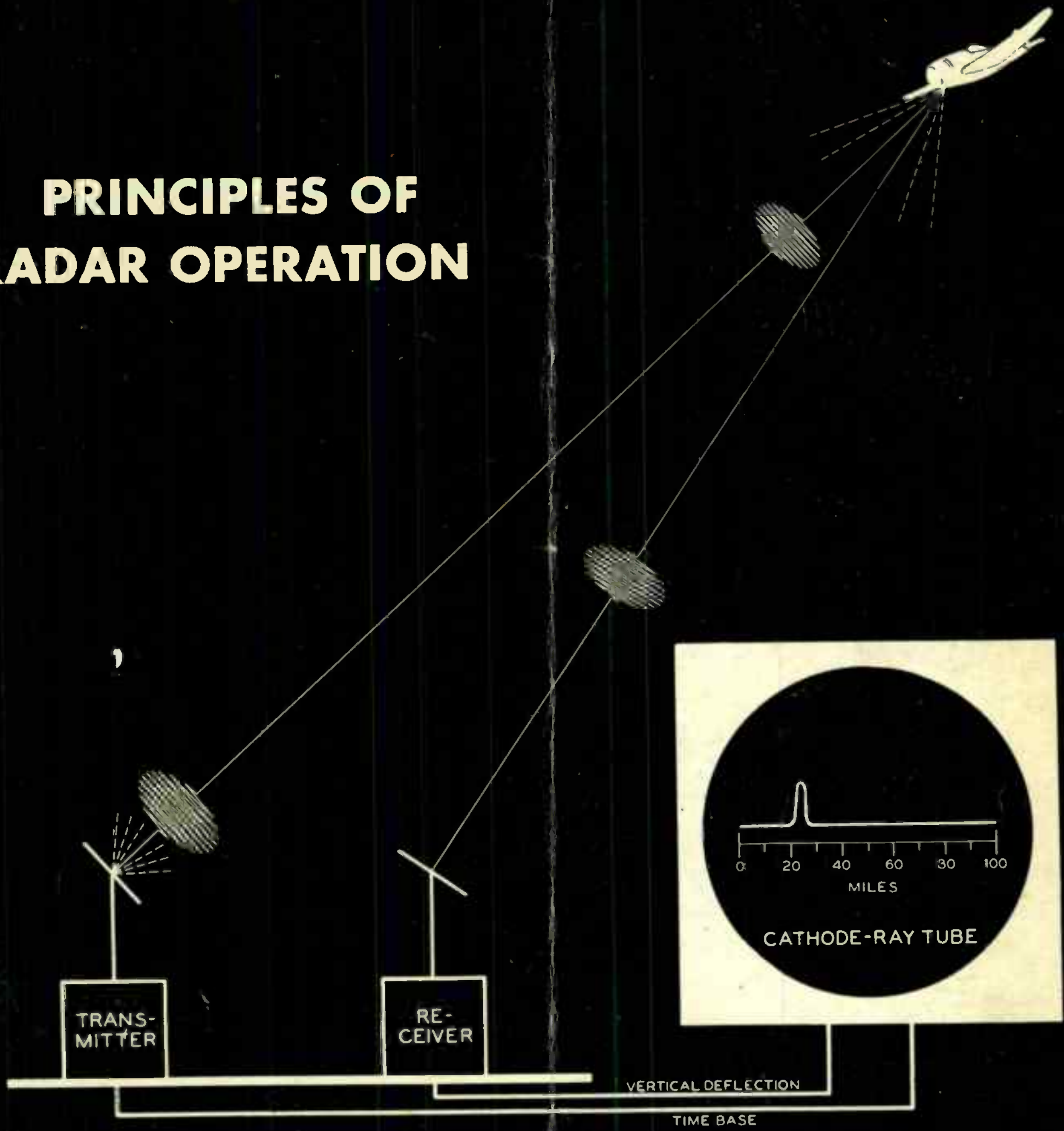
PRICE—TWENTY-FIVE CENTS

FM AND TELEVISION

MARCH 1945

PRINCIPLES OF RADAR OPERATION



Broadcast Station Directory

★ ★ Edited by Milton B. Sleeper ★ ★

REG. U. S. PAT. OFF.

FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 5 | MARCH, 1945 | NO. 3

CONTENTS

★ ★ ★ ★ ★ ★

MILTON B. SLEEPER, *Editor and Publisher*

René Hemmes, *Assistant Editor*

William T. Mohrman, *Advertising Manager*

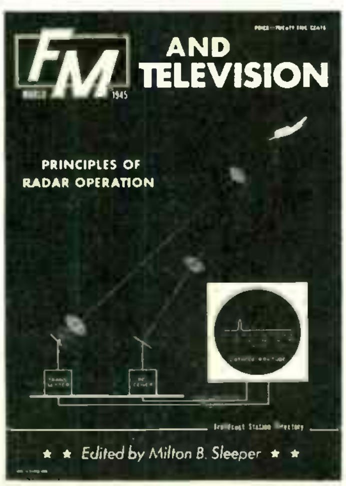
Ethel V. Sleeper, *Circulation Manager*

Published by: FM COMPANY

Advertising and Circulation Office: 511 Fifth Avenue, New York 17, Tel. VA 6-2483
Editorial Office: Radio Hill, Great Barrington, Mass. Tel. Great Barrington 1014
Chicago Representative:
Marian Fleischman, 360 N. Michigan Ave., Tel. STAte 4822
West Coast Advertising Representative:
Milo D. Pugh, 541 S. Spring St., Los Angeles 13, Calif. Tel. Tucker 7981

FM Magazine is issued on the 30th of each month. Single copies 25¢ — Yearly subscription in the U. S. A. $3.00; foreign $4.00. Subscriptions should be sent to FM Company, 511 Fifth Avenue, New York 17, N. Y.

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



THIS MONTH'S COVER

It has been stated repeatedly that research on radar equipment has added materially to the progress of television. Even from the limited amount of information which can be published now on the subject of radar, it is clear that postwar television will benefit from this military development.

Moreover, radar opens many avenues leading to new techniques and services, of which the radio industry will hear a great deal when the days of peace return.

WHAT'S NEW THIS MONTH

1. Tokyo Rose
2. FM in Action

1. Although it has not been reported in the papers, Baby Face Petrillo has a headache. The cause is a certain broadcast station that he'd like to close down, but can't. This situation may, indeed, mark the beginning of the end for the little man who, while our Armed Forces were fighting in Italy, established a control over the broadcasting and recording industry in the United States as absolute as was Il Duce's in the land where Petrillo was born.

Here are the facts, and they are available from any soldier, sailor, or marine who has served in the Pacific theatre:

When news of U. S. labor troubles are received in Japan (and they are reported there promptly and accurately), that same night Japanese bombers and fighters are sent out in force against American troops or ships. The following day, Tokyo Rose comes on the air over the Jap propaganda station which beams its programs to our men in the Pacific.

"How did you sleep last night?" she inquires. "Didn't get much rest, did you? And what do you suppose was going on at home while you spent the night shivering at your stations, or in your foxholes? Well, I'll tell you . . ."

She does, too. She tells about the labor troubles at home, how labor leaders bring military production to a halt while they battle for personal power over jurisdictional disputes, and how the workers stay at home under orders from the union chiefs, or in spite of them, while the men of our Armed Forces give their lives to carry out the orders of *their* officers.

Then she concludes: "Aren't you men suckers!" To which an increasing number of our men now reply: "Yes, we are, but wait till we get back home!"

Tokyo Rose has become an important sources of news in the Pacific. Our men have come to rely upon what she says because her information is accurate, and is invariably confirmed by letters from home and by men newly arrived from the United States.

A year ago, the labor leader most hated by Americans in the Pacific was John L. Lewis. Now, reports have it, Petrillo is the man on the hot seat. The reason is not altogether clear. Perhaps it is because broadcasting becomes of greater

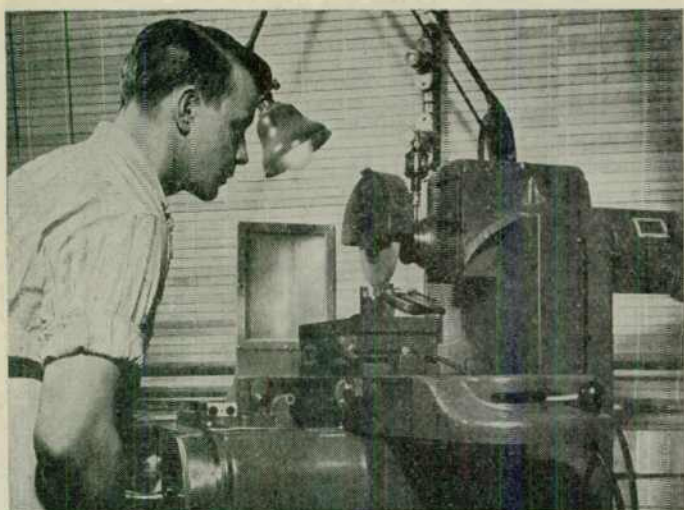
(CONTINUED ON PAGE 81)

SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

MARCH — *Published in the Interests of Better Sight and Sound* — 1945

Well-Equipped Sylvania Plant Makes Own Small Parts to Assure Top Quality in Radio Tubes

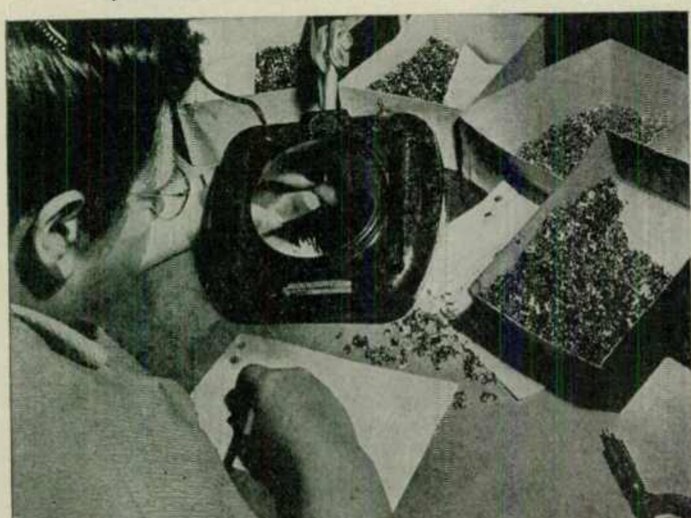


Many of the special tools required for turning out small tube parts are tailor-made right at Sylvania's Emporium plant.

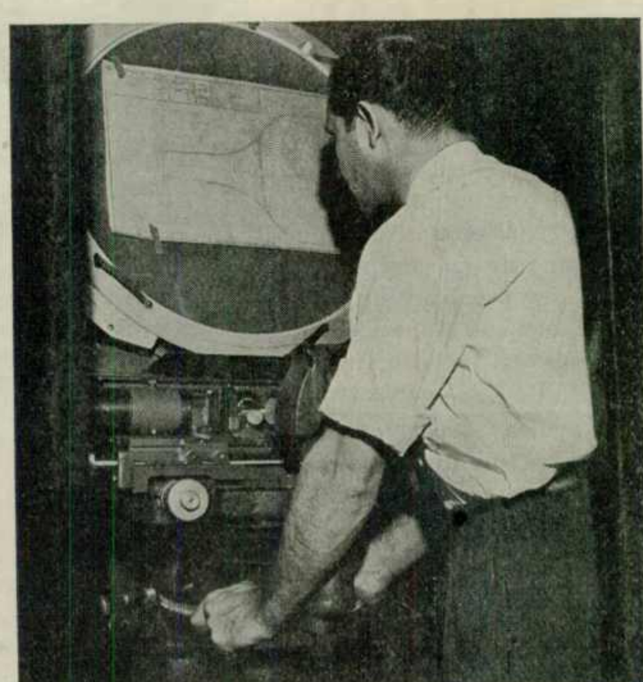
To insure that all Sylvania-made radio tubes will be of the very best quality, the well equipped tube plant in Emporium, Pennsylvania, provides extensive facilities for making over 8500 of the delicate small parts that go into Sylvania tubes.

Each month over 600 million small parts are turned out. In making these intricate parts, Sylvania craftsmen work with a variety of metals such as tungsten, steel, copper, phosphor bronze, beryllium copper and tantalum.

The Emporium staff includes highly skilled production engineers, tool and design men, and expert tube makers.



By a sampling method, watchful Sylvania inspectors carefully study each batch of small parts for detailed perfection.



Tiny tube parts are magnified and their outlines superimposed on scale drawings to insure meeting the extremely close dimensional tolerances required.

SYLVANIA ELECTRIC

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.

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

ADVERTISERS INDEX

ENGINEERING SALES

Stancor: Has appointed Grant Shaffer as representative for its jobber and industrial divisions, to serve the Detroit area. Associated with the Company for several years in an engineering capacity, Shaffer is experienced in both application and design problems of transformers. His office will be at 6432 Cass Avenue, Detroit.

Westinghouse: Will be represented in the southeast by Curtis W. Lehner, as district manager of the home radio division. With headquarters in Atlanta, he will serve North and South Carolina, Georgia, Florida, Alabama, Louisiana, and parts of Tennessee and Mississippi.

Motorola: Davis Radio Company, 2501 Tulare Street, Fresno, has been appointed distributor for the California counties of Stanislaus, Tuolumne, Merced, Mariposa, Madera, Fresno, Kings, Tulare, and Kern. Extensive alterations are being made at the Davis show room to accommodate radio set displays.

Meck: Has prepared a 16-page brochure illustrating postwar radio sets described as "The line the dealers designed." Copies can be obtained by writing John Meck Industries, Plymouth, Ind.

National Union: New Sales manager of the distributor division is Ed DeNike, for many years in charge of advertising and sales promotion at NU, and from 1939 until the start of the war, district sales manager of the New York state territory. Since 1942, he has headed the public relations department.

Chicago: On March 15th, Fred R. Ellinger, 9 S. Clinton Street, completed 20 years as a radio manufacturers representative. His territory is Indiana, Illinois, Wisconsin, Iowa, Nebraska, and Minnesota.

Carter: Magmotors and generators will be handled in Tennessee by J. M. Cartwright & Son, 1276 Peabody Avenue, Memphis.

UTC: Under a major expansion plan, Samuel Baraf has taken over merchandising activities as director of sales and merchandising. Ben Miller, for many years purchasing agent for Wholesale Radio and later sales manager for Meissner, has joined UTC as general sales manager.

