapolis Ind

Radex Corp 53 W Jackson Blvd Chicago Ill R R Cook C Holmes

Radiart Corp W 62 St Cleveland Ohio J N Schwerkert R Blauvelt

Radiation Prods Inc 1142 Wall St Los Angeles R Lewis G M Urey

Radio City Prods Co 127 W 26 St N Y C M Reiner M Liebich

Radio Condenser Co Camden N J R E Cramer J S Robb

Radio Corp of America RCA Victor Div Camden 2 N J Dr C B Jolliffe

Radio Craftsmen 1341 S Mich Av Chicago B L Friend B L Friend

Radio Elec Serv Co of Pa N W Cor 7 & Arch Sts Philadelphia 6 Pa M Green

Radio Engineering Labs Inc L I City N Y C Srebroff F A Gunther

Radio Frequency Labs Boonton N J R Corbin R W Seabury

Radio Inventions Inc 155 Perry St N Y C R W Bristol J V L Hogan

Radio Mfg Engineers Inc 306 First Av Peoria 6 Ill R M Planck

Radiomarine Corp of America 75 Varick St New York City I F Byrnes

Radio Receptor Co Inc 251 W 19 St N Y C H Cohn E D Gibbs

Radio Speakers Inc 221 E Cullerton Chicago H C Forster G S Holly

Radio Studios Inc 136 E 3 St Salt Lake City Utah G W Stillman G W Stillman

Radio Transceiver Labs 8717 117 St Richmond Hill N Y F Jacobs F Jacobs

Radio Wire Telev Inc 100 6 Av N Y C 3 B Lehman L Marko

Rauland Corp 4245 N Knox Av Chicago 41 E N Rauland J J O'Callaghan

Raumond Mfg Co Corry Pa E W Feldt P Goring

Raymond Rosen & Co Radio Eng Prod Div 32 & Walnut Sts Philadelphia 4 Pa L P Clark D N Lapp

Raytheon Mfg Co Foundry Av Waltham Mass L K Marshall P L Spencer

Readrite Meter Works Bluffton O

Rea Magnet Wire Co E Pontiac St Ft Wayne Ind E I Snyder

R E C Mfg Corp 1250 Highland St Holliston Mass R E Chick N F Huntley

Redmond Co A G Owosso Mich R H McCabe E Latta

Reeves Sound Labs 62 W 47 St N Y C H E Reeves

Rehtron Corp 2159 Magnolia Av Chicago

Reliance Die & Stamping Co 1260 Clybourn Chicago Ill

Remler Co Ltd 2101 Bryant St San Francisco E G Danielson H A Greene

Republic Steel Corp Republic Bldg Cleveland

Revere Copper & Brass 230 Park Av N Y C

Richardson Co Melrose Park Ill

Richardson Allen Corp 15 W 20 St N Y C E H Connelly

Rider Labs John F 404 4 Av N Y C J M Borst

Rockbestos Prods Corp New Haven 4 Conn B H Reeves H S Moore

Roebling's Sons Co John Trenton N J C R Tyson C M Jones

Rogan Bros 2001 S Michigan Av Chicago

Rohn & Haas Co Wash Sq Philadelphia Pa

Rola Co Inc 2530 Superior Av Cleveland O J Q Tiedje

Roller-Smith Div Realty & Industrial Corp Bethlehem Pa W S Gubelmann Jr A C Bates

Rowe Industries Inc Toledo O

Royal Engineering Co East Hanover N J C K Rose

Ruby Chemical Co 68-70 McDowell St Columbus 8 Ohio G C Baker G C Baker

Runzel Cord & Wire Co 4723 Montrose Av Chicago Ill

Russel, Burdsall & Ward Bolt & Nut Co Port Chester N Y

Russell Co Chicago Ill

Ryerson & Son Inc Jos T Chicago Ill

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Sanborn Co 39 Osborne St Cambridge Mass J L Jenks Jr A Miller

Sangamo Electric Co Springfield Ill H L Kunz F C Holtz

Schott Co Walter L 9306 Santa Monica Blvd Beverly Hills Calif W L Schott F Wilborn

Schuttig & Co 9 & Kearny Sts N E Washington 17 D C L A Schuttig W S Williams

Scientific Radio Prods Co 738 W B'way Council Bluffs Ia L I Meyerson A Shidler

Scientific Radio Serv 4301 Sheridan St University Pk Hyattsville Md H D Eisenhauer

Scott Radio Labs Inc 4450 Ravenswood Av Chicago Ill E J Halter M Hobbs

Scovill Mfg Co 99 Mill St Waterbury Conn N A Cornell

Security Steel Equip Corp Avenel N J

Seeburg Corp J P 1510 Dayton St Chicago J L Barron M W Kenney

Selectar Mfg Corp 21-10 49 Ave L I City N Y C R deSyles J T Powers

Selenium Corp of America 1719 W Pico Blvd Los Angeles Calif M Burlin E Lidow

Sensitive Research Inst Co 9-11 Elm Av Mt Vernon N Y D E Wolf V P Cronin

Sentinel Radio Corp Evanston Ill

Setchell Carlson Inc 2233 Univ Av St Paul 4 Minn B T Setchell B T Setchell

Seymour Mfg Co Seymour Conn

Shakeproof Inc 2501 N Keeler Av Chicago W M Hanneman

Shallcross Mfg Co Collingdale Pa D H Shallcross F D V Mitchell

Shand Radio Specialties 203 W Kearsley St Flint 3 Mich E H Shand

Sherman Mfg Co H B Battle Creek Mich

Sherron Metallic Corp Flushing Av Bklyn P H Sherron M V Barasch

Shure Bros 225 W Huron Chicago Ill S N Shure B B Bauer

Sickles Co F W 165 Front St Chicopee Mass M Cohen H J Benner

Signal Electric Mfg Menominee Mich O H Henes R Winthers

Sigma Inst Inc 70 Ceylon St Boston 21 Mass R T Fisher

Signal Indicator Corp 140 Cedar St N Y C

Simplex Wire & Cable Co 79 Sidney St Cambridge 39 Mass E W Davis

Simpson Electric Co 5208 W Kinzie St Chicago 44 Ill
H A Bernreuter — H A Bernreuter
Slater Electric & Mfg Co Brooklyn N Y
Small Motors Inc 1308 Elston Av Chicago 22
A C Johnson — G E Ditzler
Snyder Mfg Co 22 & Ontario Sts Phila
B L Snyder — G Snyder
Sola Elec Co 2525 Clybourn Av Chicago 14
M A Tennyson
Solar Mfg Corp 285 Madison Ave N Y C 17
J I Cornell
Sonora Radio & Telev Corp 325 N Hoyne Av Chicago Ill
J Geri — D Fetterman
Sound Equipment Corp 3903 San Fernando Rd Glendale 4 Calif
D Wright — D Jones
Southeastern Radio Supply Co 11 E Hargett Raleigh N C
A Rothstein — S H Kahn
Southern Wholesalers Inc 1519 F St N W Washington D C
W E O'Connor
Southington Hdwre Mfg Co Southington Conn
W Smith
Sparks Withington Co Jackson Mich
C J Kayko — H V Nielsen
Spaulding Fibre Co Inc 233 B'way N Y C
C C Steck — E A Russell
Speer Resistor Corp St Marys Pa
G G Herrick — H N Veley
Spencer Thermostat Co 34 Forest St Attleboro Mass
V G Vaughan — J D Bolesky
Sperry Gyroscope Co Inc Garden City N Y
P R Bassett — E C Sparling
Sperti Inc Norwood Station Cincinnati O
R A Lostro — H Rinehardt
Sprague Electric Co North Adams Mass
Stackpole Carbon Co Electronic Components Div St Marys Pa
J H Stackpole — H Dressel
Stallman of Ithaca 210-212 N Tioga St Ithaca N Y
R J West — P F Loveless
Standard Piezo Co Carlisle Pa
F E Reader — W E Richmond
Standard Pressed Stee Co Jenkintown Pa
Standard Radio Parts Co 1244 State Racine Wis
J A Swanson — J A Swanson
Standard Spring & Mfg Co 236 42 St Brooklyn
F Costello — A H Costello
Standard Transformer Corp 1500 N Halsted Chicago Ill
H H Kreft
Standard Winding Co 44-62 Johns St Newburgh N Y
F A Catanzariti
Stanley Tools 111 Elm St New Britain Conn
M A Coe
Star Porcelain Co Trenton N J
Steel Sales Corp 129 S Jefferson St Chicago
Steward Mfg Co Chattanooga Tenn
Steward Mfg Corp 4311 Ravenswood Av Chicago 13
O C Koch — J M Hrouda
Stewart Stamping Co 621 E 216 St Bronx N Y
Stewart-Warner Corp 1826 Diversey Pkway Chicago Ill
Sticht Co Inc H H 27 Park Pl N Y C
A H Volker
Stille-Young Corp 2300 N Ashland Av Chicago
E F Schneider
Stokes Rubber Co Joseph Trenton N J
Stokes Machine Co F J Philadelphia Pa
Stromberg-Carlson Co Rochester 3 N Y
R H Manson — F C Young
Struthers-Dunn Inc 1321 Cherry St Phila
Stupakoff Ceramic & Mfg Co Latrobe Pa
S H Stupakoff — R E Stark
Sullivan Varnish Co 410 N Hart St Chicago
M Sullivan
Sun Radio Co 212 Fulton St N Y C
S Schwartz
Super Electric Products Corp 1057 Summit Jersey City N J
Superior Electric Co Bristol Conn
Superior Tube Co Norristown Pa
S L Gabel — E W Miller
Supreme Inst Co Greenwood Miss
E G Perkins — R Soward
Surprenant Elec Insulation Co 84 Purchase Boston 10 Mass
E M Quill — G E Forsberg
Sylvania Electric Prods Inc Emporium Pa
M F Balcom — R M Wise
Synthane Corp Oaks Pa
R R Titus

— T —

Tablet & Ticket Co 1021 W Adams St Chicago
W A Spielmann
Taylor Fibre Co Norristown Pa
Taylor Tubes Inc 2341 Wabansia Chicago
Tech Art Plastics Co Inc 41-01 36 Av Long Island City N Y
R E Berg — J Petersen
Technical Appliance Corp 516 W 34 St N Y C
H H Brown — T Lundahl
Technical Labs 7 Lincoln St Jersey City N J
M Bjorndal
Telegraph Apparatus Co 324 W Huron St Chicago 10 Ill
J E Goode
Telephonics Corp 350 W 31 St N Y C
J F Stengel — W T Weidenman
Teleradio Eng Corp Shannon & Barrett Sts Wilkes-Barre Pa — N E Leddo
Templetone Radio Mfg Co New London Conn
O Dane — Dr D Pollack
Tenney Engineering Inc 26 Av B Newark 5 N J
M Seligmon — C A Sewell
Thermador Electrical Mfg Co 5119 Riverside Los Angeles 22 Calif
W E Cranston Jr — J Wardell
Thomas & Betts Co 36 Butler St Elizabeth N J
C A Badeau
Thomas & Skinner Steel Prod Co Indianapolis
Thompson Clock Co H C Bristol Conn
Thordarson Elec Mfg Co 500 W Huron Chicago 10
Tillotson Furniture Corp 22 Steele St Jamestown N Y
J Tillotson Jr
Trade-Wind Motorfans Inc 5725 S Main St Los Angeles Calif
Transmitter Equipment Mfg Co Inc 345 Hudson St N Y C 14
M B Kahn — S L Sack
Trav-Ler Karenola Radio & Telev Corp 571 W Jackson Blvd Chicago 6 Ill
J Friedman — R J O'Brien
Treitel-Gratz Co Inc 142 E 32 St N Y C
F W Gratz
Trent Co Harold E Philadelphia Pa
Trimm Inc 1770 W Berteau Chicago
Triplett Elec Instrument Co Bluffton O
R L Triplett — F J Lingel
Triumph Mfg Co 4017 W Lake St Chicago
Truscon Steel Co Youngstown O
Tull Metal & Supply Co Atlanta Ga
Tungsol Lamp Works Inc 95 8 Av Newark N J
A K Wright
Turner Co 909 17 St N E Cedar Rapids Ia
R P Evans — R H Mayer

— U —

Ucinite Co Newtonville Mass
G V Sweetman — C A Woodward
Ungar Inc Harry A 615 Ducommun St Los Angeles 54 Calif
S D Ungar
United Cinephone Corp Torrington Conn
L B Cornwell — J M Miller Jr
United Electronics Co 42 Spring St Newark N J
B F Steiger
United Scientific Labs 440 Lafayette N Y C
L Weiss — M Glaser
United Transformer Co 150 Varick N Y C
Universal Microphone Co 424 Warren Av Inglewood Calif
L Willyard
Universal Plastics Corp New Brunswick N J
R O A Peterson — E F Keusch
University Labs 225 Varick St N Y C
A Blumenfeld
United Screw & Bolt Corp 71 Murray N Y C
U S Rubber Co 1230 6 Av N Y C
Utah Radio Prods Co 820 Orleans Chicago 10
W A Ellmore — M S Danisch

— V —

Valpey Crystal Corp 1244 Highland Holliston Mass
T S Valpey — D MacDougall
Varflex Corp 305 N Jay St Rome N Y
Victor Insulators Inc Victor N Y
E M Meyer
Vasco Elec Mfg Co 4116 Avalon Blvd Los Angeles Calif
Vibration Specialty Co 1536 Winter St Philadelphia Pa
Vulcan Elec Co Lynn Mass