Stromberg-Carlson: H. A. McRae & Company, Troy, N. Y., S-C distributors for

(CONCLUDED ON PAGE 77)

98% HERMETIC PRODUCTION

The need for maximum dependability in transformer products has swung UTC production into high gear on Hermetic designs. Work at our Varick Street plant, for example, is now 98% Hermetic.

May we cooperate with you on design savings for your applications...war or postwar?

United Transformer Co.

150 VARICK STREET **NEW YORK 13, N. Y.**

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

MILLIWATTS

Western

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.

From tiny tubes to eight foot water cooled giants—from vest pocket aids for the hard of hearing to super-powered radio transmitters—Western Electric has led the way in electrical communications equipment for many years.

Western Electric vacuum tubes for over 30 years have been noted for their uniformity and long life. Scores of new and radically different

BROADCASTING

MARINE RADIO

AVIATION RADIO

MOBILE RADIO

Western Electric has specialized

"make it a STROMBERG-CARLSON"

for the main radio in your home

Many of our friends in the trade are telling us that our current advertising expresses soundly the basic superiorities of Stromberg-Carlson products. This idea that the *main radio* in a home should be as fine a radio as its purchaser can buy—a *Stromberg-Carlson*—is being carried to the public by over 475,000,000 impressions in thirteen leading national magazines.

Experienced radio merchants feel they can profitably tie their own post-war merchandising plans to this theme. For they rate Stromberg-Carlson as: the *important* radio line; the radio line that will make real *profits;* the radio line with assured and growing *public acceptance.*

You, too, will want to organize your own post-war selling program around this widely accepted Stromberg-Carlson sales theme. You'll find the Stromberg-Carlson *"main radio"* a profit maker—whether in an outstanding table model, console, or radio-phonograph combination. Write for the name and address of your distributor, who will be happy to supply additional information about Stromberg-Carlson.

STROMBERG-CARLSON

ROCHESTER 3, NEW YORK
RADIOS...TELEVISION...
TELEPHONES AND
SOUND EQUIPMENT

Something to Remember

about having your CAPACITOR SPECIFICATIONS MATCHED

SPRAGUE CAPACITOR TYPES

Dry Electrolytic
Paper Dielectric
Mica Dielectric
Power Factor Correction
Motor Starting
High Voltage Networks
Radio Noise Suppression Filters, etc., etc.

In designing or producing a radio or electrical product, there are plenty of things to think of besides capacitors. Moreover, unless you've specialized, it's difficult to keep fully abreast of modern capacitor developments. That's why we make this suggestion:

Write today for a supply of Sprague Sample Request Forms. Then, as capacitor applications arise, use these forms to send full details to Sprague engineers. Let them make suggestions. Benefit from their broad experience, as well as from the fact that Sprague regularly produces dozens of standard Capacitor types, plus hundreds of adaptations and special units.

Such a request places you under no obligation to buy the recommended type. It simply assures you of specialized attention in the selection of an important component on which there are many factors to consider—angles which cannot always be cataloged completely or promptly, or which cannot be uncovered in any other way than through this personalized engineering service.

Write today for a supply of Capacitor Sample Request Forms.

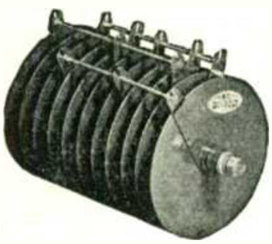
SPRAGUE ELECTRIC COMPANY, North Adams, Mass.
(Formerly Sprague Specialties Co.)

A typical group of Sprague Dry Electrolytic Capacitors designed to match special specifications.

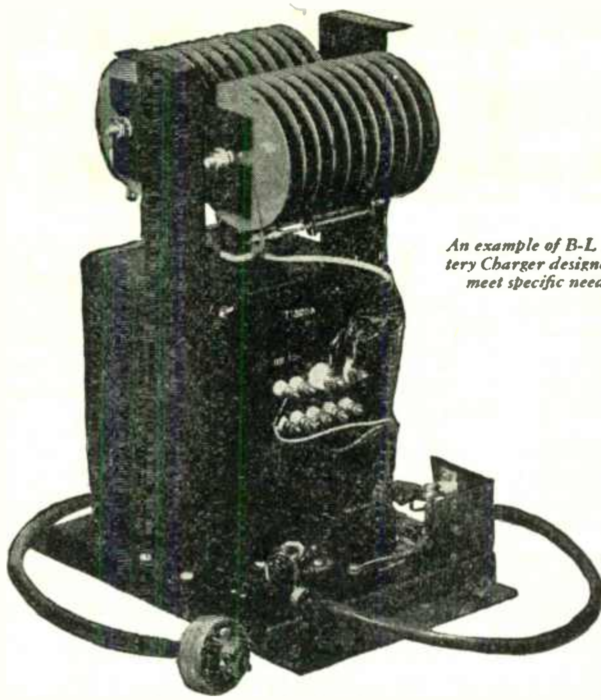
SPRAGUE

CAPACITORS • KOOLOHM RESISTORS

T. M. REG. U. S. PAT. OFF.



B-L Selenium Rectifier converts AC to DC.



An example of B-L Battery Charger designed to meet specific needs.

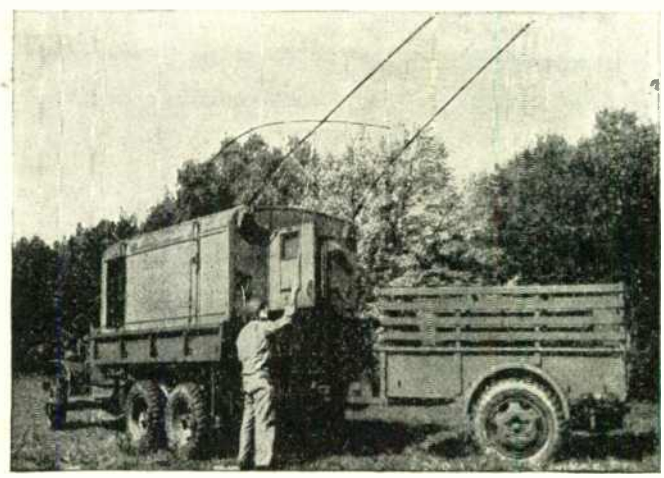
Specially designed B-L Transformer delivers 12 volts from the 115 volt output of the power supply.

This B-L Battery Charger meets special requirements of the Signal Corps

The problem of designing and manufacturing a charger for Signal Corps equipment which would meet the needs of increased loads was submitted to B-L engineers. The result is a Battery Charger producing *three times* the rate originally employed. It charges the batteries, and *keeps them charged*, in the Signal Corps equipment shown at the right.

The alternating current power supply is converted to direct current by sturdy, specially built B-L Selenium Rectifiers which meet the demands of this unit for charging the 6-cell 12-volt batteries. . . . The Charger itself is built to withstand rough usage and the severe moisture of the tropics.

A switch controls rate of delivery—5 amperes or 15 amperes . . . The built-in Thermal Circuit Breaker protects against overloads — the push button resets . . . The cut-out relay provides against any discharge of batteries in the event of power failure . . . Four fasteners permit handy removal from or installation to the base.



Mobile Unit, with Trailer, made for the U. S. Signal Corps by The Hallicrafters Co., Chicago.

Have You a Conversion Problem?

Twenty-five years of B-L specialized skill in AC-DC conversion problems is available to you. We are designers of Selenium and Copper Sulphide Rectifiers, Battery Chargers, and DC Power Supplies for practically every requirement. We invite your inquiries — without obligation.

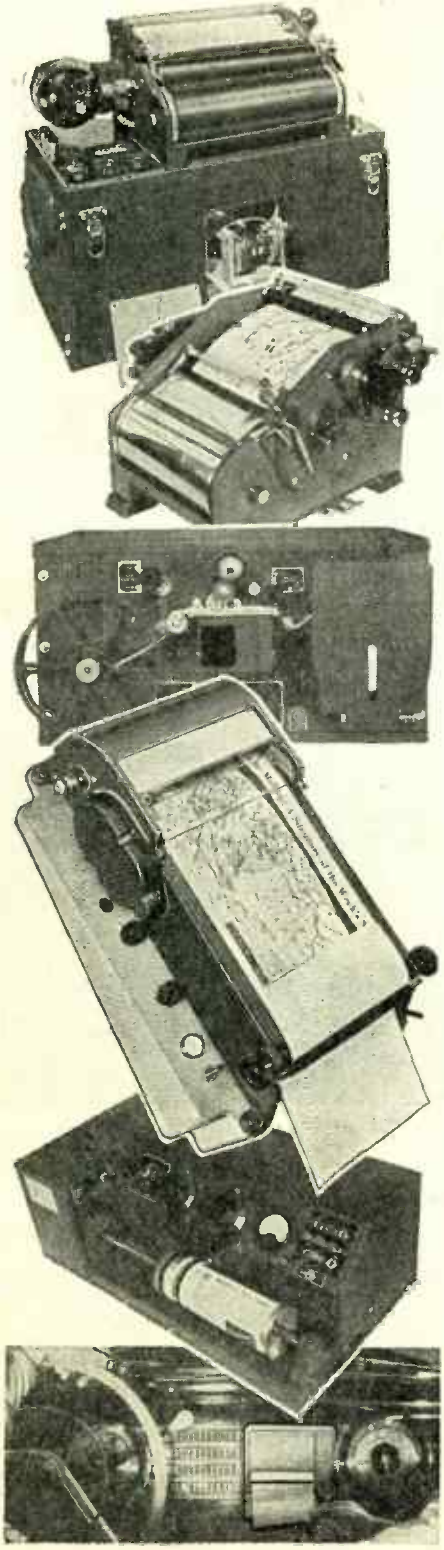
SELENIUM B-L ELECTRICAL RECTIFIERS **COPPER SULPHIDE**

THE BENWOOD LINZE COMPANY

1815 Locust Street • • • St. Louis 3; Mo.

DESIGNERS AND MANUFACTURERS OF COPPER SULPHIDE AND SELENIUM RECTIFIERS, BATTERY CHARGERS, AND D. C. POWER SUPPLIES FOR PRACTICALLY EVERY REQUIREMENT.

ALDEN



for Graphic Recording of any kind

OUR YEARS OF EXPERIENCE, and cumulative skills, in the designing and production of RADIO COMPONENTS, are now being used in making equipment which covers ***the entire field of FACSIMILE.***

Actual service, as found in war and communication work under all conditions, has given a PRACTICAL quality to our equipment which, under ordinary conditions, would not have been obtained in years of engineering with limited application.

ALDEN PRODUCTS COMPANY is manufacturing practically ALL TYPES AND SIZES of facsimile and impulse recording equipment—using all the varied recording mediums: Photographic Paper, Film, Electrolytic Paper, Teledeltos, and Ink.

ALFAX IMPULSE RECORDING PAPER

•

By "COVERING THE ENTIRE FIELD," we mean . . .

1. Some of our equipment has been used for the transmitting and receiving of photographic pictures of reasonably high resolution (such as the war pictures now appearing in the news).

2. Continuous Recorders—of the type whose value has been proven on National and International news service circuits—are now on their way to the Orient, to be used for the receiving of the so-called "picture" languages.

3. Also, through the use of ALFAX (the first high-speed black and white permanent recording paper), HIGH-SPEED Signal Analysis Equipment has been made possible for various laboratories and Government Departments. Other equipments have employed Teledeltos Paper for message work and other purposes.

4. The ability of ALFAX Paper and ALDEN Machines to record impulses *as they* occur, without the inertia problems of many previous methods, has made possible other recorders of various speeds (including slow). They will record a whole day's history of related phenomena, with time indicated, and often—with self-calibrated linear reference marks for ready interpretation.

5. ALDEN Tape Recorders (recording medium, ink)—have been designed to operate with a minimum of trouble and adjustments, and have PROVED MOST SATISFACTORY for day to day service.

ALDEN PRODUCTS COMPANY

117 North Main Street

BROCKTON [64F1], MASSACHUSETTS

• • • • • • •

FACSIMILE

The BUILDING of the EQUIPMENT shown on the opposite page has solved most of the problems (as well as providing us with adaptable UNITS and SUB-ASSEMBLIES) in the design and making of models that are in their advanced stage for:

HOME RECORDERS—that are simple—attractive—and which produce clear black and white copy.

★

DISPATCH RECORDERS—which use a minimum of panel space; for Railroads, Emergency Service Cars, Aircraft, Police Cars, Taxes, etc., etc.

★

LARGE AREA CONTINUOUS RECORDERS—for maps on paper that is readily drawn on, for interpretation or notes and which can be made translucent for the making for duplicate prints.

★

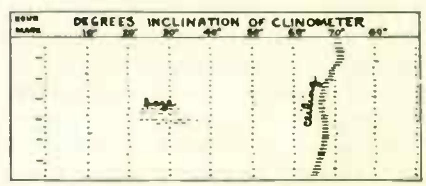
INTER-DEPARTMENT, or INTER-COMPANY MESSAGE, DESK SIZE RECORDERS—for memorandum or sketch dispatch, using ordinary typewriting for the scanning, but enlarged one and a half times, for legibility.

★

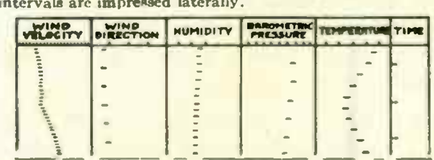
We do not want to miss an opportunity to discuss with you any interest you may have in facsimile or impulse recording. Write . . . or, better still, visit us by appointment.

Alden recorders use the medium best suited to the job. Illustrated above are recordings on Photographic film, paper tape and Teledeltos paper.

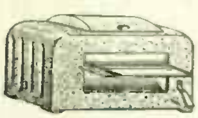
CATCHING THE CATHODE RAY SIGNALS IN A PERMANENT RECORD • Probably one of the greatest of all recent developments is the application of the cathode ray tube to make visible high frequency current for study and analysis. Now, Alfax paper and Alden recorders are the next step, making possible with certain ingenuity a permanent record on paper of what can be seen instantaneously on the cathode ray tube screen.



REFERENCE MARKS MAKE IT EASY TO INTERPRET RECORDING • This type of recording shows how standard or definite reference marks are recorded vertically for the accurate interpretation of received signals, whose intensity is indicated by shade and width of mark. Time intervals are impressed laterally.



HOW AN HOUR BY HOUR HISTORY OF FIVE RELATED PHENOMENA IS RECORDED • The above record will suggest the possibilities of recording several different types of phenomena conditions or values (usually related) which need to be recorded or studied together with time indicated. For instance, in process control, rate of flow, pressure, velocity, temperature, humidity — is recorded day by day or hour by hour, nearby or at a remote center.



Scanner

Typewriter

Recorder

HERE IS A NEW SYSTEM PARTICULARLY FOR DISPATCH MESSAGES

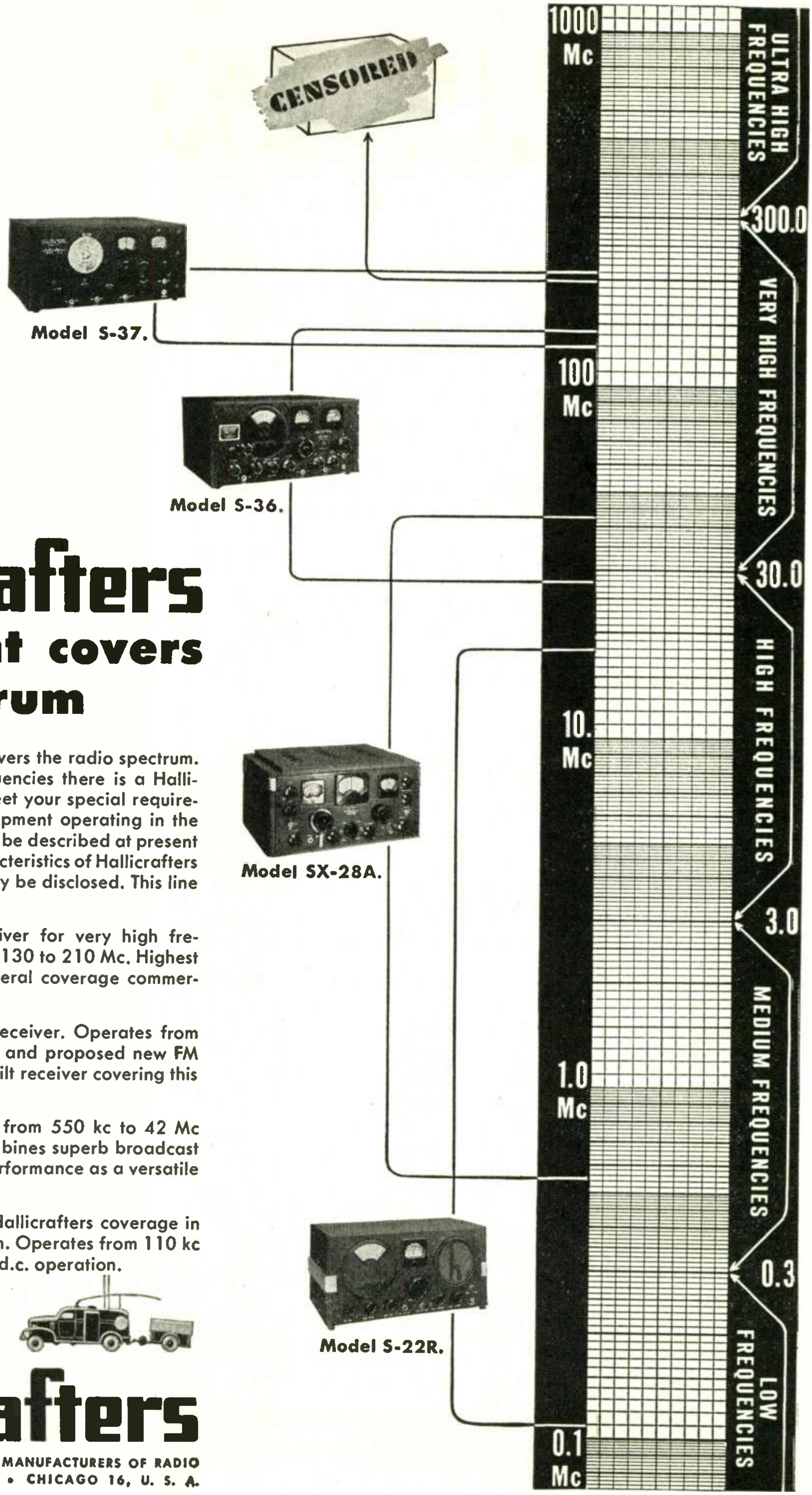
Now you can write or type a message, insert in scanner, press a button, and—scanner automatically starts, (transmitting signal to start recorder). Copy is scanned and ejected, then scanner resets. Copy can be hand written or, for dispatch messages, typed on roll paper as shown, in an ordinary typewriter. May be received enlarged one-and-one-half times appearing much like bold face type easily read several feet away. Ordinary typewriter may be used with adding machine or stenotype width paper for copy.

Recorder is neat, simple and extremely compact. Mounts flat against dashboard, panel or desk. Parts that wear are made as replaceable units.

A practical system for messages to police, firemen, plane and ship pilots, taxidrivers, emergency service men, etc., when the proper radio or wire links are available.

HOME RECORDERS using ALFAX paper will be ready to meet the demand, when frequency allocations and broadcast programs have been arranged. Clear black and white copy that does not smudge, continuous recordings, simplicity of operation are features of Alden equipment.

ALFAX ELECTRICAL IMPULSE RECORDING PAPER



hallicrafters

equipment covers the spectrum

● Hallicrafters equipment covers the radio spectrum. From low to ultra high frequencies there is a Hallicrafters receiver ready to meet your special requirements. Although certain equipment operating in the ultra high frequencies cannot be described at present for security reasons, the characteristics of Hallicrafters standard line of receivers may be disclosed. This line includes:

Model S-37. FM-AM receiver for very high frequency work. Operates from 130 to 210 Mc. Highest frequency range of any general coverage commercial type receiver.

Model S-36. FM-AM-CW receiver. Operates from 27.8 to 143 Mc. Covers old and proposed new FM bands. Only commercially built receiver covering this range.

Model SX-28A. Operates from 550 kc to 42 Mc continuous in six bands. Combines superb broadcast reception with the highest performance as a versatile communications receiver.

Model S-22R. Completes Hallicrafters coverage in the lower end of the spectrum. Operates from 110 kc to 18 Mc in four bands. A.c./d.c. operation.

BUY A WAR BOND TODAY!

hallicrafters

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

REPORT ON THE FM ORAL ARGUMENT

Attitude of FCC Indicates Possibility of Undisclosed Future Plans for Lower Frequencies

BY MILTON B. SLEEPER

THAT the FCC and the radio industry, through RTPB, did a remarkably fine job of planning frequency allocations for 25 to 30,000 mc. is clear from the fact that the only serious complaints voiced at the Oral Argument, February 28th to March 3rd, came from the FM broadcasters and manufacturers. Surprisingly, the television group were satisfied, except for a difference of opinion as to whether the FCC's characterization of downstairs frequencies as "temporary" should mean literally that, or if at least a 10-year tenure should be assured.

FM Frequencies ★ At the Allocations Hearing last fall, there was a definite feeling that the Commissioners wanted to center the FM broadcast band at 90 mc. From their questions to the witnesses, it was clear that they were more concerned with finding out if FM could move up, than with reasons why it should not.

This impression was shared by all who attended the Hearing. No one was surprised when the FCC disregarded the RTPB recommendations, based on the judgment of those experienced in the manufacture and use of FM equipment, and set the band at 84 to 102 mc.

Subsequently, this observer expressed the thought (*FM* & T Jan. '45) that: "It seemed certain . . . the FCC would not take the responsibility for keeping FM broadcasting on the lower frequencies because of the possible long-distance interference in that band. Rather, if FM is to stay about where it is now, it would be only at the insistence of the industry."

At the Oral Argument on allocations, the Commissioners gave every indication of having decided that FM would move up despite the expressed conviction of the FM group that there were no sound technical reasons why it should, nor definite economic reasons why it should not. In fact, general opinion expressed by those who gave testimony against the move was: "We were licked before we came here!"

What's Behind It? ★ Why does the FCC want to discard all the present experience, progress, and investment in FM?

No one has ventured an opinion as to the answer. It has everyone puzzled, including those who have something to gain by the shift. Still, it is interesting to examine the possible reasons, as indicated by the voluminous records of the proceedings:

1. The explanation given by the Commissioners was that: "Public interest requires that FM be established in a permanent place in the radio spectrum before a considerable investment is made by the listening public in receiving sets and by the broadcasters in transmitting equipment. FM must be located in a region free of skywave interference if its full capabilities are to be utilized. From the evidence we believe that such interference in the 40–50 mc. region would be severe enough to impair the utility of this service to such an extent that the full development of FM might be retarded. The testimony has established, however, that skywave transmission would be negligible in the vicinity of 80 mc., and would be practically non-existent beyond 100 mc. Accordingly, the Commission proposes to assign FM to a band commencing at 84 mc. and continuing to 102 mc." [1]

Perhaps that is the whole story. It seems unlikely, though, because the "evidence" of skywave interference was only the opinion of Dr. L. P. Wheeler and K. A. Norton, both of whom were FCC witnesses. Their testimony, unconfirmed by measurements and observations, and contrary to data presented by experts experienced in radio communications, was so tenuous that it is doubtful if it would have been accepted if it had been offered by RTPB to Commissioners who had reason for favoring the lower frequencies.

2. If, as it appears, there is some reason of FCC policy for moving FM up, what can it be? Is it because the frequencies from 44 mc. upward offer some advantage to television? That does not seem to be the case, according to Commissioner E. K. Jett. At the FCC press conference when the allocations proposal was made public, Commissioner E. K. Jett, in response to a question by the writer, stated: "You might say to me: Well, the interference problems, in so far as television is concerned, would be just as bad with FM. As an engineer, I will agree to that. However, FM is to be started and developed as a permanent broadcasting service for the future. Television may or may not be a permanent service in the bands below 225 mc. because we are encouraging the development of television above 480 mc. We fully expect after a number of years that truly competitive operations in this country will be in the bands above 480 mc. Therefore, of the two services, when you consider that we must select between one and the other, the 6-mc. television service will be of a temporary character. I admit, of course, that the temporary character may extend for some years. Therefore, the service that is temporary in character should take the interference; not the one that will be with the public throughout the entire future." [2]

There was further discussion [3] of effects of long-distance interference at the lower frequencies on this occasion:

DR. WHEELER: Your reply to one of Mr. Sleeper's questions, I think, did not cover quite the whole question.

COMMISSIONER JETT: I am glad to have you elaborate.

DR. WHEELER: Mr. Sleeper stated, in putting television down to 44 and 50, that it would suffer more interference than the FM at present.

Now, in view of the large ratio, the large numbers of FM stations to be operating, compared with the relatively small number of television stations, and in view of the fact that this long-distance interference is a co-channel proposition, there will actually be less interference to television in that band than there would be to FM. Because there will be fewer stations on the same channel at the proper geographical distance to bring in the long-distance interference.

COMMISSIONER JETT: I am glad you made that point.

DR. WHEELER: Less interference with television.

MR. SLEEPER: If there aren't too many television stations.

DR. WHEELER: What did you say, 250 applications for FM transmitters? There is nothing like that for television at all. And it is a question of the geographical distance at which that interference can come in, the separation. So that there is an overwhelming probability that there will be less interference in television from this

(CONTINUED ON PAGE 80)

[1] *Report on Proposed Allocations from 25,000 Kilocycles to 30,000,000 Kilocycles*, page 71, Docket 6651, Jan. 16, 1945.

[2] *Official Report of Proceedings before the Federal Communications Commission*, Press Conference, January 15, 1945, page 11.

[3] As above, pages 45, 46.

BASIC PRINCIPLES OF RADAR OPERATION

Information Is Presented Here to the Extent Disclosed in English Magazines Admitted to the U.S.A.

THE word *radar* is a contraction of radio-detecting-and-ranging, and relates to equipment employed principally to detect the presence and position of objects, notably airplanes, which cannot be seen either because of their distance or because vision is obscured.

English authorities generally credit radar, or RDF as they call it, with playing a major rôle in the defeat of the German Luftwaffe during the Battle of Britain. Using radar to detect the approach of enemy planes and to determine their exact course, it was possible for the RAF to ready anti-aircraft defenses and to get their fighters aloft before the raiders had crossed the Channel.

Continuous research has expanded the use and increased the effectiveness of radar equipment. Shortly after the first landing by Americans at Iwo Jima, the newspapers announced that this island had been used by the Japs as a radar station to detect the passage of our B-29's en route to Tokyo. Thus the Japanese homeland was being warned of impending raids while our bombers were still far out at sea.

IN many instances, the first news of military matters has been released in England. So it is with the very interesting subject of radar.

Although, at this time of writing, no information concerning radar principles has been released by our Navy or Signal Corps, certain fundamentals were disclosed by Dr. R. L. Smith-Rose in the February 1945 Issue of the English "Wireless World," copies of which have been admitted to this Country by the U. S. censors.

Accordingly, we are presenting here as much, but no more, information as was published by our esteemed English contemporary.

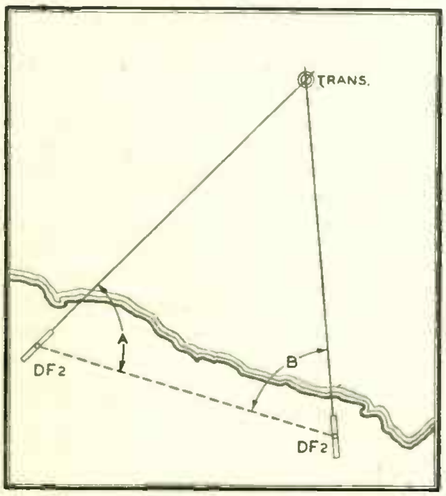


FIG. 1. STANDARD METHOD FOR LOCATING A DISTANT TRANSMITTER

Direction Finding & Ranging ★ The development of the radio direction-finder, which dates back long before World War 1, makes it possible to determine the position of a distant transmitter at sea or on land by the simple method of triangulation illustrated in Fig. 1.

The operator at DF1, upon picking up a signal, determines the angle *A* and telephones the information to DF2.

Station DF2 is equipped with a map on which arcs are drawn around the locations of the direction-finders. The operator at DF2, having determined angle *B*, pulls out strings, fastened to the map at points DF1 and DF2, to the proper angles. The point at which they cross indicates the location of the distant transmitter.

The limitation of this method lies in the fact that the station can be located only if and when it transmits signals. It cannot be used to locate enemy planes or ships, since they unobligingly maintain radio silence en route to their targets.