— W —

Walker-Jimieson Inc 311 S Western Av Chicago 12 Ill
R E Walker — P Chauncey
Walker-Turner Co Inc Plainfield N J
Wallace Mfg Co Wm T Madison & Chili Peru Ind
W T Wallace — J R Myers
Ward Leonard Elec Co 31 South St Mt Vernon N Y
A A Berard — W W Miller
Ward Prods Corp 1523 E 45 Cleveland O
Warwick Mfg Corp 4640 W Harrison Chicago 44
J S Holmes — H A Gates
Watterson Radio Mfg Co Dallas Texas
J W Davis — D C O'Neill
Webster Products 3825 W Armitage Av Chicago
D MacGregor — N L Conrad
Western Electric Co Inc 120 Bway N Y C 5
F R Lack — H N Willets
Western Felt Works 4031 Ogden Av Chicago
Western Lithograph Co 600 E 2 St Los Angeles 54 Calif
G W Hall — C E Shaw
Westinghouse Elec & Mfg Co 2519 Wilkens Baltimore 3 Md
C J Burnside — R N Harmon
Westinghouse Lamp Div Bloomfield N J
Weston Elec Inst Corp 614 Frelinghuysen Newark 5 N J
E R Mellen — J H Miller
Wheeler Insulated Wire Co Inc Bridgeport Conn
A Sieplan — G B Horn
Wheelco Insts Co 847 Harrison Chicago
P A Blandford — T A Cohen
White Dental Mfg Co 10 E 40 St N Y C
Whitehead Metal Prods Co 303 W 10 St N Y C
Whitney Screw Corp Nashua N H
Wick Organ Co Highland Ill
Wilcox-Electric Co Inc 1400 Chestnut St Kansas City 1 Mo
J V Wilcox — A P Stuhrman
Wilcox-Gay Corp Charlotte Mich
Williams & Co Inc Pittsburgh Pa
A C Armstrong
Willor Mfg Corp 794 E 140 St N Y C
Wilmington Fibre Specialty Co Wilmington Del
J W Morris
Wilson Co H A 105 Chestnut Newark N J
Wincharger Corp Sioux City 6 Ia
R F Weinig — V C Miron
Winslow Co Inc 9 Liberty St Newark N J
R R Knapp
Winsted Div Hudson Wire Co Winsted Conn
O F Bitzer — A E Griffin
Wirt Co 5221 Greene St Phila 44 Pa
P H Stuckey
Worner Electronic Devices 609 W Lake St Chicago 6 Ill
L L Worner — A E Eldam
Wyatt Cornick Inc Grace at 14 St Richmond Va
G M Wyatt Jr — J M Wyatt Jr

— Y —

Yancey Co Inc 340 W Peachtree St Atlanta Ga
M W Edwards

— Z —

Zeiss Inc Carl 485 Fifth Av N Y C
Zenith Radio Corp 6001 Dickens Av Chicago 39
E F McDonald Jr — G E Gustafson
Zierick Mfg Co 385 Girard Av Bronx N Y
Zobrist Co Herb E 2125 Westlake Av Seattle 1 Wash
Zophar Mills Inc 112-130 26 St Brooklyn
A Saunders

GENERAL MANAGERS

— A —

Abrahams AI — Racon Electric Co Inc
Abrams B — Emerson Radio & Phono Corp
Aitchison RJ — Fansteel Metallurgical Corp
Alden M — Alden Prods Co
Allen JM — Erie Resistor Corp
Amrine LH — Imperial Molded Prods Corp
Amy EV — Amy Aceves & King
Andersen RH — Heintz & Kaufman Ltd
Andrea FAD — Andrea Radio Corp
Andrew FJ — Andrew Co
Armstrong AC — Williams & Co Inc
Atkinson LH — Elastic Stop Nut Corp
Avery RS — Avery Adhesives

— B —

Bachner EF — Chicago Molded Prods Corp
Bailey JJ — Cover Dual Signal Systems
Baker GC — Ruby Chemical Co
Balcom MF — Sylvania Electric Prods Inc
Baldwin JP — Corbin Screw Corp
Ballantyne J — Philco Corp
Barron JL — JP Seeburg Corp
Bassett PR — Spery Gyroscope Co
Bassett RE — Bassett Inc Rex
Beers OE — Conn Ltd C G
Behringer GF — American Steel Package
Bellezza RG — Locke Insulator Corp
Benson GO — Premax Prods Div Chisholm-Ryder Co
Berard AA — Ward Leonard Elec Co
Berg RE — Tech Art Plastics Co Inc
Berke SW — Lafayette Radio Corp
Bernreuter HA — Simpson Electric Co
Bicknell RS — American Lava Corp
Birnbach N — Birnbach Radio Co
Bitzer OF — Winsted Div Hudson Wire Co
Bixler RM — J-B-T Instruments Inc
Blandford PA — Wheelco Instruments Co
Bliley FD — Bliley Electric Co
Blumenthal CR — Atlas Sound Corp
Boes WW — Boes Co WW
Bowman H — Quartz Labs
Brannan RE — Bakelite Corp
Brassil WT — Adams & Westlake Co
Brister JE — Bakelite Corp
Bristol RW — Radio Inventions Inc
Brown HH — Technical Appliance Corp
Bunch CH — Acme Elec & Mfg Co
Burlin M — Selenium Corp of America
Burnett TD — G C Hunt & Sons
Burnside CJ — Westinghouse Elec & Mfg
Burritt HW — Eureka Vacuum Cleaner Co

— C —

Cain JE — Mallory & Co Inc
Cannon RJ — Cannon Mfg Corp
Capron HLM — Panoramic Radio Corp
Carbonara VE — Kollsman Inst Div
Cardwell DA — Cardwell Mfg Corp
Carson RW — Instrument Specialties Co
Carter RW — Carter Motor Co
Cerny JJ — Lectrohm Inc
Cezar A — Electronic Transformer Co
Chapman AK — Eastman Kodak Co
Chapman MA — Mica Insulator Co
Charney WM — Ntl Fabricated Prods
Chick RE — R E C Mfg Corp
Christian FW — Lee de Forest Labs
Church VS — Burton-Rogers Co
Clare CP — Clare & Co C P
Clark LP — Raymond Rosen & Co
Coe MA — Stanley Tools
Cohen M — Sickles Co F W
Cohn H — Radio Receptor Co Inc
Cohon MM — Carron Mfg Co
Cole SI — Aerovox Corp
Collins AA — Collins Radio Co
Collman CC — Bliley Elec Co
Connelly EH — Allen Richardson Corp
Conover RA — Haydon Mfg Co Inc
Cook J — Cornish Wire Co Inc
Cook RR — Radex Corp
Copelin JG — Litton Engineering Labs
Cooper BW — Delco Radio Div
Corbin R — Radio Frequency Labs Inc
Cornwell LB — United Cinephone Corp
Cosgrove RC — Crosley Corp
Costello F — Standard Spring & Mfg Co
Courteol HC — Mercoid Corp
Cowles AL — Bluff City Distributing Co
Craigmile CS — Belden Mfg Co
Cramer RE — Radio Condenser Co
Crane ER — Lear Inc
Cranston WE — Thermador Electrical Mfg
Crawford RM — Durez Plastics & Chem
Crompton EE — Burke Electric Co
Cummings BR — Farnsworth Telev & Radio
Curtis JA — Halstead Traffic Comm Corp

— D —

Dane O — Templetone Radio Mfg Co
Daniels JV — Kemlite Labs
Danielson EG — Remler Co Ltd
Danziger HI — Crowley & Co Inc
Darnell DD — Air Communications Inc
Davis JW — Watterson Radio Mfg Co
Day CH — Browning Labs Inc
Decker WC — Corning Glass Works
DeShazo GH — Gray Radio Co
de Syles CR — Selectar Mfg Corp
Diehl WF — Airplane & Marine Inst Inc
Dine FE — Higgins Industries Inc
Doherty EW — American Elec Heater Co
Donohoe NR — Magnetic Windings Co
Dow WH — Dow Chemical Co
Downsbrough GA — Boonton Radio Corp
Doyle RF — Alliance Mfg Co
Driver FL — Driver-Harris Co
DuMont AB — DuMont Labs Inc
DuVall FB — Electronic Mechanics Inc

— E —

Eberts FS — Dinion Coil Co Inc
Eckstein EA — Eckstein Radio & Telev Co
Edwards MW — Yancey Co Inc
Eisenhauer HD — Scientific Radio Serv
Ellinger EE — Jefferson-Travis Radio Mfg
Ellmore WA — Utah Radio Prods Co
Engle KD — Industrial Condenser Corp
Engelson DH — Federal Mfg & Eng Corp
Esposito JR — Ault & Wiborg Div
Evans RP — Turner Co

— F —

Falck FW — Advance Elec Co
Favor LA — Knights Co James
Feldt EW — Raumond Mfg Co
Felker MN — Felker Mfg Co
Fisher AR — Philharmonic Radio Corp
Fisher A — Condenser Prods Co
Flanzer JA — Electro Motive Mfg Co
Forster HC — Radio Speakers
Foute AJ — Drake Mfg Co
Frank J — Airking Prods Co
Franklin AW — Franklin Mfg Corp
Fredericks WH — Electrical Industries
Freed A — Freed Radio Corp
Freed L — Freed Transformer Co
Friedlander E — Ntl Electronic Mfg Co
Friedman J — Trav-Ler Karenola Radio Telev Corp
Friend BL — The Radio Craftsmen
Funderburg JD — Megard Corp

— G —

Gabel SL — Superior Tube Co
Gage NE — American Insulator Corp
Gardiner RA — Gardiner Metal Co
Gardner AH — Colonial Radio Corp
Garstand WW — Electronic Labs Inc
Geri J — Sonora Radio & Telev Corp
Gertsch EP — Air Associates Inc
Gervais E — Edwards Co W H
Gilfillan SW — Gilfillan Bros Inc
Girard WE — H-B Electric Co
Gladfelter RH — Detroit Power Screw-driver
Glass AA — Premier Crystal Labs Inc
Goffstein A — American Telev & Radio Co
Goldberg I — Pilot Radio Corp
Goode JE — Telegraph Apparatus Co
Gothard RW — Gothard Mfg Co
Gotthold PM — Industrial Inst Inc
Gray AS — Insulation Mfgrs Corp
Gray CA — Grenby Mfg Co
Gray D — Doolittle Radio Inc
Green M — Radio Elec Serv Co of Pa
Griffin DA — Communication Measurements Lab
Griffin W — Jefferson Inc Ray
Gubelman WS — Roller-Smith Div
Gunter J — Hollywood Electronics

— H —

Haase GR — Operadio Mfg Co
Haas ML — Bud Radio Inc
Hadley RM — R M Hadley Co
Hall BW — Western Lithograph Co
Halligan WJ — Hallicrafters Co
Halligan WJ — Echophone Radio Co
Halter EJ — Scott Radio Labs
Hamilton HG — Eastern Air Devices
Harnett DE — Hazeltine Electronics Corp
Harrison WE — Harrison Radio Corp
Harvey LA — Harvey Machine Co Inc
Harwell HW — Connecticut Tel & Elec
Hastings TM — Gen Comm Co
Hawkins GM — Isolantite Inc
Henes OH — Signal Electric Mfg
Herold MJ — Newark Transformer Co
Herrick GG — Speer Resistor Corp
Hess JC — Leeds & Northrup
Hickok RD — Hickok Electrical Inst Co
Hilliard WP — Bendix Radio Div
Hindle JC — N Y Transformer Co
Hoffman AG — Midwest Radio Corp
Homes JS — Warwick Mfg Corp
Holmstrom F — H H Eby Inc
Hopkins JC — Girard-Hopkins
Hopp P — Hopp Press Inc
Hotchkin JR — Palnut Co
Houch HW — Measurements Corp
Houseman AJ — Automatic Radio Mfg Co
Howe JS — Ohmite Mfg Co
Hoyt AE — Herb E Zobrist Co

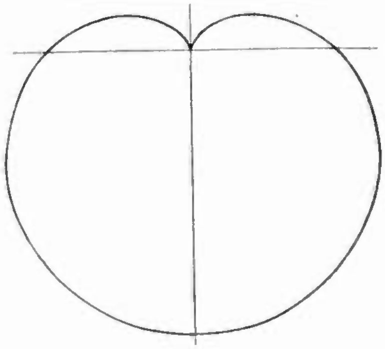
— J —

Jack NH — Precision Tube Co
Jacobs F — Radio Transceiver Labs
Jenks JL — Sanborn Co
Jennings DS — Central Screw Co
Johnson AC — Small Motors Inc
Johnson AL — Hexacon Electric Co
Johnson EF — Johnson Co E F
Johnson EH — Gear Specialties
Johnson RW — Bouts Aircraft Nut Corp
Johnston JK — National Vulcanized Fibre
Jones CH — Kato Engineering Co
Jones GM — Ace Mfg Corp
Juvilier J — Hamilton Radio Corp

— K —

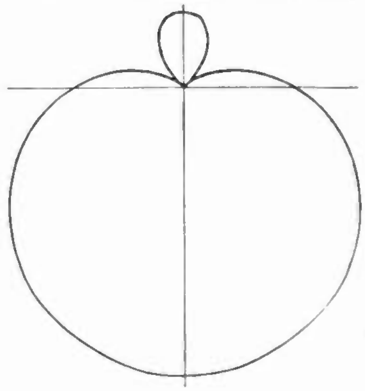
Kaar JM — Kaar Engineering Co
Kahn AR — Electro-Voice Corp
Kahn MB — Transmitter Equip Mfg Co
Karr IJ — General Electric Co
Kayko CJ — Sparks Withington Co
Kelleigh WJ — General Control Co
Kelly EJ — No American Philips Co
Kimball R — Communications Equip Corp
Kirkland HR — Kirkland Co H R
Kirsch MJ — Federal Engineering Co
Klunder AE — Janette Mfg Co
Knapp RR — Winslow Co
Koch CC — Merit Coil & Transformer Corp
Koch OC — Steward Mfg Corp
Kohring WM — Cont Carbon Co
Kopinski L — Fast & Co John E
Krueger FG — Krueger & Hudepohl
Kruse RH — Cambridge Inst Co
Kulka W — Kulka Elec Mfg Co Inc
Kunz HL — Sangamo Electric Co

. . This is Cardioid



"Cardioid" means heart-shaped. It describes the pickup pattern of a microphone as illustrated in this diagram. Unwanted sounds approaching from the rear are cancelled out and the pickup of random noise energy is reduced by 66%. The actual front to back ratio of reproduction of random sound energy is 7 to 1.