Radar ranging, however, combines a transmitter and receiver to send out waves and to pick up those waves which are reflected or reradiated by an object whose conductivity is different from that of air. Then, by measuring the time required for the waves to travel to the object and back, radar adds the important information as to the distance from the ground station to the object. Therein lies the basic advantage of radar over conventional direction-finding equipment.

Reflection of Electric Waves ★ The classic demonstrations of electromagnetic wave phenomena given by Hertz (1885–1889) showed that electric waves possessed properties similar to those of light. That is, they can be reflected by metal plates, refracted upon passage through prisms of insulating material, and concentrated into beams by metal reflectors.

Marconi was one of the first to make practical use of reflectors for the transmission of extremely short radio waves. The phenomenon of reflection and refraction of radio waves by materials of different conductivity is employed for sub-surface surveys to locate oil and mineral deposits.

Light Waves ★ If a searchlight is turned on an airplane at night, the plane is made visible to the operator by light reflected from the surfaces of the plane. The direction of the plane as to elevation and azimuth can be determined by the position of the searchlight, but there is no indication of distance. That could be determined, however, if a pulse of light could be directed toward the plane, and a measurement made of the time required for the light pulse to reach the plane and return by reflection to the point of origin.

The method employed by Fizeau (1849) to measure the speed at which light waves travel can be adapted to the measurement of distance, knowing the speed of light.

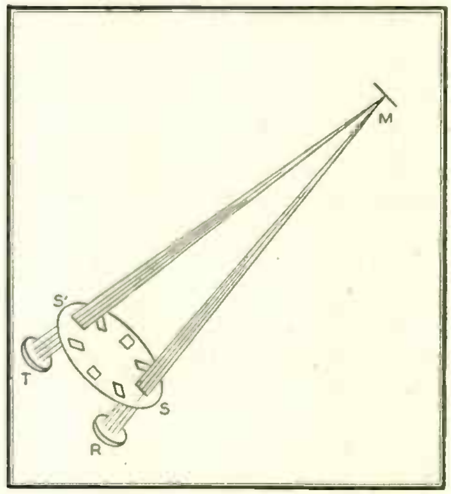


FIG. 2. ELEMENTS OF METHOD USED BY FIZEAU TO MEASURE SPEED OF LIGHT

Fig. 2 indicates Fizeau's method. It requires the use of a light source, a reflector at the distant point, and a revolving, slotted wheel.

The light source at *T* is directed through slot *S'* in the wheel to a distant mirror *M*, from which the light is reflected into slot *S*, diametrically opposite slot *S'*. When the wheel is rotated, slot *S* will be advanced in relation to the reflected pulses of light going out through slot *S'*. As the speed of the wheel is increased, the reflected light pulses through *S'* will be blocked out by the solid part of the wheel following *S*. Then, by a simple computation involving the dimensions of the slots, the speed of the wheel, and the distance to the reflector, it is possible to determine the rate at which light travels.

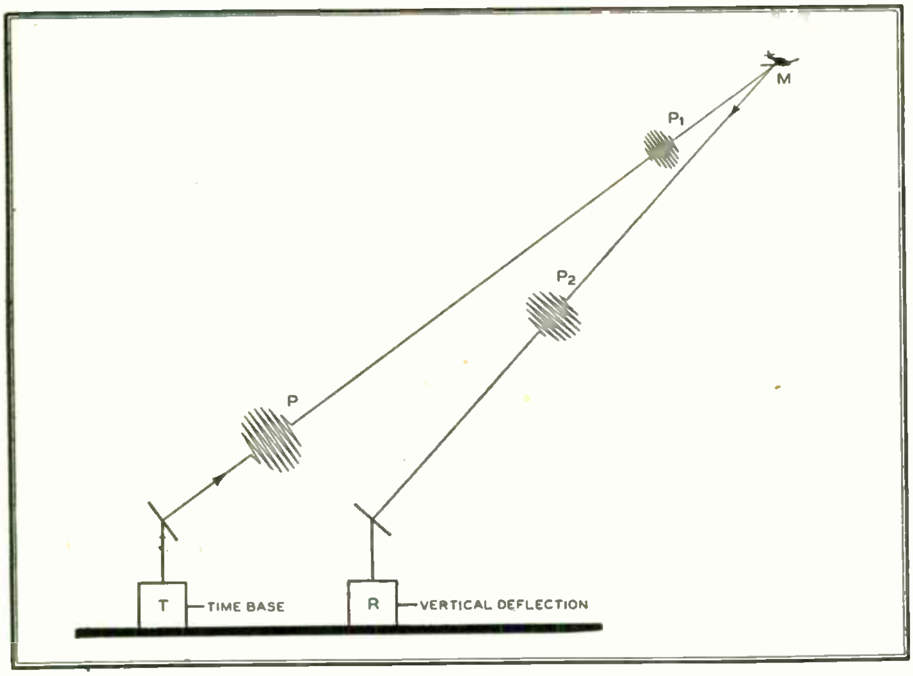


FIG. 3. RADIO PULSES FROM T ARE REFLECTED BY TARGET M TO RECEIVER R

The same apparatus, obviously, can be used to determine the distance from the wheel to the reflector *M*, after the speed of light has been found. Unfortunately, this method can be used only at distances within the range of human vision, and the time required to operate the equipment is

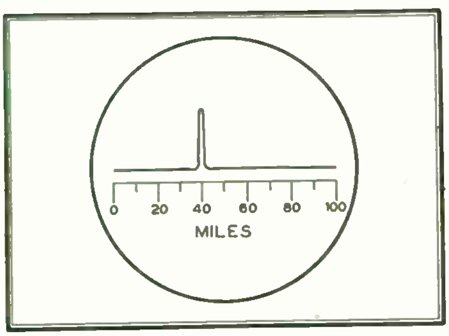


FIG. 4. INDICATION OF AN AIRPLANE AT A DISTANCE OF 40 MILES

too great for use on such a fast-moving object as an airplane.

Basic Radar Principles ★ The operation of radar equipment substitutes pulses of radio waves for Fizeau's light pulses. Thus a radar installation comprises a radio transmitter capable of sending out wave pulses from a directional antenna, and a receiver connected to a cathode-ray tube on the face of which the received impulses give an indication of distance related to a time base established by the transmitter.

Fig. 3 shows these elements. Transmitter *T* sends out the impulses in the general direction from which an enemy plane may be approaching. When a plane comes within range of the radio "searchlight," the radio pulses are reflected just as light waves would be reflected, making the plane "visible" to the ground receiver *R*.

Since radio waves are known to travel at 186,000 miles per second, the distance *TMR* can be determined by measuring the time required for a pulse to travel from

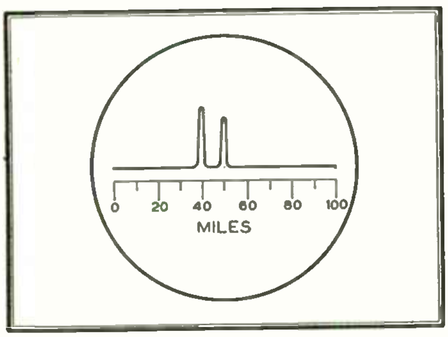


FIG. 5. TWO PLANES ARE INDICATED, 40 AND 50 MILES AWAY

the transmitter to the plane and back to the receiver.

The method of measurement is quite simple. The horizontal-deflection plates of a cathode-ray tube are used as the time base, established by the transmission of the pulses. The vertical-deflection plates are connected to the receiver.

With the time base deflection starting at the left on the cathode-ray tube screen, if the distance *TMR* is essentially zero, the reception of each pulse is instantaneous, and the vertical deflection caused by the received pulses appears at the extreme left, at the very start of the time base, since the time is zero.

As the distance *TMR* is increased, reception of the pulses is correspondingly delayed, and the deflection from the received pulses appears on the screen farther and farther to the right.

Fig. 4 shows the face of the cathode-ray tube, with the calibrated scale on which the distance from the ground installation to the target can be read directly in miles. The movement of an approaching plane, while it is still far beyond the range of vision, can be followed by the vertical deflection as it moves from right to left along the scale.

Since the strength of the waves received by reflection from the target determines the relative amplitude of the deflection on the cathode-ray tube, the amplitude at a given distance is an indication of the size and reflecting properties of the target. In fact, an experienced operator can make a shrewd guess at the nature of the target by the particular form of the deflection it causes.

The deflection shown in Fig. 4 indicates the approach of a single plane. Two planes, separated by 10 miles, might produce a deflection as in Fig. 5. If the second plane is the same size as the first, the deflection would naturally be less, and would occur later than that resulting from waves reflected by the nearer plane. On the other hand, a plywood Mosquito would reflect the transmitted waves much less effectively than an all-metal plane. The received signal voltage and the resultant deflection, therefore, would be less.

Important as is the measurement of distance, it is also necessary to locate an enemy target as to elevation *E*, Fig. 6, and azimuth bearing *A*. That is possible by the use of conventional and familiar principles.

This explanation of radar operation is, necessarily, limited to reference to fundamentals. However, it is sufficient to make clear many possible peacetime applications for modifications of this equipment. Among these is use on ships at sea, to detect the presence of other vessels, icebergs, or land when vision is obscured by fog or darkness. Another is for checking the flight of planes on commercial routes during bad weather, since ground stations could advise planes of their positions.

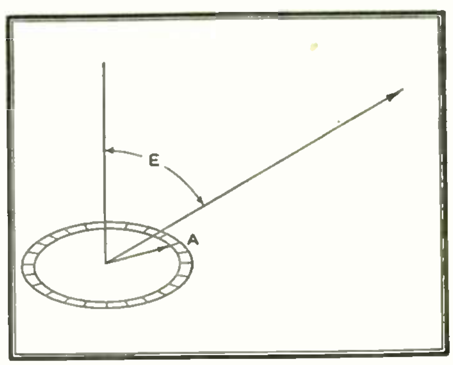


FIG. 6. ELEVATION AND BEARING ANGLES

DISCUSSION OF PROPOSED FM FREQUENCIES

Complete Text of Brief Discussing Norton Predictions of Interference on Present FM Frequencies

BY MAJOR EDWIN H. ARMSTRONG*

OF ALL the questions which have ever been presented to the Commission in hearings which it has held in the past, those questions which have come before it through the recommendations of the Radio Technical Planning Board in connection with FM broadcasting are the most complex and important that it has ever had to decide.

They are important because they deal with the technical and economic aspects of what will, without question, be the major part of the radio industry for years to come. They are complex because they deal not only with involved phenomena occurring in radio circuits and apparatus which even now a fair percentage of engineers do not understand, but also because they deal with the vagaries of propagation of the radio waves through space, one of the most complex subjects in the art.

The numerous technical problems with which FM broadcasting is concerned have been examined within the Radio Technical Planning Board, by the Panel charged with that particular duty and, because of the various conflicting interests existing within the industry, all points of view have been presented and thoroughly examined. A series of recommendations, as expressed in the report of Panel 5, were arrived at and duly submitted to the Commission.

In all save two respects, the recommendations made by the Panel have been endorsed in the Commission's preliminary proposal, whose findings coincide with the engineering thinking of the men who built the FM art.

In two aspects only have the recommendations of the Engineering Department of the Commission not coincided with those made by the RTPB. The first aspect deals with the amount of space to be allocated to FM; the second aspect deals with its position in the spectrum.

The Radio Technical Planning Board suggested an amount of space in the spectrum of 15 mc. as adequate for the possible needs of FM broadcasting. The Commission has expanded this figure to a band of 18 mc., to be available immediately, with provision for effecting an eventual expansion to 30 mc. As the Commission is charged with the responsibility for providing adequate space and is in a better position to forecast the magnitude of the demands for facilities, it is not believed its judgment on this point is open to question.

The only important difference between the Commission's proposals and the recommendation of the RTPB deals with the position of FM in the radio spectrum. The question to be decided, fundamentally, is whether, from a propagation standpoint, it is better for FM to remain in approximately the present position, expanding upward to the degree necessary to encompass the same width of spectrum proposed by the Commission, or whether it is better to move bodily to the upper end of the band. The band in question extends from 44 to 108 mc., and three services — amateur, television, and FM — are to divide the space within these limits.

BECAUSE Major Armstrong's brief on proposed FM assignments (presented at the FCC's oral argument February 28th to March 3rd, 1945, Docket No. 6651) includes reference to K. A. Norton's much-discussed curves from Exhibit 380, and full quotations from the Armstrong-Beverage-Burrows memorandum presented at the same time, the text is published here in full. This is in accordance with the policy of furnishing in FM and Television a complete reference record of the various aspects of FM broadcasting and communications.

The Question ★ The difference of opinion between the Commission's proposals and the recommendations of Panel 5 revolves about the importance of certain vagaries of transmission of radio waves through space, and the evaluation of the amount of interference which may result from the reflection of these waves from the various strata existing in the atmosphere above the earth.

The problem is the more involved by the reason that the type of interference which has been emphasized as the most serious type, namely, F2-layer transmission, is not now being experienced in any of the channels of the present FM band, and so cannot be positively evaluated by direct measurement. The range of frequencies over which F2-layer transmission may take place varies over an 11-year cycle, and it is only during the peak years of the cycle some years hence that trouble due to it is forecasted.

It is over the accuracy of these predictions of serious interference at the peak of the sunspot cycle, which is expected to occur about 1948, that this controversy arises.

The question of the importance of skywave interference in both its forms (commonly referred to by the terms "F2" and "Sporadic E") was raised within Panel 5 during its deliberations. It was suggested by those who brought the matter up that it be referred to Dr. Dellinger of the U. S. Bureau of Standards, recognized authority on the subject in the United States, for an opinion on this matter. This the Panel voted to do. Dr. Dellinger's treatment of the subject is described in detail in the report of Panel 5, and it is not necessary to examine it here other than to say that Dr. Dellinger found the fear expressed as to the possibility of serious interference from skywave propagation in its various forms "to be not well founded." Those who raised the question within the Panel accepted Dr. Dellinger's judgment.

In the closing days of the hearing, the question was again raised in testimony given on behalf of the Commission by Mr. K. A. Norton. This testimony dealt with various forms of possible skywave interference.

Three forms of interference were considered, and most of the testimony centered about an exhibit (Exhibit 380) which undertook to predict by a series of curves the intensities of these interferences and the percentage of time over which they might be expected to occur within the boundaries of the United States.

Some of these curves are based on the results of actual signal strength measurements, others are arrived at on the basis of certain assumptions from ionospheric measurements made in the United States in the past, and still others are arrived at on the basis of certain assumptions and from predictions of what the ionospheric conditions will be during the peak of the next sunspot cycle as extrapolated from ionospheric measurements which have

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

been made over less than 1/10th part of the cycle in other parts of the world.

The all-important series of curves, as regards these hearings, are those based upon ionospheric measurements taken in other parts of the world during the short period of time referred to, information about which was recently declassified as restricted military matter. On the basis of these ionospheric measurements, Mr. Norton predicted, with great definiteness, skywave interference from South America and Australia during the next sunspot maximum, of an intensity and at frequencies (80 mc.) quite out of line with the evidence of all past experience.

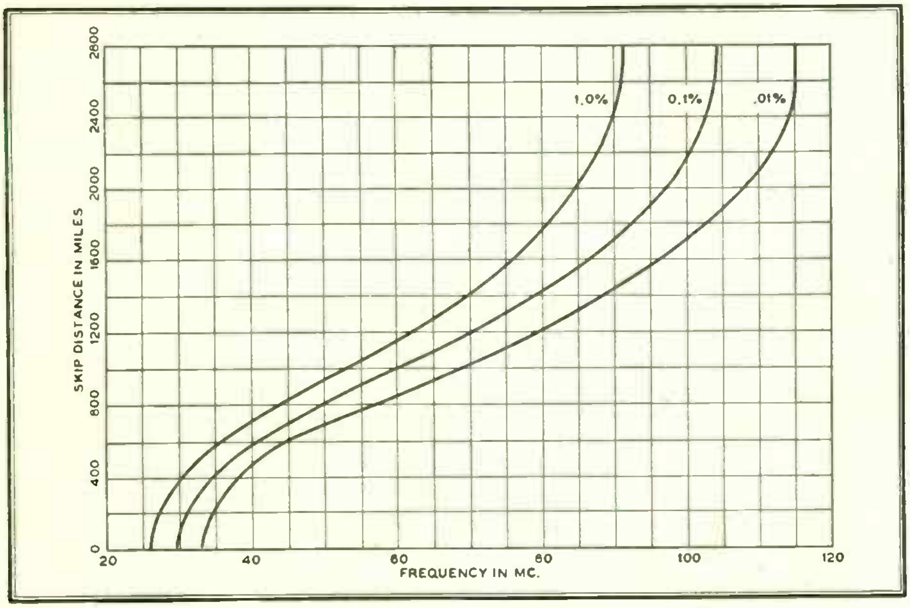
It is difficult, even for one familiar with the subject, to undertake to separate the curves which are based on fact from those which have been based on assumptions that are open to serious question. It appears that even the Commission's staff, who prepared the report dealing with the propagation matter, was confused in this respect in a number of cases. Reference will be made to this hereinafter.

Mr. Norton's testimony and the Exhibit have been carefully reviewed by a group of men who have had long experience in propagation matters. They are in agreement as to the existence of a basic error in Mr. Norton's predictions concerning F2 layer interference. This error was originally pointed out in the supplemental statement inserted in the record by Dr. Beverage, and additional evidence of the error has been discovered during the examination by the group referred to above.

The following men conducted this examination:

Dr. H. H. Beverage
Dr. G. W. Pickard
Dr. H. T. Stetson
Dr. C. R. Burrows
Mr. Stuart Bailey
Dr. Edwin H. Armstrong

The conclusions reached are covered in a memorandum prepared by Drs. Beverage, Burrows, and Armstrong. The memorandum is appended hereto.[1]



NORTON FIG. 2 — EXHIBIT 380

ESTIMATED percentage of the listening hours during the last sunspot cycle (1933–1944) for which the F-layer skip distance would have been expected to be less than the values shown for particular frequencies. (The conditions shown here are based on ionosphere measurements at the station having the highest presently-known critical frequencies and thus correspond to the worst anticipated conditions of potential F-layer interference to United States VHF stations from VHF stations in any part of the world. The measurements at this ionosphere station were available only from March through August 1944 and were estimated for sunspot cycle maximum conditions.)

Skywave & Tropospheric Transmission ★ Before proceeding to a discussion of this error and the F2-layer problem, which will follow the lines of the memorandum, a statement of the types of possible interference with which we are concerned is in order, so that some of the confusion about the characteristics of the different types may be cleared up. There are three forms of vagaries with which we are concerned:

1. F2-Layer Transmission: Reflections from the highest electrified strata of the upper atmosphere, designated as the F2-layer. Interference from this type of transmission is predicted for the frequencies now being used in FM broadcasting during the peak years of the 11-year sunspot cycle. This type of transmission can take place only during the daylight hours of the winter months. It can occur over long distances and generally appears at a point a couple of thousand miles from the transmitting station, skipping over the intervening territory. It is occurring at the present time at much lower frequencies than those with which we are concerned in the present FM band. The wave frequency at which it can take place increases as the maximum of the sunspot cycle is approached. One of the points here in controversy is how high it will go at the sunspot maximum.

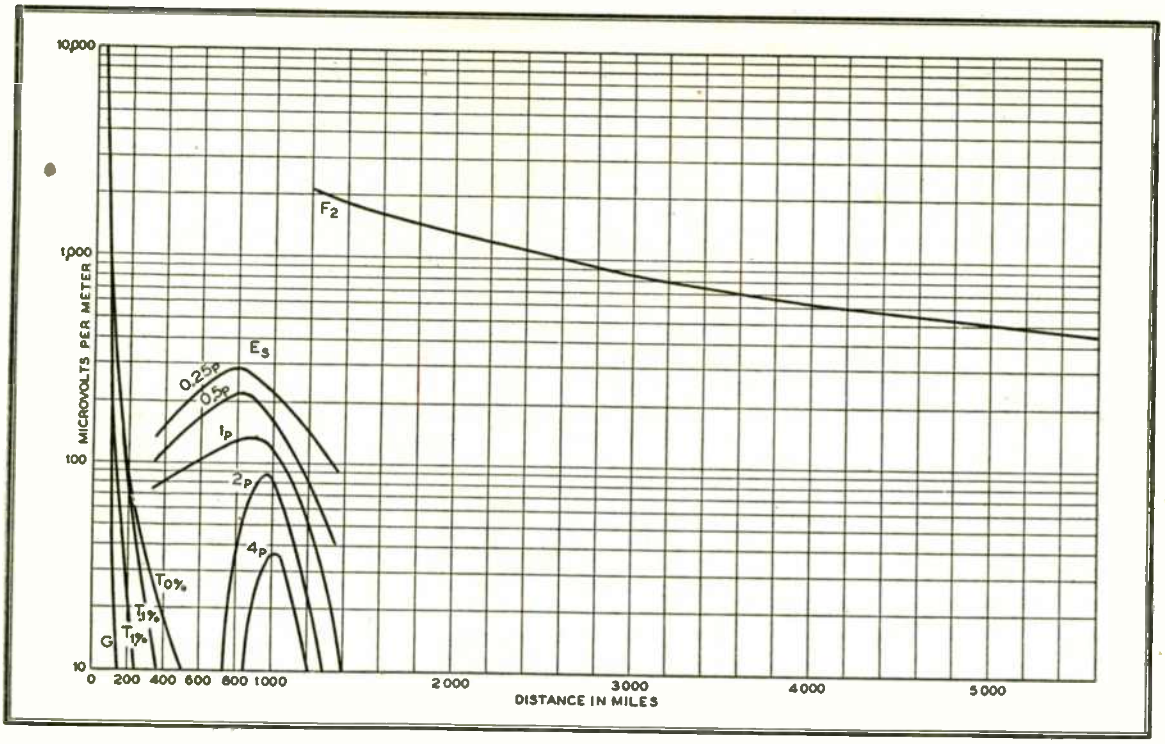
2. Sporadic E Transmission: Reflection from a lower, or intermediate level due to ionized sections of the atmosphere (commonly referred to as Sporadic E transmission). This appears to be more or less independent of the sunspot cycle. It is more prevalent during the summer months, and can occur during the hours of daylight or darkness. It decreases with the increase of the frequency of the transmitted wave at a rate which is not entirely clear, but on which some information is available. This form of transmission also hops over the intervening territory, making its presence most strongly felt at a distance of 500 to 1,000 miles.

3. Tropospheric Wave Transmission: There is a form of transmission known as tropospheric wave transmission, which results from a bending of the waves at points within a few miles of the earth's surface. This is also independent of the sunspot cycle, and can occur also during the hours of daylight or darkness. Its effects increase with the frequency of the transmitted wave, but not much information is available as to the rate. It has no skip distance, but makes its presence felt over an area surrounding the transmitting station. Its effects can extend over hundreds of miles.

A fair amount of experience has been obtained from present operation of FM broadcasting stations with respect to the second of these types of transmission, namely the Sporadic E, and it is possible to make a reasonably accurate appraisal of its interference effects.

F2 Layer Transmission ★ With this statement of the vagaries of transmission with which we are concerned, it is now in order to proceed with an examination of the real point at issue, the effects of F2 layer transmission. Subsequently, the effects of Spo-

[1] This memorandum, numerous quotations from which appear in the text, can be obtained from the Federal Communications Commission, Washington, D. C. The title of the memorandum, signed by Drs. Armstrong, Beverage, and Burrows, is *Memorandum Concerning the Steps Which Must Be Taken and the Assumptions Which Are Involved in Any Attempt to Predict Possible Interference with Very High Frequency Services from F2 Layer Transmission During the Coming Sunspot Maximum, and an Analysis of the Assumptions Made in the Preparation of Exhibit 380 for This Type of Interference.*



NORTON FIG. 4 — EXHIBIT 380

GROUND WAVE, Tropospheric wave, Sporadic E-layer sky wave, and F-layer sky wave field intensities for FM station WGTR at Paxton, Mass. (Transmitter power 83 kw.; 10-bay antenna; estimated free space field at one mile = 2540 Mv/M; antenna height 1,600 ft.)

KEY TO CURVES

G = Theoretical ground wave.

$T_{1\%}$, $T_{0.1\%}$, $T_{0\%}$ = Tropospheric wave field intensities exceeded for the percentages of the time indicated. (*Estimated from measurements made at Laurel on several FM stations and reported in Exhibit 4 of Docket 6651.*)

$E_s(1p)$ = Sporadic E-layer sky wave field intensities exceeded for the percentages of time shown as a function of distance and frequency in Fig. 3. (*Based on measurements of WGTR reported in Exhibit 4 of Docket 6651.*)

E_s (np) = Sporadic E-layer sky wave field intensities exceeded for n times the percentages of time shown in Fig. 3.

F = F-layer sky wave field intensities. (*Theoretical estimate in agreement with available data.*)

radic E transmission and the effects of the tropospheric wave will be discussed, but they are not considered by Mr. Norton to be as important as the F2 layer transmission:

". . . I think the effect of Sporadic E will be much less important in the sense that it will occur in a smaller percentage of the service area than will be the case for the F layer transmission." — *Norton, p. 3798.*

The following description of F2 layer transmission is abstracted from the memorandum referred to previously:

"F2-layer transmission is brought about by the reflection of the transmitted wave from one of the electrified strata of the upper atmosphere. This particular layer varies in height above the surface of the earth between 225 and 400 kilometers, and its ability to reflect transmitted waves back to the earth changes with the time of day, the time of year, the 11-year sunspot cycle, and the frequency of the waves transmitted. Its effects on radio transmission were discovered over 20 years ago, and it is the principal medium by means of which our intercontinental communications take place. These communications are carried on at substantially lower frequencies than those with which we are concerned in FM broadcasting. At the frequencies used in overseas communication, the F2-layer furnishes a daily and quite reliable year-round service during the daylight hours, provided these frequencies are kept below a certain critical value. Frequencies higher than this value pass off into space and do not return to earth. Over the greater part of the 11-year sunspot cycle this condition exists for the frequencies with which we are at present concerned in FM broadcasting. It is only during the 3 peak years of the sunspot maximum, during the winter months of those years, and during certain of the daylight hours (middle of the day) that the layer is in a condition where its effects can be of any importance in connection with FM broadcasting.

"The process by which F2-layer transmission in its very simplest form may be effected comes about in the following way: The transmitted wave leaves the antenna, and the part of the wave with which we are concerned passes off into space more or less tangentially to the surface of the earth. At a certain distance from the transmitting station the wave comes in contact with the surface of the layer. The distance from the transmitting station at which the wave comes in contact with the layer is determined by the height of the layer above the earth at that particular moment.

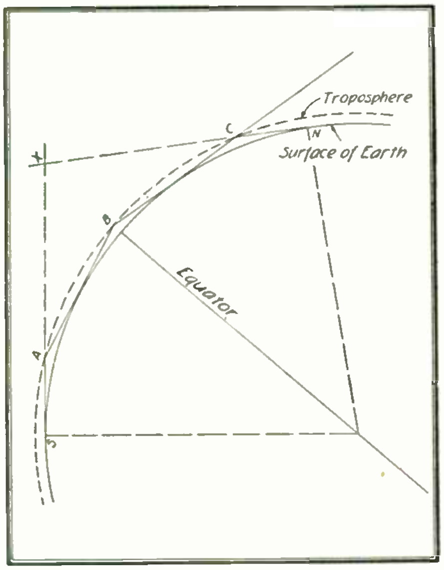
"If the condition of the layer is such that it is capable of reflecting the particular frequency transmitted, the wave is bent back from the layer at the same angle at which it impinges upon it, and strikes the earth at an equal distance therefrom; i.e., the point of reflection from the layer is midway between the point at which the wave left and the point at which it returned to the surface of the earth. The all-important relationships which determine whether transmission will occur for any given distance are: The condition of the layer at the point of contact; its height above the earth's surface; the distance to be covered; and the angle at which the wave impinges upon the layer. As will appear subsequently in this discussion, the actual cases of F2-layer transmission with which we are concerned are much more complex than this simple example may seem to indicate."

The relation between the condition of the ionosphere and long-distance transmission via the F2-layer has been studied at the Bureau of Standards in Washington, D. C. for many years, and a technique of predicting the frequencies for which transmission may occur over specified distances has been developed. These limits have coincided very well with the experimental observations which have been made during the past two sunspot cycles.

Dr. Beverage has testified that the highest transmission frequency from Europe which he has ever observed via F2-layer transmission was 45 mc., while the highest from South America was 43 mc. It is important to note that with the type of reception employed (heterodyne reception) a field strength of .1 microvolt could hardly have been passed by, had such signals been present for any appreciable period of time.