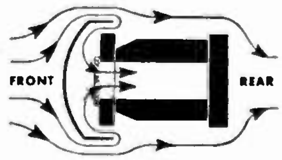
. . This is Super-Cardioid



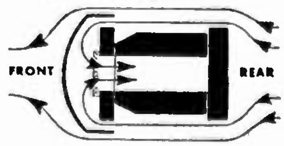
"Super-Cardioid" also describes a pickup pattern and is a further improvement in directional microphones. The Super-Cardioid has a wide front-side pickup angle with greater exclusion of sounds arriving from the sides and the rear. The front to back random sound ratio is 14 to 1 which makes it twice as unidirectional as the "Cardioid." A 73% decrease in the pickup of random noise energy is accomplished.

. . This is Uniphase

"Uniphase" describes the principle by which directional pickup is accomplished in a single Microphone unit. This is a patented Shure development and makes possible a single unit "Super-Cardioid" Directional Microphone eliminating the necessity of employing two microphone units in one case—it gives greater uniformity in production, greater ruggedness, lower cost for comparable quality and more uniform vertical pickup pattern.



Sounds entering from front.



Sounds entering from rear.

. . This is the result

The SHURE Super-Cardioid

A decrease in the pickup of random sound energy by 73%—reduction of feedback and background noise—simplification of sound pickup are among the many advantages offered by the Shure "Super-Cardioid" Dynamic. These, plus faithful reproduction, are the reasons why Shure "Super-Cardioid" Microphones are used by more than 750 Broadcast Stations in the United States alone, by our Armed Forces throughout the world, and on thousands of Public Address Systems everywhere.

SHURE BROTHERS

Designers and Manufacturers of Microphones and Acoustic Devices

225 West Huron Street Chicago 10, Illinois

SHURE MICROPHONES

General Managers, Cont.

Kurland JJ   Illinois Condenser Co
Kux JJ   Kux Machine Co

— L —

Lack FR   Western Electric Co Inc
Lane MM   Croname Inc
Lansing RP   Bendix Aviation Corp Eclipse-Pioneer Div
Lavoie SD   Lavoie Laboratories
Lee M   Burndy Engineering Co Inc
Lehman B   Radio Wire Telev Inc
Leidner J   Camburn Prods Co
Levine JM   Federal Screw Prods Co
Levingston GL   Harwood Co
Lewis R   Radiation Prods Inc
Ling EF   Corning Glass Works
Lingo JE   John E Lingo & Son
Link FM   Link Radio Corp
Lisman WF   Leland Electric Co
Lostor RA   Sperti Inc
Loveless PF   Stallman of Ithaca
Lyman F   Harvey Radio Labs Inc

— M —

MacGregor D   Webster Products
Mahler RA   Harvey Wells Elec Inc
Maneck EE   Brandywine Fibre Prods Co
Manson RH   Stromberg-Carlson Co
Marcus DA   Electronic Specialty Co
Marshall LK   Raytheon Mfg Co
Marvin S   American Transformer Co
Mascuch JT   Breeze Corps Inc
Mattes HC   Belmont Radio Corp
McCabe RH   A G Redmond Co
McDonald EF   Zenith Radio Corp
McElroy TR   McElroy Mfg Corp
McEwen LI   Gates Radio Co
McGiffin R   Lewyt Corp
McIlvaine HA   Continental Elec Co
McIlvane WJ   Copperweld Steel Co
McKenna CF   Gen Aniline & Film Corp
McKenzie WB   Power City Radio Co
McLean MP   D-X Radio Prods Corp
McLellan JD   Bunnell & Co
McMaster AJ   G-M Laboratories Inc
Meck JS   Meck Industries
Mellen ER   Weston Elect Inst Corp
Melick AH   Instrument Resistors
Menschik I   American Condenser
Merrill WA   Atlas Resistor Co
Messer CW   Audio Development Co
Metzger E   Micarta Fabricators Inc
Meyerson LI   Scientific Radio Serv
Millen J   Millen Mfg Co
Minch JA   Electric Auto-Lite Co
Mitchell DT   American Radio Hdwre Co
Morris JW   Wilmington Fibre Specialty Co
Morrison P   Gibbs & Co Thomas B
Mossman DP   Donald P Mossman Inc
Moulton AK   Ohio Carbon Co
Murray AR   Electrolux Corp
Muter LF   Muter Co
Mueller S   Mueller Electric Co
Muniz JM   Howard Radio Co

— N —

Nee TG   Acme Wire Co
Nichols P   Bendix Aviation Corp
Nickerson FW   Guided Radio Corp
Novick SJ   Electronic Corp of America
Noblitt QG   Noblitt Sparks Inc
Norton AW   Press Wireless Inc

— O —

O'Brien FJ   Galvin Mfg Corp
O'Connor WE   Southern Wholesalers Inc
Onan CW   Onan & Sons
Otis CW   Noma Electric Corp

— P —

Pariser S   Atlas Condenser Prods
Parkins EG   Supreme Instruments
Passman C   Mobile Refrigeration
Pattee LG   McClintock Co
Patton CW   Bakelite Corp
Peterson AW   Continental Elec Co
Peterson ROA   Universal Plastics
Phillips CJ   Corning Glass Works
Pinsley N   Espey Mfg Co
Plimpton CG   New England Mica Co
Pode HA   Bendix Aviation Corp
Potratz AC   Gen Armature Corp
Potter EF   Potter Co
Powell CS   Graybar Electric Co Inc
Powell RC   Presto Recording Corp
Priest CA   General Electric

— Q —

Quam JP   Quam-Nichols Co
Quill EM   Surprenant Elec Insulation Co
Quinnell LE   Magnavox Co

— R —

Rauland EN   Rauland Corp
Reader FE   Standard Pieze Co
Ready WA   National Co Inc
Reeves BH   Rockbestos Prods Corp
Reiner M   Radio City Prods Co
Replogle DE   General Electronics Inc
Riche AL   Micro Switch Div
Richmond HB   General Radio Co
Roberts HW   Pierce-Roberts Co
Robinson WA   Brach Mfg Corp
Rockey GV   Meissner Mfg Co
Rogers KE   Carborundum Co
Rose HR   Gen Telev & Radio Corp
Rothstein A   Southeastern Radio Supply
Rowell FF   Guardian Elec Mfg Co
Rude R   Barker & Williamson
Russell HS   Louthan Mfg Co
Ruth F   Aero Communications Inc
Ruth F   Erco Radio Labs Inc

— S —

Sackheim NR   Mfgrs Screw Prods
Sandstrom E   Oak Mfg Co
Sanial AJ   Powers Electronic & Comm Co
Schaffer H   Hollywood Electronics
Schier W   Hofstatter's Sons Inc
Schmitt AJ   American Phenolic Corp
Schneider AW   Comm Radio Sound Corp
Schott WL   Schott Co Walter L
Schuttig LA   Schuttig & Co
Schwartz P   Philmore Mfg Co
Schwartz S   Sun Radio Co
Schwerkert JN   Radiat Corp
Seelig LJ   General Transformer Co
Seligmon M   Tenney Eng Inc
Setchell BT   Setchell Carlson Inc
Shallcross DH   Shallcross Mfg Co
Shand EH   Shand Radio Specialties
Sharp TW   Bakelite Corp
Shaw G   Bakelite Corp
Shaw M   Lewis Electronics
Shepherd DG   Electric Specialty Co
Shermund RC   Induction Heating Corp
Sherron PH   Sherron Metallic Corp
Siemers HR   H R S Prods
Shure SN   Shure Bros
Slepian A   Wheeler Ins Wire Co Inc
Smith E   Fisher Research Lab
Smith GE   Communications Co Inc
Smith H   Bakelite Corp
Smith W   Southington Hdwre Mfg Co
Snyder BL   Snyder Mfg Co
Spiellmann WA   Tablet & Ticket Co
Srebroff C   Radio Engineering Labs Inc
Stack AR   Girard-Hopkins
Stackpole JH   Stackpole Carbon Co
Staver EF   Goat Metal Stampings Inc
Steck CC   Spaulding Fibre Co Inc
Stein J   Metaplast Co
Stengel JF   Telephonics Corp
Stevens WB   Mitchell Rand Insul Co
Stillman GW   Radio Studios Inc
Storkerson JM   Fenwal Inc
Strobel F   Mangold Radio Parts & Stpg
Stubbers AH   Ilsco Copper Tube & Prods
Stuckey PH   Wirt Co
Stupakoff SH   Stupakoff Ceramic & Mfg
Sullivan JE   Airadio Inc
Summers JM   Camloc Fastener Corp
Sundt EV   Littelfuse Inc
Swanson JA   Standard Radio Parts Co
Sweetman GV   Ucinite Co
Swikard JR   Fada Radio & Elec Co

— T —

Taishoff J   Mycalex Corp of Amer
Tartak PH   Cinaudagraph Speakers Inc
Taylor OF   Electrical Research Labs Inc
Teeden J   Patton-MacGuyer Co
Teitler SL   Lepel Labs
Thomas HD   Packard Bell Co
Tillotson J   Tillotson Furniture Corp.
Tregenza AE   Jefferson Elec Co
Triplett RL   Triplett Elec Instrument
Tyson CR   John Roebling's Sons Co

— U —

Ungar SD   Ungar Inc Harry

— V —

Valpey TS   Valpey Crystal Corp
Vaughan VG   Spencer Thermostat Co
Volker AH   Sticht Co Inc

— W —

Wahlgren WW   Gardner Elec Mfg Co
Walker RC   Aircraft Accessories Corp
Walker RE   Walker-Jimieson Inc
Wallace WT   Wallace Mfg Co Wm T
Wanvig JD   Centralab Div of Globe-Union
Ward SI   Crystal Research Labs
Wayman EL   Hudson American Corp
Weaver WJ   Ansonia Elec Co
Weining RF   Wincharger Corp
Weiss L   United Scientific Labs
West RJ   Stallman of Ithaca
White TA   Jensen Radio Mfg Co
Whiting EM   Pheoll Mfg Co
Whiting FA   Micamold Radio Corp
Wilcox JV   Wilcox Electric Co Inc
Wolf DE   Sensitive Research Inst Co
Wood TS   Corning Glass Works
Worner LL   Worner Electronic Devices
Wrape HJ   Bentley-Harris Mfg Co
Wright D   Sound Equip Corp
Wunderlich GF   Eitel-McCollough Inc
Wyatt GM   Wyatt Cornick Inc

— Y —

Yarbrough FA   American Microphone Co
Young NT   Hatry & Young
Young R   Hudson American Corp

— Z —

Zachariah VN   Zach Radio Supply
Zayac FR   Ballantine Labs Inc
Zelov V   Molded Insulation Co
Zieber G   Hewlett-Packard Co

CHIEF ENGINEERS

— A —

Abrahams AI   Racon Electric Co Inc
Alban CF   WM Chace Co
Andersen DE   J-B-T Instruments Inc
Angst W   Kollsman Inst Div of Sq D
Applegate ID   Ideal Com Dresser Co
Armstrong IW   Dinion Coil Co Inc

— B —

Babcock SK   Electronic Specialty Co
Bach HM   Premier Crystal Labs Inc
Bacon DH   National Co Inc
Badeau CA   Thomas & Betts Co
Bailey WM   Cornell-Dubilier Elec Corp
Bain GW   Ken-Rad Tube & Lamp Corp
Baker GC   Ruby Chemical Co
Barasch MV   Sherron Mettalic Corp
Barlow WA   General Winding Co
Basim DS   Airadio Inc
Bates AC   Roller-Smith Div Realty & Industrial Corp
Bauer B   Hewlett-Packard Co
Bauer BB   Shure Bros
Bausch CL   Bausch & Lomb Optical Co
Bean LG   Bristol Co
Benander GB   Monowatt Elec Corp
Benkelman GF   Cont Carbon Inc
Benner HJ   Sickles Co FW
Bennett AE   Gentleman Prods Div Henney Motor
Bergers W   Amer Spring Mfg Corp
Bernreuter HA   Simpson Electric Co
Bevington KA   American Molded Prods Co

Chief Engineers Cont.

Bingley FJ Philco Corp
Bjorndal M Technical Appliance Corp
Blackburn RK Crystal Research Labs
Blasier HE Monitor Piezo Prods
Blauvelt R Radiart Corp
Bloom Dr MC Gen Comm Co
Blumenfeld A University Labs
Blye H DeJur Amsco Corp
Bohlen WI Rex Bassett Inc
Bolesky JD Spencer Thermostat Co
Borggrafe EW Electrical Prod Corp
Borst JM Rider Labs John F
Bosh FE Driver-Harris Co
Boucher EJ McClintock Co
Bovee BA Carborundum Co—Globar Div
Boyd DL General Industries Co
Boyle HG No American Philips Co
Brainin CS Brainin Co
Breit HF Quam-Nichols Co
Breunich T Brandywine Fibre Prods Co
Brociner V Philharmonic Radio Corp
Brown D Bendix Aviation Corp
Browning GH Browning Labs Inc
Brown ME Borg-Gibbs Lab
Budelman FT Link Radio Corp
Burke R Philmore Mfg Co Inc
Burroughs LR Electro-Voice Corp
Burzycki CZ New York Transformer Co
Byrnes IF Radiomarine Corp of America

— C —

Cardwell AD Cardwell Mfg Corp
Carlson VE Aircraft-Marine Prods Inc
Carpenter JR Insuline Corp of America
Caywood RW Millen Mfg Inc James
Cezar A Electronic Transformer Co
Catanzariti FA Standard Winding Co
Celander PA Micro Switch Div
Chauncey P Walker-Jimieson Inc
Christaldi PS Du Mont Labs, Allen B
Clark RA Comm Equip & Eng Co
Clement LM Crosley Corp
Clemons CW Knapp-Monarch Co
Clifford DG Industrial & Comm Electronics
Cohen TA Wheeloo Instruments Co
Cohn M Electro Motive Mfg Co
Conrad NL Webster Products
Cox CR Andrew Co
Cornell JI Solar Mfg Corp
Cornell NA Scovill Mfg Co
Costello AH Standard Spring & Mfg Co
Craft LM Collins Radio Co
Craig P Philco Corp
Cronin FP Sensitive Research Inst Co
Crowley HL Crowley & Co Inc Henry L
Cullin JF General Armature Corp
Curtiss WR Connecticut Tel & Elec

— D —

Dalyrmple GT Boonton Radio Corp
Dalyrmple HC Guided Radio Corp
Danisch MS Utah Radio Prods Co
Dante JJ Dante Elec Mfg Co
Daugherty RM Detrola Corp
Davis EW Simplex Wire & Cable Co
DeConingh EH Mueller Electric Co
de Forest L Lee de Forest Labs
DeHorn CE General Transformer Co
DeMetrick JS Auto Radio Mfg Co Inc
DiGiacomo A Micamold Radio Corp
Ditzler GE Small Motors Inc
Donaldson WR Celanese Corp
Donato J American Radio Hdwre Co Inc
Doughman FC Electrolux Corp
Dreisbach RH Magnavox Co
Dressel H Stackpole Carbon Co
Druesne MAA James Knights Co
Duerk KA American Steel Package Co
Dunn WL Belmont Radio Corp

— E —

Eastham M General Radio Co
Eckstein EA Eckstein Radio & Telev Co
Edelman A Photobell Corp
Edwards WH Edwards Co
Ehlers GM Centralab Div of Globe-Union
Eibl LA Crystal Prod Co
Eldam AE Worner Electronic Devices
Eldredge EE Press Wireless Inc
Ellsworth AR Packard Bell Co
Enlfing E Cannon Mfg Corp

— F —

Farmer EB General Control Co
Farrell JJ General Electric Co
Faucett IT Gen Cable Corp
Ferguson J Farnsworth Telev & Radio
Fetterman D Sonora Radio & Telev Corp
Fick CG Gen Elec Co
Finn JJ Mitchell Rand Insulation Co
Fishberg S Polymet Condenser Co
Fishberg S Cosmic Radio Corp
Fisher BN Gen Inst Corp
Fisher GR Fisher Research Lab
Fisher RT Sigma Inst Inc
Floyd OH Kemlite Labs
Forbes HC Colonial Radio Corp
Forsberg GE Suprenant Elec Insul Co
Foute HK Drake Mfg Co
Franklin WS Fast & Co John E
Friend DL The Radio Craftsmen
Frost GW Gothard Mfg Co
Frye RH Electronic Labs Inc
Funk JE Noma Electric Corp

— G —

Garlick W American Transformer Co
Gates HA Warwick Mfg Corp
George EB Leland Electric Co
Gerster CW Louthan Mfg Co
Gibbs ED Radio Receptor Co Inc
Gilman WE Permoflux Corp
Glaser M DeWald Radio Corp
Glaser M United Scientific Labs
Goring P Raumond Mfg Co
Gratz FW Treitel-Gratz Co Inc
Graves ED Avery Adhesives
Gray D Doolittle Radio Inc
Gray FE Gray Radio Co
Graybill KW Automatic Elec Co
Greene HA Remler Co Ltd
Greenleaf LB Conn Ltd C G
Griffin AE Winsted Div Hudson Wire Co
Grimwood F Gates Radio Co
Gruber MM Presto Recording Corp
Gunther FA Radio Engineering Labs Inc
Gurevics D Freed Transformer Co
Gustafson GE Zenith Radio Corp
Gustofson JR Muehlhausen Spring Corp

— H —

Haas A Hudson American Corp
Hale CB Gear Specialties
Hamond GI Eagle Elec Mfg Co
Hanneman WM Shakeproof Inc
Hantz BF American Insulator Corp
Harmon RN Westinghouse Lamp Div
Harnett DE Hazeltine Elec Corp
Harsch JW Leeds & Northrup Co
Harvey H Harvey Machine Co
Harvey CA Harvey Wells Electronics Inc
Haynes NM Amplifier Co of America
Hatry LW Hatry & Young
Hector Dr LG Ntl Union Radio Corp
Hein RO All-Amer Tool & Mfg Co
Heindel HJ Andrea Radio Corp
Heller JI Panoramic Radio Corp
Helwig NC Kaar Eng Co
Hennessey SW Camloc Fastener Corp
Heppner EA Cons Radio Prod Co
Hering G Power City Radio Co
Hill E Palnut Co
Hill HH R M Hadley Co
Hinshaw MW Felker Mfg Co
Hobbs M Scott Radio Labs
Hogan JVL Radio Inventions Inc
Holby JC Onan & Sons D W
Holly GS Radio Speakers Inc
Holmes C Radex Corp
Holtz FC Sangamo Electric Co
Hood A Brach Mfg Corp
Horn GB Wheeler Ins Wire Co Inc
Hornickel HC American Microphone Co
Howes G Eitel-McCullough Inc
Hrouda JM Steward Mfg Corp
Huckabee VC Advance Elec Co
Hudepohl FH Krueger & Hudepohl
Humble CE Burke Electric Co
Hunter FL Fansteel Metallurgical
Huntley NF R E C Mfg Corp
Hutchings JH Continental Elec Co
Hutton VO Cambridge Inst Co

— I —

Israel DD Emerson Radio & Phono Corp

— J —

Jacobs F Radio Transceiver Labs
James W Howard Radio Co
Jauch J Peerless Electrical Prod Co
Jefferson R Jefferson Inc Ray
Jenkins O Quartz Labs
Jensen CH Copperweld Steel Co
Johnson AL Hexacon Electric Co
Johnson JK Hammarlund Mfg Co Inc
Joliffe Dr CB Radio Corp of America
Jones CH Kato Engineering Co
Jones CM John Roebling's Sons
Jones D Sound Equip Corp
Jones HC Delco Appliance
Jones H Merit Coil & Transformer Corp

— K —

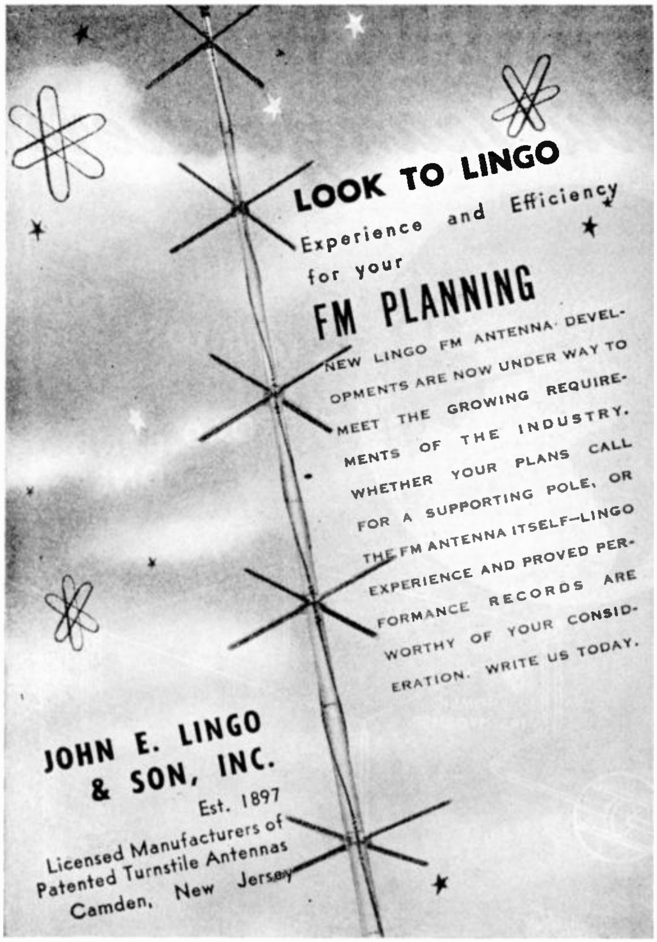
Kahn L Aerovox Corp
Kahn SH Southeastern Radio Supply Co
Kalb RM Kellogg Switchb'd & Supply
Kaplowitz M Federal Mfg & Eng Corp
Karlby H Elastic Stop Nut Corp of Amer
Kasch MH Kurtz Kasch Inc
Katzman J Dumont Elec Co
Kaufman AA Industrial Synthetics Corp
Keefe OA Newark Transformer Co
Kenney MW Seeburg Corp J P
Keusch EF Univ Plastic Corp
Kimball CN Aircraft Accessories Corp
Kimball R Communications Equip Corp
Kirsch MJ Federal Engineering Co
Klein F Camburn Prods Co
Knowles HS Jensen Radio Mfg Co
Koerner CA Donald Mossman Inc
Komorous LJ Parisian Novelty Co
Kotchevar J Janette Mfg Co
Krefft HH Standard Transformer Corp
Kreinick HC American Condenser Co
Kreis JG Acme Wire Co
Kroening W Gen Telev & Radio Corp
Kulka ER Kulka Elec Mfg Co Inc
Kux AS Kux Machine Co

— L —

LaMargue JW Graybar Elec Co Inc
Lapp DN Raymond Rosen & Co
Lasswell C Girard-Hopkins
Latta E A G Redmond Co
Lawler J Auburn Button Works
Leap GA Communications Co Inc
Lebedeff G Heintz & Kaufman Ltd
Leddo NE Teleradio Engineering Corp
Lehnert WE Audio Development Co
Leline A Croname Inc
Lester F Electronic Corp of America
Levenberg MH Condenser Prods Co
Levy H Ohmite Mfg Co
Lewis GW Lewis Electronics
Lidow E Selenium Corp of America
Lieblach M Radio City Prods Co
Lylyblad RH Camfield Mfg Co
Lindgerg CA Air Way Elec Appl Corp
Linell CS Carron Mfg Co
Lingel FJ Triplett Elec Instr Co
Lodwig E Mobile Refrigeration Div
Loomis G Dures Plastics & Chemicals Inc
Loveless PF Stallman of Ithaca
Lowit R Callite Tungsten Corp
Lundahl T Technical Appliance Corp
Lunt AP Ansonia Elec Co

— M —

MacAllister JW Ind Filter & Pump Mfg Co
MacDougall D Valpey Crystal Corp
MacLeod AD Alden Prods Co
Mallard MT Cornish Wire Co Inc
Malloy JB Cuyahoga Springs Co
Mansfield WR New England Mica Co
Margolish G Printloid Inc
Marko L Radio Wire Telev Inc
Marsten J International Resistance
Mastney EJ Oak Mfg Co
Matthey LH Hartman Corp of America



Chief Engineers, Cont.