In sharpest contrast to these ideas on which the art has been proceeding for many years are the predictions contained in Fig. 2 of Mr. Norton's Exhibit 380 which is entitled:

"*Estimated Percentage of the Listening Hours During the Last Sun-Spot Cycle (1933-1944) for Which the F-layer Skip Distance Would Have Been Expected to Be Less Than the Values Shown for Particular Frequencies.* (The conditions shown here are based on ionosphere measurements at the station having the highest presently known critical frequencies, and thus correspond to the worst anticipated conditions of potential F-layer interference to United States VHF stations from VHF stations in any part of the world. The measurements at this ionosphere station were available only from March through August, 1944, and were estimated for sun-spot cycle maximum conditions.)"



ARMSTRONG FIG. 1. TROPOSPHERIC REFLECTIONS OCCURRING OVER GREAT DISTANCES

These curves predict transmission via the F2-layer at frequencies running up to over 100 mc., a figure about twice as high as has been heretofore accepted as the upper limit for this type of transmission. Not only has he predicted the F2 transmission will occur at frequencies far higher than any heretofore experienced in the United States, but he has predicted in the F2 transmission curve of Fig. 4 a strength of interfering signal far in excess of any which have been recorded on the lower frequencies, where F2 transmission has been observed to take place.

The basic error of this prediction of the high frequencies for F2 layer interference in the United States will appear from the following treatment of the subject in the memorandum[1]:

"Why is it that such conditions were not observed during the past two sunspot cycles, when careful observations were made over the South American path between Buenos Aires and New York? Dr. Beverage has testified that the highest frequency over which transmission was observed was 43 mc., and it is important to note that with the type of reception employed (heterodyne reception) a field strength of .1 microvolt could hardly have been passed by had such signals been present for any appreciable period of time. We think the explanation for the difference between the predictions and the experimental observations of the past will be found in the explanation set forth in the statement by one of us (Dr. Beverage) filed during the recent Commission Hearings. An excerpt is quoted herewith:

"'All of our experience has indicated that F2-layer transmission at very high frequencies is at a maximum during the winter months over all daylight paths at the sunspot maximum. This favors transmissions in a North-South direction as contrasted with East-West paths. Why is it, then, that we have not observed transmission from South America on frequencies higher than we have observed on the North Atlantic path? As I understand it, the greatest possible distance for single-hop F2-layer reflections is approximately 3,500 kilometers or 2,170 miles, and it is for this condition that we have transmission at the highest possible frequency. This means, then, that the reflection point in the ionosphere is approximately half way between the receiver and the transmitter, or a little over 1,000 miles from the receiver. If the transmitter is more than 2,170 miles away, say 4,000 miles, for example, single-hop transmission cannot take place and the signal arrives by 2, 3, or more hops. For the multiple-hop condition, the last point of reflection from the ionosphere will be even closer to the receiver than 1,000 miles. Therefore, even though the ionosphere may reflect very high frequencies at a point over South America, the highest frequency that will arrive at Washington is the highest frequency that the ionosphere will reflect at a point within approximately 1,000 miles of Washington. If this be so, we would expect that the highest frequency that could get through to Washington would be substantially that predicted by the ionosphere measurements made at Washington and should be independent of direction. This seems to be in accord with our observations.'

"Stated briefly, the chain of transmission is no stronger than its weakest link.

"An examination of Mr. Norton's testimony shows the existence of a basic error — the assumption that all that need be considered for transmission between two points on the earth's surface is the existence of a 'hot spot' or point of high critical frequency between them, to support transmission in a single hop between the two points. This is clear from a number of places in his testimony. Referring to the possibility of intercontinental interference, he testified as follows:

"'In this connection, since we are considering F-layer transmission and since such transmission is possible over very great distances, it was necessary to consider the possibility of transmission even from such distant continents as Europe, South America, and Australia.

"'The CHAIRMAN: Does this limited condition which is applicable to the ionospheric status here in Washington or is that applicable over a broad area, say in the eastern part of the United States, or will that vary from one or two hundred mile distant points to another?

"'Mr. NORTON: It is applicable for an area, I should think, with a radius of at least 500 miles around Washington and probably more than that.

"'The CHAIRMAN: In other words, it would in all likelihood be applicable to all of the eastern centers, the heavy centers of population?

"'Mr. NORTON: That is right, but only in this sense, that the reflections from the ionosphere would take place in this region. The interference in this part of the country from distant points might be much greater because the ionosphere that was doing the reflecting would be at a different point, that is, located over a different point. As an example, transmissions from South America might be *reflected from the ionosphere on a point over the equator* so it would be a *point over the equator* and we would be interested in the ionosphere as far as undesired transmissions from South America are concerned to a point in the eastern part of the United States.'"

Since the equator is approximately 3,000 miles from the eastern centers of population, and since the longest single hop which can take place is about 2,200 miles, it is clear that transmissions coming from South America must arrive in the eastern United States by 2, 3, or more hops, and that the condition of the ionosphere at each point of impact must be taken into account. Mr. Norton takes into account only the point over the equator, that is, the strongest link in the chain.

From the geometry of the situation, the matter will be quite clear from reference to (Armstrong) Fig. 1, which is self-explanatory. According to Mr. Norton's explanation, transmission from point S in South America to point N in North America would take place via the path marked S, X, N. It will be observed that point X is far beyond the ionosphere. The actual path would have to be by transmission via 3 hops and reflections at points A, B, and C, as pointed out by Dr. Beverage in his supplemental memorandum. (This illustrates merely the simplest form of multiple-hop transmission.) The condition of the ionosphere, not merely of point B over the equator but of all three of these points, must be taken into account. Regardless of the condition of the ionosphere at points A and B, the transmission cannot pass into the United States unless the condition of the ionosphere at point C permits reflection. This condition will be found to be much closer to Washington data than any of the predictions of Mr. Norton's Fig. 2. This error of Mr. Norton's is fundamental. It appears also in the shape of the curves of Fig. 1 (Exhibit 380).

Since interference resulting from an unwanted signal arriving by reflections from the F2-layer depends on the strength of the unwanted signal, as well as the frequencies at which it takes place and the duration of the transmission, it is important to examine this aspect of Mr. Norton's testimony.

Fig. 4 of Exhibit 380 contains a curve predicting the intensity of interference which may be expected. It is not in accord with past experience. During the 3 peak years of the past sunspot cycle, observations were made at a point on Long Island by RCA Communications, Inc., on the signals which came through from the London television transmitter. Proceeding on the basis of the curve of Fig. 4 for an estimate of intensity, one would reach the conclusion that a median field strength of at least 85 microvolts per meter would be received. Fig. 1 indicates that this would take place for approximately 1,400 hours of the sunspot cycle. The following is abstracted from the memorandum:

"An analysis of a series of recorded measurements of signals from this station (the London television transmitter) made during the 3 peak years of the last sunspot cycle, gives a very different picture.

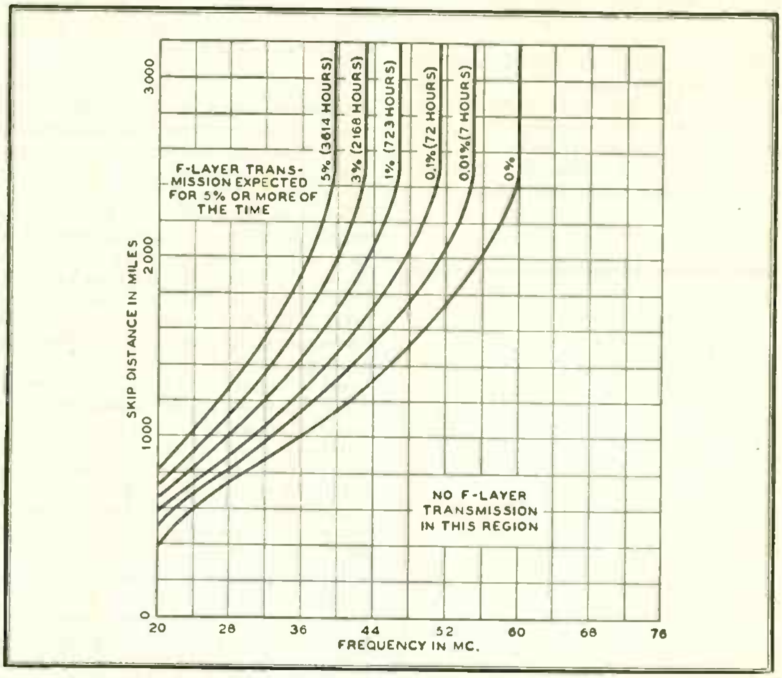
"Out of 334 days of observation of these signals, during the peak periods of the 3 years, a field strength of 100 microvolts was never obtained. The maximum field strength was in the vicinity of 70 microvolts, which was attained 3 times over a period of minutes during the total period of observation.

"During the entire series of measurements, in the winter of 1936-37, 10 microvolts per meter was exceeded only 3 days; in 1937-38, 11 days; and in 1938-39, 16 days. This, in effect, represents the picture for the entire 11 years of the cycle, since the most favorable hours of the day, during the period when the signals were coming through, were selected for making these tests.

"That more factors remain to be taken into account than are indicated by Figs. 1 and 4 of Exhibit 380 is shown by the fact that in 1936–37, during the hours when F2-layer transmission might have been expected to occur, for 75% of the days when observations were made the video channel could not be received. In 1937-38, for 55% of the days it did not come through; and in 1938-39, for 72% of the time it was unreceivable. This despite the fact that a large rhombic antenna of 400 ft. on a side, located at the most favorable height above the ground, (50 ft.), was employed. (Total length nearly 800 ft.)

"Observations of these signals were made during 2 years of the cycle by Dr. G. W. Pickard at Seabrook Beach, N. H., who reports signal peaks of about 10 to 20 microvolts per meter at an antenna height of 50 ft. for the sound channel on 41 mc., and a substantially weaker response for the sight channel on 45 mc.

"A more detailed analysis of the results which we have been discussing is contained in the table below. These results were reported in a paper entitled *Trans-Atlantic Reception of London Television Signals* by Mr. D. R. Goddard, which appeared in the *Proceedings of The Institute of Radio Engineers* for November, 1939, reporting his observations on the transmissions over a period of 3 years."



NORTON FIG. 1 — EXHIBIT 380

PERCENTAGE of the listening hours and (in parentheses) the number of listening hours (6 A.M. to Midnight) during the last sunspot cycle (1933–1944) for which the F-layer skip distance was less than the values shown for particular frequencies. *Estimated from the National Bureau of Standards Ionosphere measurements at Washington, D. C.*

It is important to note that on only 30 days — or less than 10% of the days listened — did the signal on the 45-mc. channel rise, even for a moment, over 10 microvolts per meter. It is also important to note that these figures are given for an antenna 45 ft. high and that the peak power of the London television transmitter when modulating white could have produced at the receiving point on Long Island, on the basis of an inverse distance field, a maximum value of field strength of 170 microvolts per meter.

It is important to note that if this station is continued in operation after the war, the interference level as regards the 25 or more FM channels included within its band of transmission would be subjected to interfering field strength of less than 1/5 of those which were actually measured. This is because the field strength measured encompasses transmission over a band of about 5 mc., and the band width of admission of the standard FM channel is of the order of 1/7 of a megacycle.

While admittedly the London-New York transmission path is not a good one, the strength of signals and the frequency with which they got across is so out of line with the predictions that more consideration than was accorded them in Mr. Norton's testimony is required. This is particularly true in view of the R.C.A.C. tests on the South American path where the upper limit of signals heard was 43 mc.

In view of the preceding discussion, there seems to be no reason for believing that the conclusions resulting from past experience with F2-layer transmission are in error. I believe that Dr. Dellinger in his opinion has given us a practical picture of what our experience is likely to be in the next sunspot maximum.

RECEPTION FROM LONDON TELEVISION STATION

Year	Total Days Listened	% Days over 100 Mv/M	% Days over 10 Mv/M	% Days over 1 Mv/M	% Days Heard
		Sound Channel 41.5 Mc.			
1936–37	67	0 = 0%	11 = 16.4%	31 = 46%	45 = 67%
1937–38	140	7 = 5	45 = 32	83 = 59	113 = 81
1938–39	126	2 = 1.6	16 = 12.7	50 = 40	102 = 81
		Video Channel 45 Mc.			
1936–37	62	0 = 0%	3 = 4.9%	8 = 13%	15 = 24%
1937–38	137	0 = 0	11 = 8	25 = 18.3	61 = 45
1938–39	135	0 = 0	16 = 11.9	24 = 17.8	38 = 28

Sporadic E Transmission ★ This form of transmission, as has been previously pointed out, is most prevalent during the summertime and is substantially independent of the sunspot cycle. It may occur in both the hours of daylight or darkness. Its effects have been measured for a period of about a year in the Commission's monitoring stations, and the curves in Fig. 4 dealing with the effects of Sporadic E embody the results of this experience. These are the only curves based on actual measurement of interfering signals in the Exhibit.

In Mr. Norton's testimony, given on page 3771, he undertook to apply the Sporadic E curves of Fig. 4 to illustrate the interference which would be created by Sporadic E transmission between two Paxton-type transmitters located 590 miles apart. Since his illustration did not evaluate the interference in terms of service range, he was cross-examined on the matter to determine what the reduction in range would be for the field strengths which he had used in his illustration. On page 3797, he was asked the following questions and gave the following answers:

"*Q*. Now, in the case of E-layer interference, again taking Paxton, rather two Paxtons, located 590 miles apart, you found that 1/10 of the time there would be 105 microvolts interference or, rather, that 105 microvolts per meter would be exceeded .1% of the time, and 222 microvolts per meter .025% of the time?

"*A*. Yes. I believe the first figure was .1%, was it not?

"*Q*. Yes.

"*A*. Yes.

"*Q*. And from the ground wave curve of Paxton which you gave on Fig. 4, I have read off the following values: that the 50-microvolt field comes around 120 miles, and the field necessary to override an interference of 105 microvolts, or let us say 210 microvolts, comes at about 100 miles, and the field necessary to override the 222 microvolts comes at 80 miles, and that last field would be 444 microvolts. Would you say that was approximately correct?

"*A*. Yes, that is right. I think the effect of Sporadic E will be much less important in the sense that it will occur in the smaller percentage of the service area than will be the case for the F-layer transmissions.

"*Q*. I worked out that you would lose 1/3 of the range .025% of the time. That is, you would go in from 120 miles to 80 miles, 1/3 of the range, .025% of the time. I think that checks with your testimony.

"*A*. Yes, that is probably correct."