Maurer L   Jefferson Elec Co
Mayer RH   Turner Co
Mazzola JR   Automatic Mfg Corp
McCabe IE   Mercoid Corp
McCoy RL   Locke Insulator Corp
McCraigh JF   Operadio Mfg Co
McElroy TR   McElroy Mfg Corp
McMaster AJ   G-M Laboratories Inc
McNamara BF   Insulation Mfgrs Corp
Merrill E   Atlas Resistor Co
Meyer EM   Victor Insulators Inc
Miller A   Sanborn Co
Miller EA   Acme Elec & Mfg Co
Miller EW   Superior Tube Co
Miller JH   Weston Elec Inst Corp
Miller JM   United Cinephone Corp
Miller WW   Ward Leonard Elec Co
Minnium BB   Erie Resistor Corp
Minter JB   Measurements Corp
Miron VC   Wincharger Corp
Mitchell FDV   Shallcross Mfg Co
Mitchell DH   Galvin Mfg Corp
Moore F   Dejur-Amsco Corp
Moore HS   Rockbestos Prods Corp
Monack AJ   Mycalex Corp of America
Morris JG   Ault & Wiberg Div
Mosow WA   Manufacturers Screw Prods
Mountjoy G   Fada Radio & Elec Co
Mucher GJ   Clarestat Mfg Co Inc
Myers JR   Wallace Mfg Co Wm T

— N —

Nelsen M   Guardian Elec Mfg Co
Nielsen HV   Sparks Withington Co
Nordlie L   Micarta Fabricators Inc

— O —

Oberle EJ   Gen Electronic Inc
O'Brien RJ   Trav-Ler Karenola Radio & Telev Co
O'Callaghan JJ   Rauland Corp
O'Connor P   Miller Co J W
Olander LW   Johnson Co E F
Omer CL   Air Communications Inc
O'Neill DC   Watterson Radio Mfg Co
O'Neill RE   Imperial Molded Prods Corp
Osterland E   Ballantine Labs Inc

— P —

Pacholke F   Majestic Radio & Telev Corp
Patla LJ   D-X Radio Prods Co
Patton RC   Patton-McGuyer Co
Pauly AJ   Ilsco Copper Tube & Prods Inc
Pearce CE   Precision Piezo Serv
Pearson AC   Harwood Co
Peters CE   Benwood Linze Co
Petersen J   Tech Art Plastics Co Inc
Peterson H   Lepel Labs
Peterson GE   Continental Elec Co
Pierce FL   Eureka Vacuum Cleaner Co
Planck RM   Radio Mfg Engineers Inc
Pollack Dr D   Templetone Radio Mfg Co
Poole WR   Corbin Screw Corp
Ports EG   Federal Telephone & Radio Co
Potter WF   Potter Co
Powers JT   Selectar Mfg Corp
Pratt LC   Eastern Air Devices
Pray GE   Airplane & Marine Inst Inc
Prince MA   Metaplast Co

— Q —

Quackenbush C   American Phenolic Corp
Quirk AL   Harvey Radio Labs Inc

— R —

Rall CA   Bodine Electric Co
Ramsey T   Gen Armature Corp
Rankin CS   Cont Diamond Fibre Co
Rattray A   Lafayette Radio Corp
Ravdin J   Hamilton Radio Corp
Reed CM   Haydon Mfg Co Inc
Reeves HE   Reeves Sound Labs
Reich RA   Ohio Nut & Bolt Co
Reinhardt RC   Atlas Sound Corp
Replogle DE   Electronic Mechanics Inc
Reynolds WH   American Inst Co
Rhoads JA   Air Associates Inc
Rice LA   Electrical Prods Supply Co
Richards LJ   Dow Chemical Co
Richmond WE   Standard Piezo Co
Rinehardt H   Sperti Inc
Ritsch H   Ntl Fabricated Prods
Rittenhouse A   Magnetic Windings Co
Robb JS   Radio Condenser Co
Robbin L   Mallory & Co P R
Rollefson KE   Muter Co
Roche WP   Central Screw Co
Rose CK   Royal Engineering Co
Rosenbaum J   Espey Mfg Co Inc
Rubenstein HW   Centralab Div
Rudd WE   Induction Heating Corp
Rusher G   Oxford-Tartak Radio Corp
Russell EA   Spaulding Fibre Co Inc
Russell V   Crescent Industries Inc
Ruth E   Erco Radio Labs Inc
Ruth E   Aero Communications Inc

— S —

Sack SL   Transmitter Equip Mfg Co Inc
Saliba GJ   Presto Recording Corp
Samuelson RE   Echophone Radio Co
Samuelson RE   Hallicrafters Co
Saunders A   Zophar Mills Inc
Schaefer E   Harco Steel Constr Co Inc
Schellenger NC   Chicago Tel Supply
Schmeling AM   Lavoie Laboratories
Schneider EF   Stille-Young Corp
Schneider EV   Alliance Mfg Co
Schnell WJ   Electrical Research Labs Inc
Schnoll N   Industrial Instruments Inc
Schum WR   Cover Dual Signal Systems
Schum WR   Electra Voice Corp
Schutz FC   Ace Mfg Corp
Schwartz BA   Delco Radio Div
Schwennesen D   Chicago Trans Corp
Seabury RW   Radio Frequency Labs
Setchell BT   Setchell Carlson Inc
Sewell CA   Tenney Eng Inc
Shapiro LC   Pilot Radio Corp
Shaw CE   Western Lithograph Co
Shidler A   Scientific Radio Prods Co
Shimer RB   Kenyon Transformer Co Inc
Silva AE   Noblitt Sparks Inc
Sklar HL   Industrial Condenser Corp
Smith JP   Daven Co
Smith P   Midwest Radio Corp

Snyder EI REA Magnet Wire Co
Snyder G Snyder Mfg Co
Sobel AD Air King Prods Co Inc
Soward R Supreme Instr Corp
Sparling CE Sperry Gyroscope Co
Spencer PL Raytheon Mfg Co
Spry RH Mica Insulator Co
Stanmyre EJ Meissner Mfg Co
Stark RE Stupakoff Ceramic & Mfg Co
Staubitz EJ Blaw-Knox Co
Steiger BF United Electronics Co
Sternad AF Gardiner Metal Co
Stevens FJ American Lava Corp
Stickney FS Instrument Specialties Co
Stillman GW Radio Studios Inc
Stoffel LL Ohio Chemical Co
Strobel F Mangold Radio Parts & Stpg
Strunk KG Breeze Corps Inc
Stuhrman AP Wilcox Electric Co
Sullivan M Sullivan Varnish Co
Swanson F Chicago Molded Prods Corp
Swanson JA Standard Radio Parts Co
Sylvander R Bendix Aviation Corp
Sylvane AA Comm Radio Sound Corp

— T —

Taplin J Fenwal Inc
Tennyson MA Sola Elec Co
Thatcher EV Halstead Traffic Comm
Thomas LS Blake Radio Equip Co
Thompson W John Elingo & Son
Thunen GW Electrical Prod Corp
Tish FP Pheoll Mfg Co
Titus RR Synthane Corp
Townsend CS Bendix Radio Div
Trickey PH Diehl Mfg Co
Trott BS Garod Radio Corp
Troup A Megard Corp
Turney E Precision Tube Co
Tuttle FE Eastman Kodak Co

— U —

Urey GM Radiation Prods Inc

— V —

Veley HN Speer Resistor Corp
Viser JH Bluff City Distributing Co

— W —

Wagener WC Litton Engineering Labs
Wahlgreen WW Gardner Elec Mfg
Wanner LR H H Eby Inc
Wardell J Thermador Electrical Mfg
Warren RS Adams & Westlake Co
Webb WL Bendix Radio Div
Webster FD Bunnell & Co J H
Weidenman WT Telephonics Corp
Weinreich GF Clare & Co C P
Weinstein M Freed Radio Corp
Weise RC Barker & Williamson
Weiss WA Hickok Electrical Inst Co
Wermine HH Belden Mfg Co
Wetzel FH Electric Auto-Lite Co
Wexler C Meck Industries John
Whitney LH Grenby Mfg Co
Wickham P Gibbs & Co Thomas B
Wilborn F Schott Co Walter L
Wilkens WB Jefferson-Travis Radio Mfg
Willets HN Western Electric Co
Williams WS Schuttig & Co
Willyard L Universal Microphone Co
Winthers R Signal Electric Mfg
Wise RM Sylvania Electric Prods Inc
Wolcott CF Gilfillan Bros Inc
Wolf A Lewyt Corp
Wolfskill JM Bliley Electric Co
Woodward CA Ucinite Co
Wootton W Boots Aircraft Nut Corp
Woycke LG Lear Inc
Wright JA Tungsol Lamp Works Inc
Wyatt JM Jr Wyatt Cornick Inc

— Y —

Young FC Stromberg-Carlson Co
Young WS W W Boes Co

— Z —

Zaleski J Northern Labs Ltd
Zender RG Lenz Elec Mfg Co
Zillger A Molded Insulation Co
Zmuda D H R S Products
Zobrist HE Herb E Zobrist Co
Zottu PD Girdler Corp
Zurian PD Press Wireless Inc

SPOT NEWS NOTES

(CONTINUED FROM PAGE 36)

pulses, or they can be stored on a wire recorder and fed to the machine subsequently. It is possible to duplex voice and printer signals, so that the Radiotype can be used over police and other FM communications systems without interfering with speech transmission. The small insert shown here is a full-size reproduction of the actual typing.

FM for Public Utilities: So successful have FM communications systems proved in expediting service and repairs on public utility systems that this field of application is growing rapidly now, and will expand greatly when equipment is more readily obtainable. Among recent systems in-

(CONCLUDED ON PAGE 66)

SPOT NEWS NOTES

(CONTINUED FROM PAGE 65)

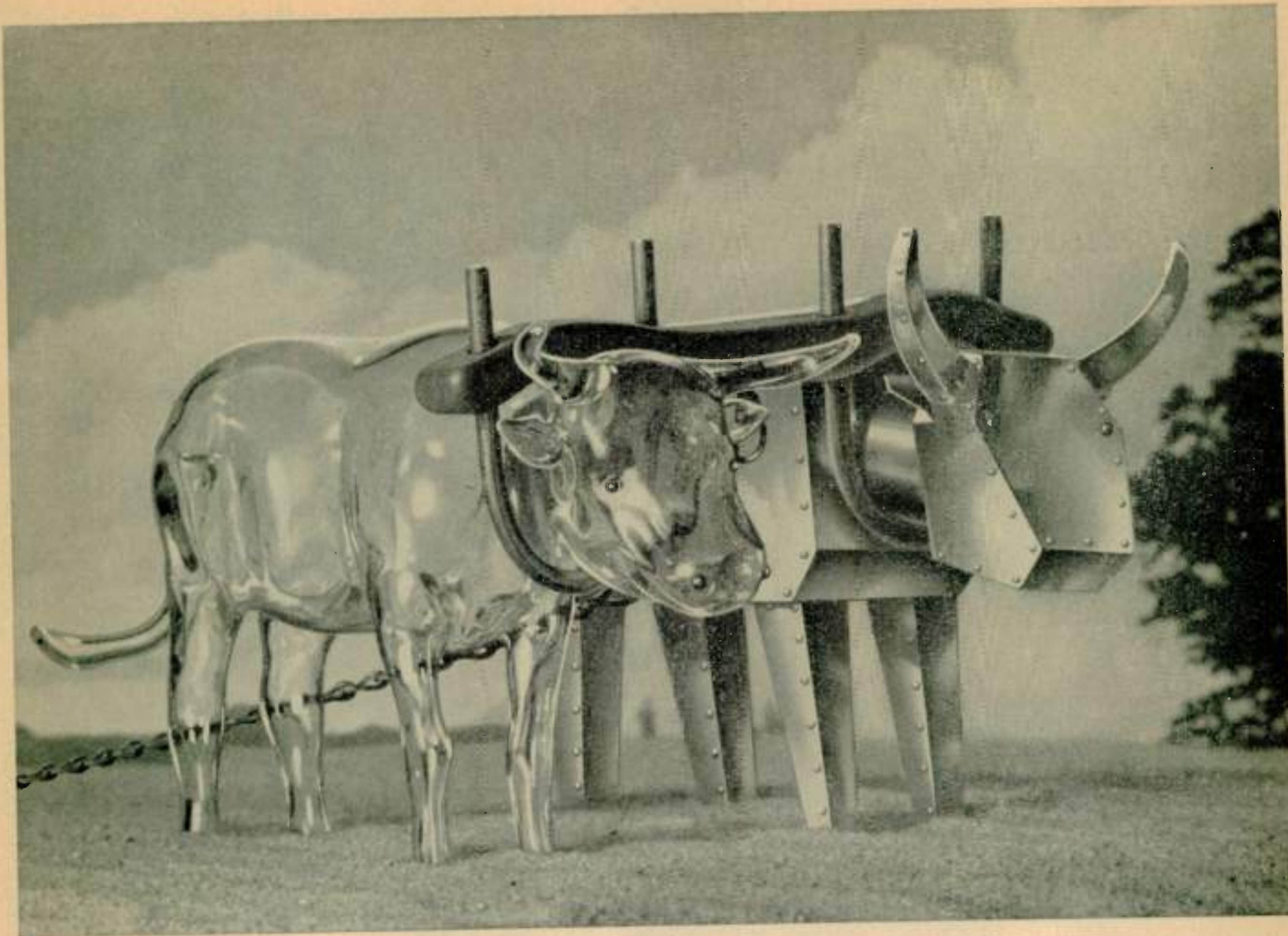
stalled are those for the Louisiana Power & Light Company of New Orleans; Union Gas System, Inc., Independence, Kan.; San Antonio Transit Company; Florida Power & Light Company, Miami; Union Sulphur Company, Sulphur, La.; and California Electric Power Company, Riverside, Calif. These are Motorola installations.

Rochester, N. Y.: Following a record year in 1944 when production exceeded $55,000,000, Stromberg-Carlson has reshuffled top executives in preparation for further expansion. Wesley M. Angle, president since 1934, has been elevated to the chairmanship of the board of directors. Dr. Ray H. Manson, formerly executive vice president and general manager, has been elected president. His assistant, Lee McCanne, now takes over Dr. Manson's post. Dr. George R. Towne will continue as manager of engineering and research, with the added title of assistant secretary. Executives reëlected to their posts include Lloyd L. Spencer, vice president in charge of sales; Frederick C. Young, vice president in charge of engineering and research; and William Fay, vice president in charge of broadcasting.

Thomas F. Joyce: Television has lost one of its most enthusiastic champions, but Tom Joyce is satisfying an ambition to be in business for himself by acquiring an interest in Raymond Rosen & Company, 32nd and Walnut Streets, Philadelphia, where he will act as general manager. Of this new undertaking, he said, "In my new work, I shall feel I have been successful if I can make a contribution to a program which is so vital to our Country — the success of the independent dealer." Certainly every one who knows Tom Joyce will be pleased to see him succeed in this new undertaking.

Crystal Business: Models of the first home radio sets using crystal-controlled push-button tuning will be ready to show soon after the FCC announces its final decision on FM frequencies. Those who have had experience with plug-in crystals for automatic tuning on home receivers believe that the convenience with which frequencies can be selected and the freedom from drift problems will more than offset any price advantage of the relatively unstable mechanical selection methods. If so, this will provide the largest peacetime market for quartz crystals.

William A. Rogge: Formerly in charge of Bloomingdale's radio department in New York, is now executive assistant to Major W. S. Williams, recently named officer in charge of the Monmouth Contract Adjustment Unit of the Army Service Forces, processing terminations of Signal Corps contracts at Bradley Beach, N. J.



TOGETHER THEY FORM A GREAT TEAM...

thanks to Corning Metalizing!

GLASS and metal work together for the electronics industry under a yoke fashioned by Corning Research in Glass.

Metalized glass has been used for many years, mainly for decorative purposes. But Corning Research developed a metalizing process which can be accurately controlled and which is permanent under severe industrial service conditions.

The superior electrical properties of glass are well known in the electronics field. Low power factor, high dielectric strength, extremely high resistance, wide range of dielectric constants — coupled with fine mechanical properties — make glass invaluable in electronic applications. The addition of metalized areas permits hermetic seals between glass and metal by ordinary soldering methods. Corning's metalizing process, particularly when applied to low expansion glasses, also produces accurate and fixed inductances, capacitances or shielding.

Perhaps our team of glass and metal can help you. Write us about your problem. Address Electronic Sales Department F-5, Bulb and Tubing Division, Corning Glass Works, Corning, N. Y.

CORNING
— *means* —
Research in Glass

Electronic Glassware

VYCOR
CORNING
PYREX

"PYREX", "VYCOR" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.

Combining 1. SPECIAL PURPOSE ENGINEERING 2. RECEIVING TUBE TECHNIQUES

The 2C26A exemplifies Hytron's ability to build in soft glass, at high speed, and for economical prices, special purpose tubes. Hytron solved a tough problem for the Services by designing in the 2C26A a tube capable of performance and high ratings never before — or since — achieved in soft glass. This small tube — approximately the same size as the 50L6GT Bantam — is capable of delivering 2 KW of useful r.f. power at 200 megacycles. It replaces larger and much more expensive hard glass transmitting tubes which must be operated at much higher potentials.

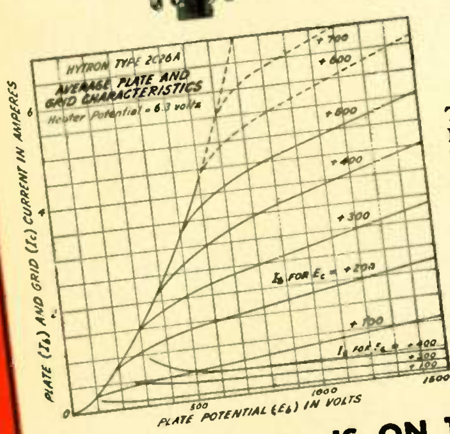
HYTRON TYPE 2C26A

VERY-HIGH-FREQUENCY TRIODE PULSE OSCILLATOR

The Hytron type 2C26A is a special triode for use as a grid or plate pulse oscillator up to 300 megacycles. Its cathode is designed and processed to provide the extremely high peak plate currents required in pulse operation. Special top cap design permits use of the maximum potentials, without external voltage breakdown, at the higher altitudes. Other notable features are: convenient size, standard octal base, high-voltage internal ceramic insulators, and extremely rugged construction.

ELECTRICAL

Coated Unipotential Cathode	
Heater Voltage	6.3 volts
Heater Current	1.1 amps.
Plate Dissipation	10 max. watts
Grid Dissipation	2.5 max. watts
Plate Potential (plate pulsed)	3500 max. peak volts
Plate Potential (grid pulsed)	2500 max. dc volts
Grid Bias	– 700 max. dc volts
Average Characteristics for	Eb:400V; Ec:-15V; Eh:6.3V
Plate Current	16 ma.
Amplification Factor	16.3
Transconductance	2250 micromhos
Average Direct Interelectrode Capacitances	
Grid-to-Plate	2.8 mmf.
Grid-to-Cathode	2.6 mmf.
Plate-to-Cathode	1.1 mmf.
Frequency for Maximum Rating	300 MC



MECHANICAL

Type of cooling	Convection
Base	Intermediate shell octal 8-pin phenolic
Top Caps	Skirted miniature with insulating bushing
Bulb	T-9
Maximum overall dimensions	
Length	3 11/16 inches
Seated Height	3 1/8 inches
Diameter	1 5/16 inches
Net Weight	1 1/2 ounces

2C26A IS ON THE ARMY-NAVY PREFERRED LIST

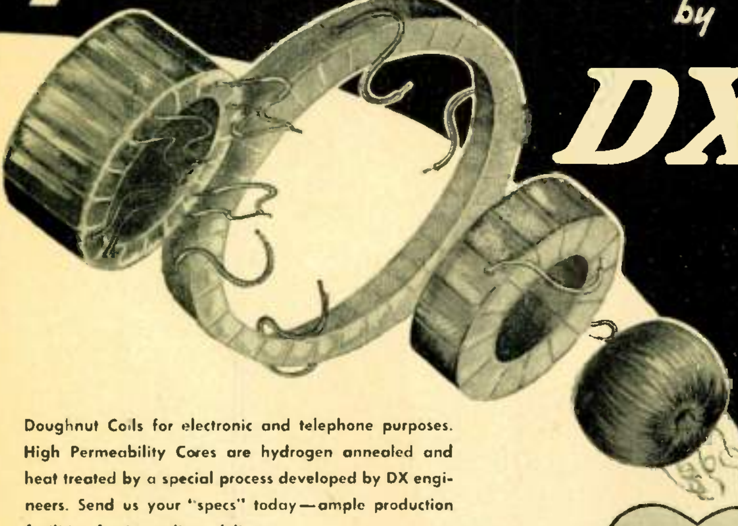
OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON RADIO AND ELECTRONICS CORP.

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

FORMERLY HYTRON CORPORATION

Toroids.. by DX



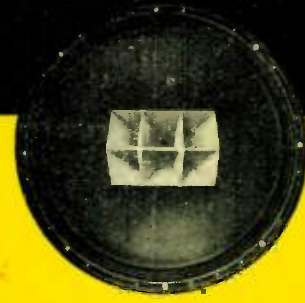
Doughnut Coils for electronic and telephone purposes. High Permeability Cores are hydrogen annealed and heat treated by a special process developed by DX engineers. Send us your "specs" today—ample production facilities for immediate delivery.

DX RADIO PRODUCTS CO.

GENERAL OFFICES 1200 N. CLAREMONT AVE., CHICAGO 22, ILL., U.S.A.

DX COILS "the heart of a good receiver"

KEEP OFF THE Beam



WITH THE DUPLEX SPEAKER

The very objectionable concentrated beam at high frequencies in sound reproduction is eliminated by the Duplex Speaker. Even at 15,000 cycles plus, the DUPLEX speaker distributes high quality sound 60 degrees horizontally and 40 degrees vertically as compared to the 5 degrees of single unit speakers of comparable size. Another reason why the DUPLEX is the SPEAKER that REVOLUTIONIZES the methods of sound REPRODUCTION.

SEND FOR BULLETINS

ALTEC LANSING CORPORATION

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250 WEST 57 STREET, NEW YORK 19, N. Y.
IN CANADA: NORTHERN ELECTRIC CO.

Laboratory Standards

PULSE GENERATOR

MODEL 79-B

SPECIFICATIONS:

FREQUENCY: continuously variable 60 to 100,000 cycles.
PULSE WIDTH: continuously variable 0.5 to 40 microseconds.
OUTPUT VOLTAGE: Approximately 150 volts positive.
OUTPUT IMPEDANCE: 6Y6G cathode follower with 1000 ohm load.
R. F. MODULATOR: Built-in carrier modulator applies pulse modulation to any r.f. carrier below 100 mc.
MISCELLANEOUS: Displaced sync output, individually calibrated frequency and pulse width dials, 117 volt, 40-60 cycles operation, size 14"x10"x10", wt. 31 lbs.

Price: $295.00 F.O.B. BOONTON — Immediate Delivery

MEASUREMENTS CORPORATION

BOONTON • NEW JERSEY

Treat in store for MUSIC LOVERS

This advertisement is addressed to the millions whose cultured taste in broadcast and recorded music demands the finest in reproduction. It will be seen and read by the millions who regularly read The American Weekly, Fortune, Life, Saturday Evening Post, Collier's, Liberty, Newsweek, National Geographic, This Week Magazine and Popular Publications.

There'll be none *Finer* . . .

Soon after Victory releases us from our obligation to the armed services, we will deliver the new Motorola Radios. They will be fine musical instruments. They will deliver rich, round, concert quality tone and clean, crisp reproduction of the spoken word. They will add grace and distinction to the loveliest home.

For the Army and the Navy, Motorola engineers have produced their "Handie Talkie," an amazing two-way radiotelephone system complete in a package weighing about five pounds. The "Walkie Talkie," a more powerful two-way radio, is an F-M job also perfected by Motorola Radio Engineers.

This record of engineering and production signalized by five consecutive Army-Navy "E" awards is your positive guarantee that among Post War Radios, ***there will be none finer than Motorola!***

GALVIN Mfg. Corporation • Chicago 51, Illinois

Motorola Radio

☆ FOR HOME AND CAR ☆

F-M & A-M HOME RADIO • AUTO RADIO • AUTOMATIC PHONOGRAPHS • TELEVISION • F-M POLICE RADIO • RADAR • MILITARY RADIO

Communication with, or between, moving vehicles becomes more important as this Age of Speed advances. Every factor is vital which promotes clarity of transmission. When trains, taxis, ships and passenger cars can contact each other or their "home stations" at will, Amphenol Cable Assemblies, Connectors and Sockets will do their share to provide good electrical contact *within the equipment.* Atmospheric and static conditions excepted, successful radio communication in transit depends largely on low-loss stability and good design of the equipment's component parts. The name "Amphenol" indicates to the user that they have been designed, made and tested to give the best possible service in spite of interference, vibration and moisture. Detailed technical information on all Amphenol products in which you may be interested is available and will be sent on your request—ask for Catalog Section D.

Depend upon AMPHENOL *Quality*

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
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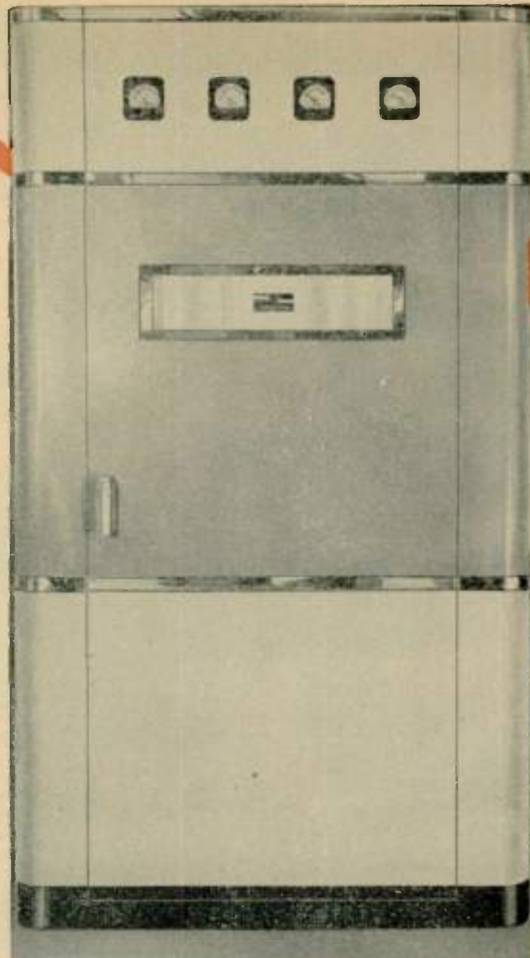
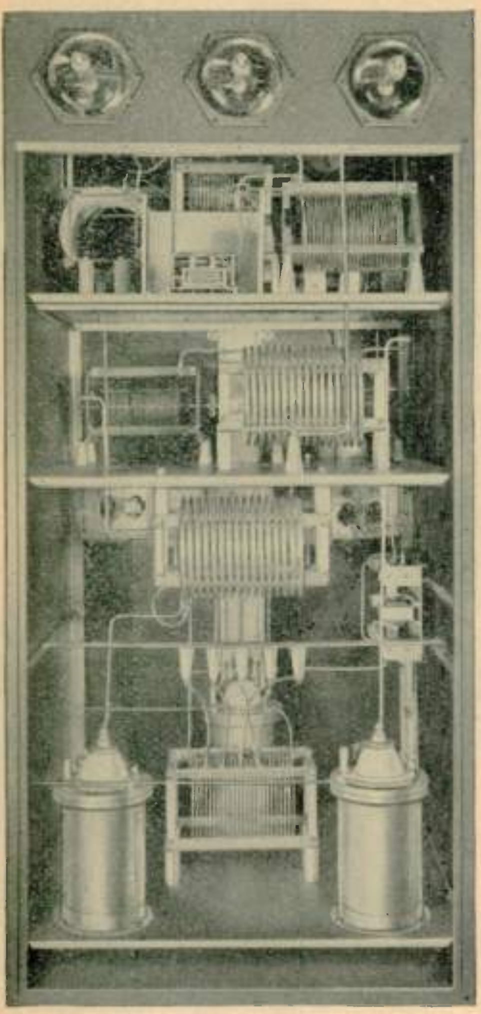
U.H.F. Cables and Connectors—Radio Parts—Cable Assemblies —Conduit—Connectors (A-N and British)—Plastics for Industry

DIRECTIONAL ANTENNA EQUIPMENT





Johnson engineers have designed many highly successful installations of phasing and antenna coupling equipment to individual specifications. These units may be built to match any existing transmitter and thus become an integral part of your station. Let us help you and your consulting engineer plan your transmitting equipment for better market coverage. Orders received now will get first attention when priority restrictions are removed.