Stated another way, Mr. Norton agreed that a station normally having a range of 120 miles would cover, without interference, a range of 100 of those miles 99.9% of the time, and that for 99.975% of the time 80 miles of that range would be covered without interference. These figures were based on measurements made on 44 mc., the present frequency of the Paxton transmitter.

Fig. 3 of Exhibit 380 purports to show the variation of the time during which interference may be expected for different frequencies of transmission.

On page 3799, Mr. Norton, on cross-examination, agreed that if stations of the Paxton type were moved from the present frequency of 44 mc., for which the foregoing figures were considered, to 60 mc., the duration of the interference would be reduced to 1/10 of its duration at 44 mc. The meaning of this is that the reduction in range from 120 to 100 miles would occur .01% of the time, and the loss of range from 100 to 80 miles would occur .0025% of the time.

Now I do not wish to be understood as implying that anything can be calculated or predicted, even on the basis of measurements of those sporadic effects in radio transmission, to such fantastically minute amounts. I do say, however, that these results follow inevitably from the evidence submitted on behalf of the Commission, and they furnish a strange contrast to some of the statements which have been made about FM transmission being destroyed or completely washed out, with the implication that it is over a station's complete area for long periods of time.

The above figures were given for interference between two stations of the Paxton type. The presence of more stations of the same type at appropriate distances throughout the Country would increase this value somewhat, but the number which could be erected within the interference range would be such that the interference figure would still be of no importance. It should be noted that the time duration of the interference does not add up directly as the number of stations.

Months after Mr. Norton's testimony was given, and after the full implications of the cross-examination were realized, Mr. Allen, speaking at a discussion concerning a paper presented by Mr. Norton and himself at the I.R.E. January Convention, made the following considered statement about the extent of the interference between two Paxton transmitters located at optimum distance of 500 to 1,000 miles apart:

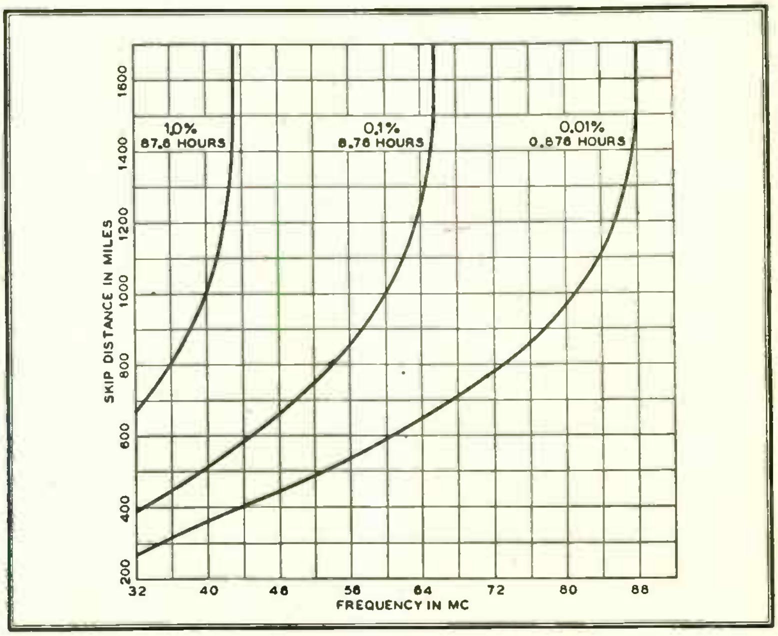
"How severe is that? Well, of course Sporadic E on a station the size of Paxton, where you started out with 18,000 square miles in the primary area, for .1% of the time you would reduce that area to 9,200 square miles, or almost one-half, if you had a receiver which was capable of rejecting a co-channel 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 .1% of the time."

That is, if ½ of the area were lost, approximately .3 of the range would be lost for .1% of the time. Up to this point, Mr. Allen's statement was based on factual measurement. For full-channel occupancy of a series of Paxtons throughout the United States, Mr. Allen made the following prediction:

"That may be .5% or more for complete channel occupancy on the basis of 5 to 1 ratio of expected times."

It is unnecessary to argue about the accuracy of this estimate. Mr. Allen's statement is made on the basis of the Paxton transmitters at 44 mc., and on the basis of the curve submitted in his paper, which is Mr. Norton's curve of Fig. 3, Exhibit 380, this .5% or more of the time would have to be reduced to .1 of that value. The figure of interference time is still negligible.

Up to this point we have been considering the case of interference between two Paxton-type transmitters. Mr. Norton



NORTON FIG. 3 — EXHIBIT 380

PERCENTAGE of the time and (parentheses) the number of hours during the period September 1943 through August 1944 for which the Sporadic E-layer skip distance was less than the values shown for particular frequencies. *Estimated from the National Bureau of Standards Ionosphere measurements at Washington, D. C.*

was cross-examined as to the extent of the interference which would occur between low-power transmitters capable of covering a radius of about 50 miles. The specific instance was between two 1-kw. transmitters having antenna heights of 1,000 ft. separated 590 miles, and capable of giving a field strength of 50 microvolts at a height of 30 ft. at a distance of 55 miles from the transmitter. This type of station was originally used in an illustration of a case of F2-layer interference on page 3790.

On page 3798, Mr. Norton was asked the following questions concerning the extent of the interference between two such stations located 590 miles apart. These questions were directed to Sporadic E interference:

Q. For the same case as before, which we took of the low-power station on the F2-layer interference, it worked out that there is an interference field of 5.7 microvolts for .1% of the time, and 12 microvolts for .025% of the time for the same two proportionate fields, that we took for Paxton.

A. Yes.

Q. Does that seem to be correct?

A. That seems reasonable. I haven't checked it, but I assume it is all right. The other case was.

Q. I figured it by taking 1/18 of the field of Paxton.

A. Sure.

Q. And divided it into the 105 and the 222 microvolts.

A. Surely.

This means that between low-power stations operating under the conditions shown, Sporadic E interference between two such stations will not even dent the 50-microvolt service line. In other words, there is no problem of Sporadic E interference between low-power stations capable of covering 50 miles or less with the antenna height given. This will still be true for an antenna height half as high, and also for the strictly local-range stations of less than 25 miles with antenna heights of all reasonable values.

The consideration of the problem of Sporadic E interference between the low-power stations has all been considered on the basis of the 44-mc. measurements.

The Tropospheric Wave ★ This type of transmission is brought about by the bending of the waves a short distance above the surface of the earth so that the transmission over a certain percentage of the time extends outward from the antenna to a distance more than twice the ground wave coverage. Mr. Norton testified, p. 3773:

"We see by Fig. 4, Exhibit 380, that the interference range, that is the range to the 25-microvolt per meter contour, due to the tropospheric wave, is more than twice the ground wave range for small percentages of the time. As the frequency is increased the tropospheric wave interference range may be expected to increase."

He does not evaluate the magnitude of the increase in distance of this interference, beyond stating that at 44 mc. it is more than twice the ground wave range and that it increases with increasing frequency of the transmission.

There are, however, instances where transmission over hundreds of miles due to this effect has taken place with relatively low power. Insufficient information is available to evaluate it properly; but if, as I believe, the problem of F2-layer interference can be avoided, then the question from a propagation standpoint resolves itself into facing a known small percentage of Sporadic E effects which, on the basis of Exhibit 380, will not be serious, or running the risk of encountering some unforeseen difficulty in the higher frequency range.

Discussion of F2-Layer Testimony ★ The question of F2-layer interference, which had been decided within Panel 5 after Dr. Dellinger's opinion was rendered, came up the second time with the introduction of Fig. 2 of Exhibit 380 and the testimony about it. This figure indicated that F2-layer transmission at the peak of the sunspot cycle extended to frequencies 100% higher than those indicated by Fig. 1, which were based on the Washington data.

Mr. Norton testified that Fig. 2 showed frequencies far higher than would be expected in view of our experience during the past sunspot cycle (p. 3766). On cross examination when the question was raised about the applicability of Fig. 2 to the United States he stated (p. 3799):

". . . Fig. 1 . . . is not applicable to the whole United States and we do know that there are other places in the United States where the situation is more like Fig. 2 although not as high."

Efforts to elicit further information at this time were unsuccessful. The reason advanced was the classified nature of the material.

However, new light has now been thrown upon this subject in a paper presented before the annual convention of the Institute of Radio Engineers, held in January last, by Messrs. Norton and Allen. This paper in its final form was recently published by the Commission under the title *Very-High-Frequency and Ultra-High-Frequency Signal Ranges as Limited by Noise and Co-Channel Interference* by E. W. Allen, Jr. It contains much of the material of Exhibit 380, except that Fig. 2 of that Exhibit is missing.

On page 6, referring to Fig. 4 of the paper, identical with Fig. 1 of Exhibit 380, appears the statement that "the frequencies shown in Fig. 4 should be increased by *15%* when considering conditions applicable to interference throughout the United States."

If by "throughout the United States" is meant interference between our own stations, it is believed to be still incorrect.

If it is understood that the critical frequencies as determined by the Washington measurements should be increased by 15% for certain parts of the United States for interference coming from without the Country, then I think we shall have arrived at the facts with respect to Fig. 2.

While in Mr. Allen's paper the explanation of the double hop is now introduced, evidence of the fundamental error still exists in the shape of the curves of Fig. 4 of the paper (Fig. 1 of Exhibit 380).

In an earlier page in this memorandum, reference was made to certain confusion which has appeared in various places concerning the F2-layer and Sporadic E type of transmission, and the difficulty of disentangling the observed facts from predictions.

On page 69 of the Commission's report (paragraph 3) Mr. Lodge's statement during a meeting of Panel 5, that there was good reason to believe that FM service "would be washed out for as many as 4 or 5 hours of an evening, for 3 or 4 winter months, for as many as 2, 3, or 4 years at the time of the sunspot maximum" is quoted correctly from the proceedings of the Panel.

However, the only skywave which peaks up at the sunspot maximum is that due to F2 transmission and this occurs only during the daylight hours. It is not clear what weight of authority this quotation adds to the report, when the authority quoted appears to be unaware of this fact. In paragraph 4 on the same page appears the statement:

"However it was recognized that the Sporadic E or F2-layer transmissions have occurred with sufficient intensity and frequency in the present band to degrade the service." — *Jansky Tr. 1000; Craven Tr. 1139; Lodge Tr. 1241.*

This statement appears again to confuse prediction with fact as it seems to imply that F2-layer interference has actually been encountered. The fact is that no F2 interference has been encountered, nor could it be until the arrival of the sunspot maximum.

Summing up the situation with respect to F2-layer transmission, we appear to be in the same position we were when Dr. Dellinger rendered his opinion to Panel 5. The experience of past sunspot cycles still seems to be a safe guide as to the practical picture of what we may expect. Dis-

(CONCLUDED ON PAGE 81)

THE PEOPLE'S RADIO FOUNDATION

A Plan to Foster the Establishment of Community FM Stations in the UAW-CIO-PAC Pattern

BY PAUL KONECKY*

". . . THERE HAS emerged a circumstance that completely overshadows all other considerations. It has now become possible for every community, however small, to have a voice on the air, provided it can support it. Economic conditions, rather than shortage of technical facilities, now limit the number of stations."

Major Edwin H. Armstrong made these significant remarks at the conclusion of his statement before the panel on FM, Television, and facsimile at the NAB Chicago Conference, August 30, 1944.

It was not known to Major Armstrong then that six weeks before, on October 18, in New York City, a luncheon meeting had taken place at which a group of thirty to forty persons discussed the problem of establishing community FM stations. After the discussion, the sum of $16,000 was pledged toward the establishment of the People's Radio Foundation, Inc., for the purpose of operating a community station in New York City and initiating similar groups in other cities. At this gathering were labor leaders, fraternal leaders, clergymen, and representatives of various professions.

The People's Radio Foundation Inc., with its office at 100 Fifth Avenue, New York City, was officially approved as a stock corporation under New York State laws in November 1944.

Shortly afterward, the United Auto Workers, CIO, the largest single union in America with 1¼ million members, filed applications with the FCC for six FM stations at Detroit, Newark, Flint, Chicago, Los Angeles and Cleveland. UAW President R. J. Thomas emphasized that, in entering the radio field, the UAW-CIO was anxious to coöperate with all progressive elements in the field in the furtherance of freedom of expression. He said that the UAW was not so much interested in the narrow application of this idea to labor problems only but "in the greatest educational advantage for the whole listening public."

These two developments forecast something new in FM broadcasting which may have far-reaching effects in expansion of the number of stations nationwide when FCC wartime limitations are removed. While the UAW-CIO and the PRF activities in entering FM radio are not directly connected, they both represent aspects of a single movement for labor and community FM stations which is beginning to sweep the country. In order to grasp the vital significance of this movement, let us examine, briefly, the facts of its origin, and the nature of its activities.

Union Members Study FM ★ In 1940, two members of the United Office and Professional Workers of America (UOPWA-CIO) in New York City, Leslie A. Gould and Eugene Konecky, both former radio men, began to study the possibilities of FM with an eye to the suitability of the new art to the needs of labor organizations. Later, Leslie A. Gould entered the Armed Forces.

Between 1923 and 1930, Konecky had accumulated a substantial and varied radio experience at station WOW, Omaha NBC outlet. He had served as publicity, program, and commercial director, announcer, special events reporter, script writer, book reviewer and production director. Subsequently, in New York, he engaged in radio publicity work.

Between 1933 and 1940, he accumulated another type of experience as labor reporter, trade union organizer, and publicity-writer for a fraternal labor society.

It was therefore inevitable, in approaching FM broadcasting, that he should integrate his radio and labor experiences. FM presented labor with an unexpected opportunity to obtain a place in the radio world. When, by 1940, labor had become radio-conscious, it was already, in the main, frozen out of AM broadcasting. As a rule, labor unions were unable to find the large sums necessary for buying network time. They also found themselves subjected to drastic censorship.

FCC wartime restrictions temporarily put a halt to the activities and plans to interest labor in FM broadcasting. At the same time, the formation of the CIO Political Action Committee (PAC) focused the attention of labor leaders on the practical problem of utilizing AM broadcasting in the 1944 elections.

In the face of these obstacles, a three-point program of strategy was pursued:

1. To study the technical, economic, and financial aspects of FM radio.
2. To publish the findings in educational articles on FM in the labor press.
3. To draw together, by personal contact and correspondence, all individuals and groups in and around the labor movement who showed an interest in FM.

At the same time, officials of the International Workers Order[1], a fraternal labor society, where Konecky is employed as publicity director, became keenly interested in FM.