Here are two of the many installations of phasing equipment Johnson has furnished for Broadcast Stations, built to match existing equipment. Other items available from Johnson, made to individual specifications, are gas filled pressure condensers, coupling networks, tower lighting filters and special inductors.

JOHNSON
a famous name in Radio

E. F. JOHNSON COMPANY
WASECA, MINNESOTA

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

Regular television broadcasts would be scheduled mainly in the evening peak audience periods. This dual use of transmitters and receivers will permit maximum use of television broadcasting equipment, receivers, and allotted frequencies. It will permit speedier development of both FM and television because the new receivers will be of dual purpose, thus easier to sell to the public.

Applicants can furnish FM immediately upon availability of equipment, and television programs can be increased as the market and finances permit. I feel that television will replace audio as surely as "talkies" replaced the "silents," but a transition period should be provided similar to what I here suggest.

Sincerely,
Radio Station KGVO
A. J. Mosby *General Manager*

This same letter was sent to FCC Chairman Porter, and the Chairman's answer has been made public. In brief, he said the television must stand on its own feet, winning public favor and financial support on its own merits, and not set up as an appendage to which another service is accommodated.

We have nothing to add to Chairman Porter's statement of FCC policy because *FM and Television* believes that while the superior service afforded by FM will replace AM transmission, sound and television broadcasting are so distinctly different in the services they perform for the public that they are no more competitive than the concert hall and the playhouse. For that reason, this publication would not favor an arrangement that would make impossible the simultaneous transmission of FM sound and television programs, any more than we would favor federal legislation prohibiting concerts during hours when plays are being given.

Mr. Mosby's letter is published here because he brings up a point on which there must be some interesting opinions — that is, whether or not television will replace audio programs as surely as the talkies replace silent pictures. We shall welcome letters expressing the views of our readers.

3. Television engineers who read Madison Cawein's excellent discussion of the relation of contrast to band width in our issue of November, 1944 will be interested in the following letter from Mr. Cawein:

My dear Mr. Sleeper:

Mr. D. E. Norgaard of the General Electric Company, Schenectady, N. Y., has been kind enough to call to my attention a rather serious error which I made in my article for your November, 1944 issue of F-M.

Mr. Norgaard has given me permission

(CONTINUED ON PAGE 77)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 75)

to use his memo on the correction to this article, which he circulated to members and alternates of the R.M.A. Sub-committee on Television Studio Facilities.

I suggest that you publish Mr. Norgaard's memo, calling attention to the error. The basic mistake which I made was to assume that when the bandwidth is less than optimum, the number of scanning lines is always automatically reduced to optimum *for equal H- and V-detail,* as calculated from equation (2) of the paper. This assumption is not at all valid, since the scanning standard remains fixed, and only the horizontal detail and contrast suffer from bandwidth limitation. Thus, my calculations are in error as explained in the following memo from Mr. Norgaard:

MEMORANDUM

Correction of Numerical Results Expressed in Paper entitled "Relation of Contrast to Width of Television Band," by Madison Cawein. (Published in FM AND TELEVISION *— November, 1944.)*

It has been noted that certain conclusions reached in the subject paper are in error, although the general considerations are believed to be justified.

Equation (2) of Cawein's paper may be written:

$$f = \frac{0.7\ Nh\ Nv\ F}{2} \text{ — where}$$

Nh = number of lines horizontal resolution

Nv = number of lines vertical resolution

This represents a substitution of Nh Nv for AN^2 in Cawein's equation 2.

Now a change in bandwidth (f) will not affect Nv, but will affect Nh to produce a variable ratio of horizontal to vertical resolution. It will be noted that breaking the term AN^2 down into Nh Nv allows an evaluation of Nh directly, since in general the "N" of Cawein's equation is unchanged by alteration of the bandwidth; i.e., the number of scanning lines remains unchanged, but Nh will be a function of bandwidth.

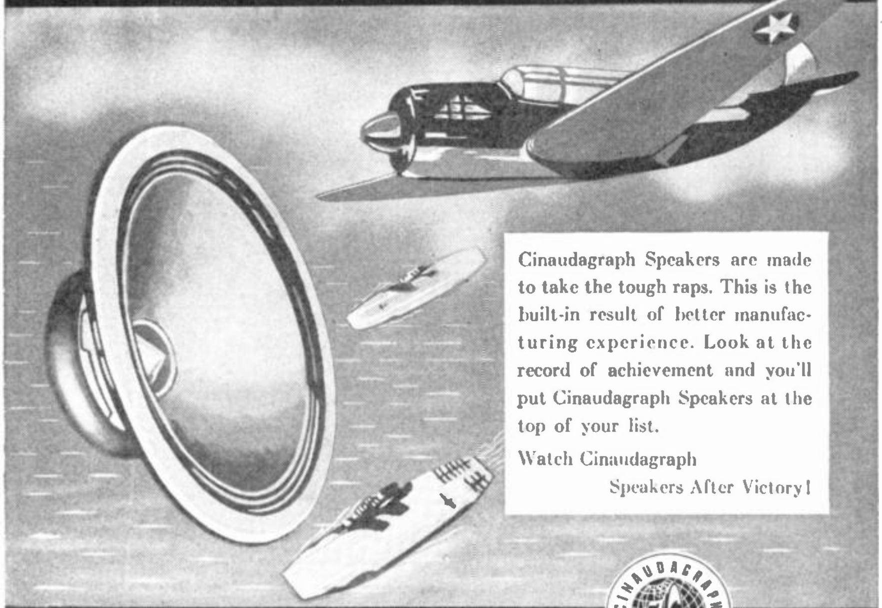
Reduction of the bandwidth to say half of a certain value will reduce Nh to half of its original value if Nv remains unchanged. However, if the number of scanning lines is reduced to 0.707 of the number used with a certain original value of bandwidth, then Nh and Nv can be 0.707 of their original value, after the bandwidth is reduced to half, and Cawein's equation 2 then holds.

In Cawein's article the second paragraph following equation 3 should be corrected to read:

"This means that if a 525-line standard picture is capable of showing a 500 line, black-white detail, when transmitted with a certain bandwidth, then the contrast will be correct for only two levels, that is, black and white, in those regions

(CONCLUDED ON PAGE 79)

TOUGH!



Cinaudagraph Speakers are made to take the tough raps. This is the built-in result of better manufacturing experience. Look at the record of achievement and you'll put Cinaudagraph Speakers at the top of your list.

Watch Cinaudagraph Speakers After Victory!

Cinaudagraph Speakers, Inc.

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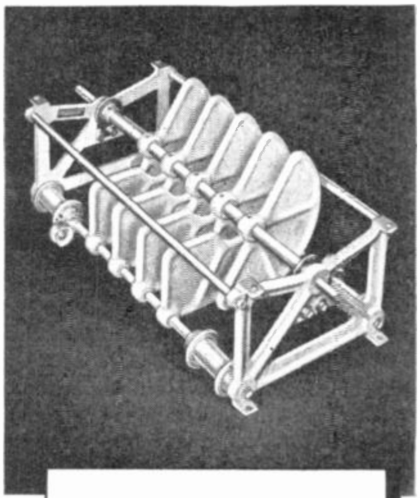
"No Finer Speaker in all the World"



TRANSMITTER VARIABLE CONDENSER

Plate design in this JOHNSON condenser allows a 75% greater voltage breakdown rating than former models having the same spacing. Without increasing the overall size of the condenser JOHNSON engineers have raised the voltage rating by more evenly distributing the electric field, decreasing the tendency to flash over. A substantial saving in weight of plates has been achieved through the use of mechanical design ideas in placing ribs and rounded edges on the plates.

Losses in the insulation have been reduced too, first by using a good low loss material and second by judicious placement of corona shields to distribute the electric field evenly through the insulation. The rotor may be counter-weighted so the shaft will not change its position after an adjustment has been made. Multi-fingered contact brushes bear on a circular rotor contact to provide low resistance, positive contact, to the rotor. A shield is arranged on the stator terminal to nearly enclose the lead wire, resulting in less danger of sparkover at this point.

Definitely a commercial job, this condenser is worthy of consideration in the design of transmitters.

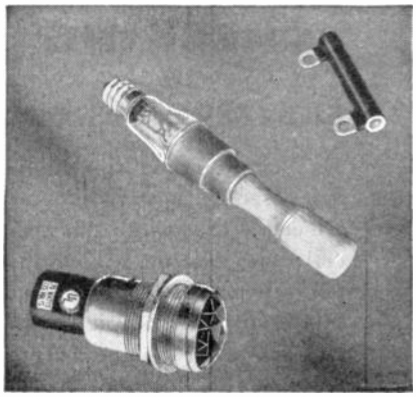
JOHNSON
a famous name in Radio

E. F. Johnson Co. Waseca, Minn.

CONSIDER THE NEW DRAKE No. 75 AP

Underwriters Approved!

TRADE demand has caused Drake to produce this new totally enclosed candelabra screw base 1″ pilot light assembly. The unit is approved by the underwriter's laboratories for 75 watt, 125 volt service. Designed to house the Mazda S6, 110 volt, 6 watt candelabra screw base lamp. Can be supplied with lamp installed. The unit mounts in a 1″ hole and is regularly furnished with a 1″ diameter faceted colored glass jewel. It is also supplied with a steel lock washer which holds the unit firmly to the panel. Mounts on any thickness panel up to ½″.



Although designed to operate on 110 volt circuits, this assembly can readily be used on 220 volt circuits by connecting our No. 116 wire wound resistor in series with the pilot light.

Lamps are easily removed with our S6 lamp remover. Anyone who has to maintain, or install in production, large numbers of S6 lamps, will find the S6 lamp remover a great convenience.

DRAKE

SOCKET AND JEWEL LIGHT ASSEMBLIES

DRAKE MANUFACTURING CO.

1713 WEST HUBBARD ST., CHICAGO 22, U. S. A.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 77)

of the picture exhibiting 500-line *horizontal* detail, but will be correct to ten levels in those regions exhibiting *151-line horizontal* detail (divide 500 by 3.32); or to five levels in the regions of *215-line horizontal* detail (divide 500 by *log 5/log 2*)."

The italicized portions of the above paragraph indicate the portions of the paragraph in which changes were made. It might be said that if a system having sufficient bandwidth to produce 500-line horizontal black and white detail on a 525-line standard be used for transmission of a 315-line standard, then the contrast will be correct to ten levels in those regions exhibiting approximately 275-line horizontal resolution; and if used for transmission on a 343-line system the contrast will be correct to five levels in the regions exhibiting approximately 330-line detail.

D. E. Norgaard

April 2, 1945

I trust that this admission-of-mistake and subsequent correction will be satisfactory to you and to your technical readers.

Sincerely yours,
Madison Cawein *Manager of Research*
Farnsworth Television & Radio Corporation

TELEVISION FREQUENCIES

(CONTINUED FROM PAGE 29)

The problem of diathermy interference at the lower frequencies now in use for television would be practically eliminated by a move to the 450- to 1000-mc. range. In addition, the ignition interference from passenger cars, buses, and trucks would be greatly reduced at the higher frequencies. The increased directivity available from practical rhombic receiving antennas would also contribute to interference reduction. The low angle of reception obtained from the rhombic type materially reduces the interference effect of "airplane doppler" so annoying with doublet antennas.

I believe that the public will soon tire of changes which continue to obsolete their receiver. If we must eventually change television assignments as the FCC has indicated, let's make the change now. Let's not make the shift difficult by changing standards at the same time and obsolete all existing transmitting and receiving equipment for a dubious improvement in resolution. The carrier frequency shift of the transmitters now in use, and the design of converters for present receivers involve certain problems but, in my opinion, these are minor in comparison to those involved in changing to a new set of standards.

ENGINEERING SALES

(CONTINUED FROM PAGE 8)

An entire floor of the Company's six-story building will be devoted to the new radio division.

Hallicrafters: Representative David N. Marshank has moved to larger quarters at 672 S. Lafayette Park Place, Los Angeles. He plans next to open a branch office in San Francisco.

Sentinel: Has appointed the following distributors: M. Seller Co., San Francisco; Waitkus Supply Co., 1418 Cornwall Avenue, Bellingham, Wash.; William Volker & Company, San Francisco; Drake Hardware Company, Burlington, Ia.; Arthur Fulmer, Ft. Wayne, Ind; and Charleston Wholesale Furniture, Charleston, W. Va.

Motorola: Boyd Distributing Company, 310 Majestic Building, Denver, will distribute Motorola radio sets in Colorado, Wyoming, and western Nebraska. Cecil H. Boyd heads this concern.

Stromberg-Carlson: In the Indianapolis area, S-C sets will be distributed by Appliance Distributors, Inc., of which William Helt is president. This concern also handles Coolerator refrigerators and Blackstone laundry equipment.

S. Sundra: Managing director of Globe Radio & Engineering Company, New Delhi, India, has been in New York to negotiate for radio lines. Prewar sales in India were just under half a million dollars annually, according to Mr. Sundra, but he believes the postwar volume will be four times that amount, or higher if suitable sets can be obtained at popular prices.

Sonora: Has appointed Walker-Jimieson, Inc., 311 South Western Avenue, Chicago, as distributor in the Chicago area.

SPORADIC E INTERFERENCE

(CONTINUED FROM PAGE 35)

antenna height and an antenna gain of four likewise do not interfere with each other. This was also for 44 mc. operation. It is therefore unnecessary to consider operation of these stations at 46, 48 or at 60 megacycles, as no difference in result would occur. It is likewise unnecessary to consider the effect of additional stations on the same channel.

* * * * *

All of the foregoing statements, except the estimate as to the length of time it would take to build 1000 Paxton type stations, follow from the set of facts agreed upon.

CONCLUSIONS

1. It has been established that stations of a local character covering 40 to 50 miles can be operated without encountering

(CONCLUDED ON PAGE 82)


REMEMBER
... remember this—when you buy antennae. Snyder offers superior quality (because of controlled manufacture)—better price—prompt delivery. Be certain of customer satisfaction. Recommend Snyder.
ANTENNAE by
SNYDER
MANUFACTURING CO. • PHILADELPHIA
COMPLETE MANUFACTURERS FROM START TO FINISH


Crystals for the Critical...
Headquarters for SPECIAL Crystals!
The men of The James Knights Company have been designing and making special precision crystals since 1932. Their extensive experience with crystals for every conceivable purpose, coupled with an active participation in Radio dating back to 1913, is available to you. These men are interested in your special crystal problems — they have the knowledge, equipment and research facilities to help you. Why not get them working on your special crystal problem today?
JK
CRYSTALS
The JAMES KNIGHTS Co.
SANDWICH, ILLINOIS
Sixty Miles Southwest of Chicago

SPORADIC E INTERFERENCE

(CONTINUED FROM PAGE 80)

Sporadic E interference within the service range from 44 megacycles upward.

2. It has been established that if the high power transmitters are operated in the vicinity of 60 megacycles and a realistic appraisal made of the practical factors bearing on the situation, that the amount of interference which may be expected is negligible.

3. Such interference as does occur, occurs in the outer ranges, and it is my considered opinion that if an attempt is made to cover these ranges in the 100 megacycle band that far worse service to the public will result by reason of shadows, tropospheric fading, and above all, long distance tropospheric transmission of the type described in a memorandum on this subject filed this day.

BETTER WAYS TO MEET LISTENERS' NEEDS

(CONTINUED FROM PAGE 41)

4. Location of wall connectors for each box:
   Number of feet of cable for each box should be included in this specification.
5. Equipment to be located in each room:
   Such as wire or disc recorder, television receiver, facsimile recorder, or automatic phonograph. Maker's names and type numbers must be included.
6. Location and description of the main equipment:
   Receivers, amplifiers, and relays, power connection. Makers' names and type numbers must be included.
7. Items and labor to be furnished by others:
   List of special cabinet work or electrical work, and names of suppliers.
8. Provisions for adding other equipment at some later time.

All these details must be set down in and signed by the owner when the price is agreed upon. If this is not done, experience with special work of this kind shows that the owner will surely say he thought that was to be this way; that he expected a more expensive type of recorder or loudspeakers; or that he didn't expect to pay the cabinetmaker for the control boxes, or the electrician for material and labor used to run wires to the speaker field supplies.

Moreover, if the owner decides to make changes while the work is in progress — and this happens invariably — there will be no question about charging extra for the additional material and labor involved.

The next step is to plan, in complete detail, the circuits and the apparatus for the system. These will be presented in Part 3.

Wanted

ENGINEERS

Radio
* Electrical
Electronic
* Mechanical
* Factory Planning
Materials Handling
Manufacturing Planning

Work in connection with the manufacture of a wide variety of new and advanced types of communications equipment and special electronic products.

Apply (or write), giving full qualifications, to:

R.L.D., EMPLOYMENT DEPT.

Western Electric Co.

100 CENTRAL AV., KEARNY, N. J.

* Also: C.A.L.

Locust Street, Haverhill, Mass.

Applicants must comply with WMC regulations

ENGINEERS

TO SERVE AS PROJECT LEADERS ON TRANSMITTERS AND RECEIVERS

Must have good engineering background and several years of broad experience in the radio industry. Also, a knowledge of civilian radio requirements will be valuable when this Company resumes production of high-quality FM receivers and phonograph combinations. Write, giving details of experience and salary expected, to:

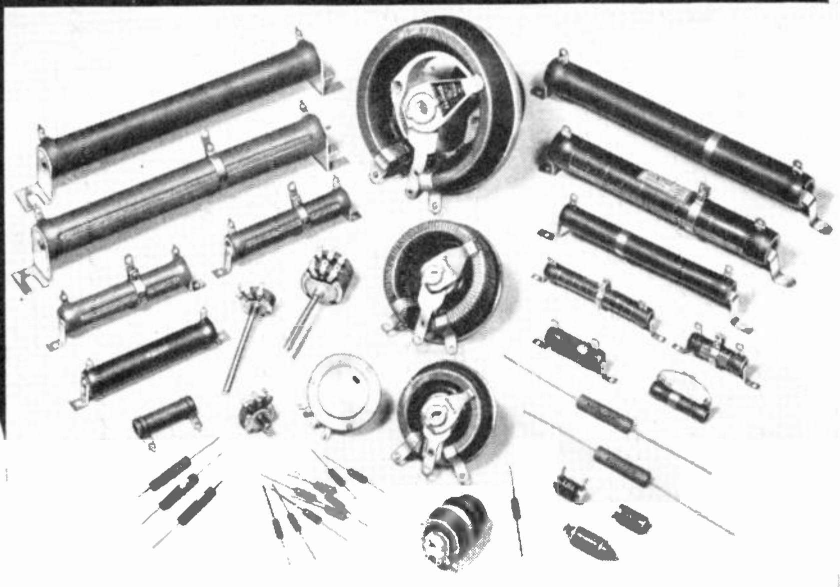
Freed Radio Corporation

200 HUDSON STREET
NEW YORK CITY

ONE CENTRAL SOURCE FOR

Leading Makes of

RESISTORS & RHEOSTATS



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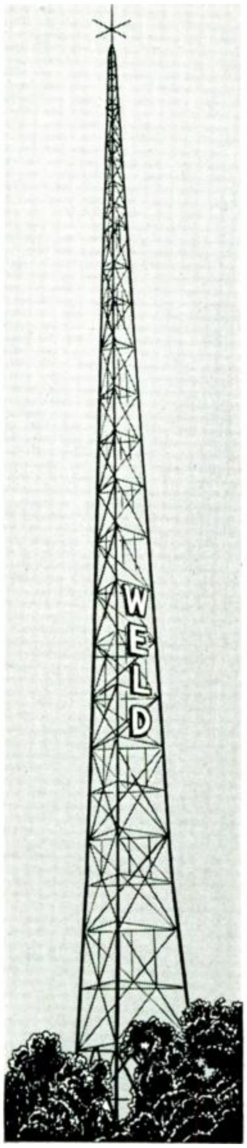
Electronic Tubes, Rectifiers, Power Supplies, Intercommunicating Systems, Sound Systems, Photo-Cell Equipment, Batteries, Chargers, Converters, Generators, Supplies for Resistance Welders, Fuses, Test Instruments, Meters, Broadcast Station Equipment, Relays, Condensers, Capacitors, Resistors, Rheostats, Transformers, Switches, Coaxial Cable, Wire, Soldering Irons, Microphones, Speakers, Technical Books, etc.


CONTACT!
Behind bombing missions and dog fights
at every one of our invasion points
you'll find Super-Pro receivers
on twenty-four hour duty with the AACS
under almost impossible
operating conditions.
BAND WIDTH
LIMITER
OFF ON
AVC
MANUAL
SUPER-PRO
THE SIGN OF QUALITY
ESTABLISHED 1910
THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., N.Y.C.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

WELD



FM STATION WELD

Ohio's First FM Station

Input to Final Amplifier: 10 KW
Antenna Output: 5 KW
Total hours operation to date: Over 18,000

Station WELD has been in operation since 1940. The above record is one more tribute to the ever-growing leadership of the Armstrong Phase Shift Method of Frequency Modulation . . . the method employed in REL transmitters of all power ratings.

REL

Let's Top Them All with the Mighty 7th War Loan!

Buy More Bonds

SPECIALIZATION IS THE ANSWER!

FM is not our sideline . . . it consumes all our thinking! It is this specialization that accounted for our pre-war leadership . . . and it is this specialization, coupled with the unique knowledge and thorough experience of our staff of engineers that will, when Victory is ours, continue to lead the way for even greater leadership in FM expansion!

Sales Representatives

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M. N. Duffy & Co., Inc.	**REL Equipment Sales, Inc.**	**N. B. Neely Enterprises**
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Pioneer Manufacturers of FM Transmitters Employing Armstrong Phase-Shift Modulation

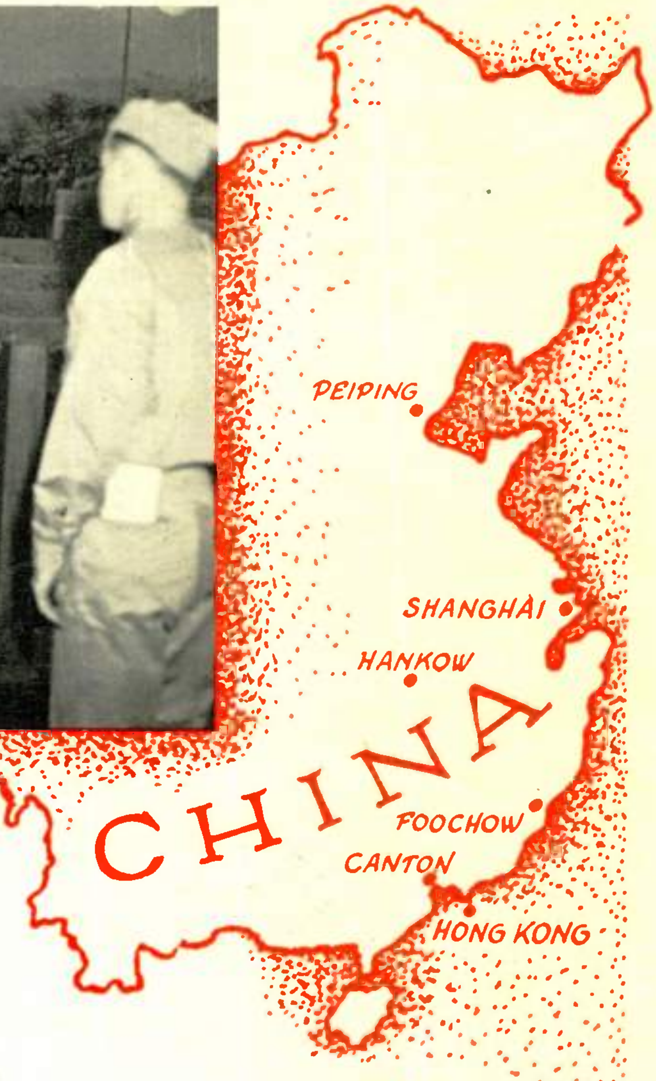
RADIO ENGINEERING LABS., INC.

Long Island City, N. Y.

RUMFORD PRESS
CONCORD, N. H.

Link EMERGENCY RADIO *has earned* INTERNATIONAL FAME ☆

GENERALISSIMO CHIANG KAI-SHEK ON TOUR OF INSPECTION. Left: LINK TYPE 50-UFS FM MAIN STATION UNIT



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Whenever there is need for administrative or tactical use of emergency radio, Link is the acknowledged pacemaker. . . . In use by Police, Sheriff, Fire, Forestry, Railway, Public Utility, Military, Government and other Emergency Services around the world.

Awarded 4th time on May 5, 1945

ENGINEER • MANUFACTURER

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