The response to the articles on FM in the labor press was prompt and widespread. Among those who appealed for more information on FM were members and leaders of labor unions.

CIO Spotlight on Radio ★ In the summer of 1944, the 48-page PAC Radio Handbook was published. On July 24th, *The CIO News* began publishing it serially. This handbook dealt largely with the use of AM broadcasting facilities. It contributed heavily toward the development of radio-consciousness in the ranks of labor.

In its issue of July 31, 1944, *The CIO News* began a series of four special articles on "FM — Future Voice of the People?"

In a caption under a picture, the article declared, "Commercial radio broadcasting companies . . . frequently censor labor broadcasts. FM stations, owned or operated by labor or people's organizations, would give unions a break on the air." Several excerpts from this article should be of interest.

> FM is such a shining hope for the future largely because of the fact that the big commercial interests have such a stout grip on AM broadcasting. There are roughly 900 AM stations "serving" the nation and 90 per cent of them take in the welcome mat when they see labor coming up the steps.
>
> On a sharply political basis, they've thrown the CIO-AFL Labor for Victory program off the air.
>
> They've denied labor time to solicit membership. They've censored local broadcasts. They have effectively prevented labor from stating its case, while allowing every conceivable type of anti-labor commentator to peddle his poison along with the cereal plugs. . . .
>
> The possibilities of FM as a people's voice for progress and democracy are enormous. A group of FM stations, dedicated to free speech and public service, could make available to the public true consumer information rather than the hokum of commercial copy-

(CONTINUED ON PAGE 63)

* Public Relations Counsel, Newspaper Guild, 40 E. 40th Street, New York City.

[1] This is a life insurance fraternal benefit society with offices at 80 Fifth Avenue, New York 11, N. Y

SPOT NEWS NOTES

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

I.R.E. Headquarters: Expanding activities of the Institute of Radio Engineers require the establishment of adequate, permanent headquarters in New York City. A Building Fund of $500,000 is necessary to fulfill this need. Radio engineers and executives are asked to contribute to this Fund in order that headquarters can be set up in keeping with the standing of our profession. Have you made your contribution?

If not, send a check payable to the Institute of Radio Engineers, Inc., to the I.R.E. Building Fund Committee, Room 930, 55 W. 42nd Street, New York 18. And be generous!

Listener Survey: Conducted by Sylvania, shows that more people will pay $75 extra for television than $10 extra for FM. but most everyone will pay $5 extra for FM. Catch there is that neither price is high enough. People won't know what they will spend until they see television of post-war quality, and hear full-fidelity FM.

New Financing: Planning expansion into aircraft, railroad, and 2-way mobile communications, Hallicrafters has filed for registration with SEC, Philadelphia, 225,000 shares of common stock, of which 150,000 are outstanding, and 75,000 will be offered for new financing. Hallicrafter sales during the current year are expected to exceed $40,000,000.

Dr. C. B. Jolliffe: Chief engineer of RCA Victor division has been elected vice president of Radio Corporation of America, in charge of RCA Laboratories. He succeeds Otto Scheirer, who has been elected staff vice president of RCA, and will now serve as a consultant on research, patents, trademarks, and licenses.

No Show: RMA has called off the War Production Conference and Parts Show which had been tentatively sheduled for June.

Raymond R. Machlett: President of Machlett Laboratories, awarded the Stenvens Institute Honor Award Medallion for the accomplishments of his Company in the production of X-ray, cathode-ray, and electronic tubes of special military types.

Television Stumbling Block: There's one hurdle ahead in television that the engineers can't be expected to jump, however agile they have proved to be in solving other television problems. It's a little man known as Baby Face Petrillo, who has decreed that no AFM member shall take part in a television broadcast.

George Henry Payne: Passed away at Hollis. Long Island on March 3rd. Born in New York City August 13, 1876, he was a journalist, author, and politically active Republican until, in July, 1934 he was appointed to a 9-year term on the newly-created FCC. For the last year, he was vice president and a director of Finch Telecommunications, Inc., Passaic, N. J.

Increased Capital: Plans have been announced by Hytron to double its working capital, in anticipation of expanded post-war radio markets. This Company employs 2,600 workers at tube plants in Salem, Newburyport, Beverly, and Lawrence, Mass.

The original name of this concern, Hytron Corporation, was changed by a vote of the directors on March 2nd to Hytron Radio and Electronics Corporation. Officers elected at that meeting are: Bruce A. Coffin president and general manager, Lloyd H. Coffin treasurer and board chairman, Edgar M. Batchelder executive vice president, and Charles F. Stromeyer vice president and director of engineering.

McMurdo Silver: Has organized McMurdo Silver Company in Hartford, Conn., to manufacture amateur parts, kits, and special equipment, and to provide consulting service to non-competing concerns in the radio-electronics field.

Television Program Laboratories: Of the Cine-Television Studios, Inc., are to occupy the entire floor of the Grand Central Terminal Building, New York City.

H. Z. Benton: Formerly chief engineer of Crowe Nameplate, has joined the engineering staff of American Phenolic Corporation, Chicago. He will be in charge of tube socket design and production, and will supervise new engineering and research on UHF antennas and reflector arrays.

Plugs for FM: The April issue of House and Garden has a two-page article, very interestingly illustrated, explaining the advantages of FM broadcasting over AM. Another break for FM is the front cover of *The Saturday Evening Post* for March 24th, devoted to a picture of one of the FM-equipped Connecticut State Police cars.

C-R Tube Life Record: An RCA type 904 cathode-ray tube, used as a monitor at WCAE, Pittsburgh, has established what is probably a record for continuous operation. Installed in August, 1939, this tube has completed 50,000 hours of operation, and is still going strong, according to James Schultz, chief engineer at WCAE. It wasn't very long ago that manufacturers were reluctant to guarantee 50 hours life for cathode-ray tubes!

Consolidation: It is expected that negotiations now under way will result in a combination between Raytheon Manufacturing Company, Newton, Mass., and Belmont Radio Corporation, Chicago. According to Lawrence Marshall and Parnell Billings, presidents of the two Companies, under such an arrangement the sales and engineering organizations would be combined for handling the postwar production of tubes and sets for home use, and for the new fields of micro-wave communication, FM, and television.

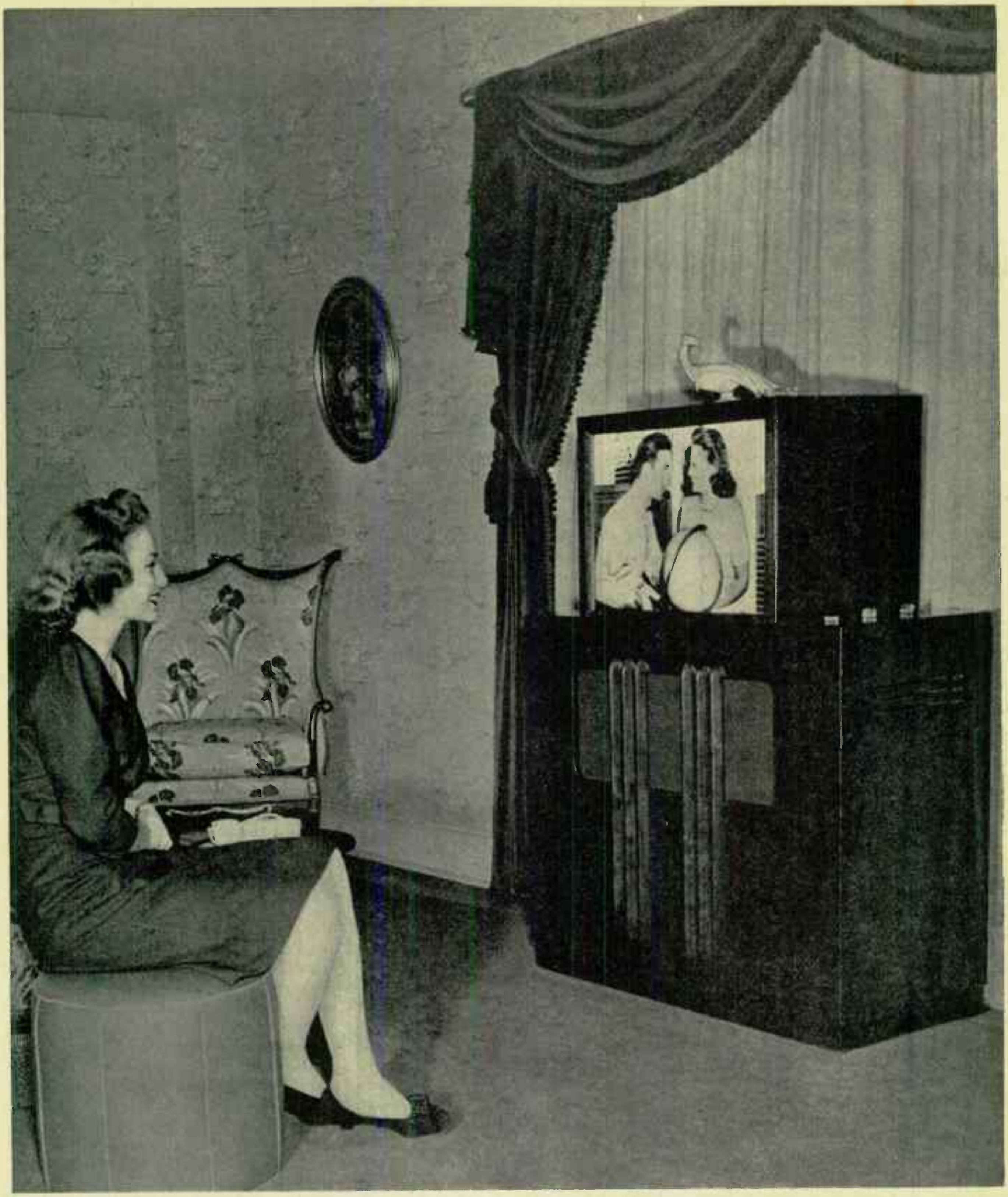
Arthur C. Omberg: Former assistant chief of the operational research branch of the Signal Corps has been appointed chief research engineer for Bendix Radio. He will be responsible for long-term product development and research on radio, radar, and television. Also joining Bendix Radio research is Dr. Harold Goldberg, formerly at Stromberg-Carlson.

Railroad Radio: Has its eye on the 102- to 108-mc. band tentatively held for FM expansion. The idea of sharing space on the lower television frequencies is not regarded favorably by railroad officials.

FCC Chairman Porter: If you haven't met him in person yet, you'll see an excellent likeness of him on the front cover of *FM* AND TELEVISION for April.

Rear Admiral Hooper: Has been selected as one of the two winners of the Elliott Creson Gold Medal, to be presented by the Franklin Institute on April 19th. This annual award, established in 1848, is for "discovery or original research, adding to the sum of human knowledge, irrespective of commercial value."

Radio for Rail Terminals: The Chicago, Burlington & Quincy road is preparing to install radio to direct switching operations at Chicago and at other large terminals. These plans are the result of tests which have already demonstrated substantial improvement in switching service and saving of time. Equipment will be supplied by Bendix.



NEWS PICTURE

HERE is a preview picture of RCA's large-screen television receiver which projects the images through a lens system onto a built-in screen 16 by 31 ins. The cabinet, though not a production design, indicates the size required for such a machine. Demonstrations are now being given of its performance at Radio City, New York. This is, of course, a posed picture, for good reception requires that lights shining on the screen be turned out. However, this does indicate the trend of progress in preparation for postwar television broadcast planning.

FM BROADCASTING & COMMUNICATIONS HANDBOOK

Chapter 2: The Operational Advantages of FM Circuits

BY RENÉ T. HEMMES

WHEN Major Armstrong presented his original paper on Frequency Modulation before the Institute of Radio Engineers in November 1935, he referred to his invention as "A Method of Reducing Disturbances in Radio Signaling by a System of Frequency Modulation." This description is most appropriate, for an outstanding advantage of FM is its freedom from the various types of interference that beset AM reception.

FM also has a number of other important advantages, such as the economies in transmitter design and operation mentioned in Chapter 1, and the improvements in fidelity that will be discussed in the latter part of this chapter and in coverage, which will be taken up in Chapter 3. However, the initial effort which led to the development of FM was directed primarily at the problem of overcoming static and other types of radio interference.

Sources of Interference ★ The principal disturbances to AM reception can be classified as follows: 1) Interference resulting from the reception of signals from stations other than the one whose program is desired. 2) Thermal agitation noise, arising from the small potentials set up by the random motion of electrons in the conductors of the first stage of the receiver. 3) Tube noise, caused by random fluctuations in the rate at which electrons arrive at the plates of the vacuum tubes in the early stages of the receiver. 4) Static, arising from electrical discharges in the atmosphere. 5) Man-made interference, which occurs when there is spurious radiation from such sources as electrical power equipment and automobile ignition systems. 6) Hum modulation of the signal, which can take place in the early stages of AC receivers, where alternating current is used to heat the cathodes, and where the rectified DC plate supply may be inadequately filtered.

All these types of interference can be practically overcome or at least greatly reduced by the use of frequency modulation *in a particular way*, provided that the voltage of the desired FM signal is somewhat greater than the voltage of the disturbance. The method by which the receiver is made unresponsive to disturbances can be understood from a knowledge of the various types of disturbances.

Interference between Two Waves ★ Consider first the simple case of the interference between two waves shown in Fig. 1. Here an undesired signal A is present at the receiver along with the desired signal B. The amplitude of the desired signal B is twice that of the interfering signal A, and the frequency of the interfering signal is slightly less, in this case, than that of the desired signal.

The voltage at the grid of the first tube of the receiver is the resultant or sum of the two signal voltages. The wave form of the resultant voltage $A + B$ is shown at the lower left of Fig. 1, and was obtained by adding the values of waves A and B from instant to instant.

It will be observed in Fig. 1 that the resultant signal has an amplitude variation between the limits of .5 and 1.5 times the amplitude of the desired signal taken alone. The form of the amplitude variation appears to approach that of a sine wave, although the negative peak is somewhat sharper than the positive peak. The frequency of the amplitude variation is the difference between the respective frequencies of the desired and the interfering signals.

In Fig. 1 it is noted that exactly the same amount of time is required for the completion of twelve cycles of the resultant as for the completion of twelve cycles of the predominant (desired) signal. Thus the *average* frequency of the resultant is the same as that of the predominant (desired) signal. However, Fig. 1 also shows that the curve of the resultant wave does not intercept its axis at equal time intervals, indicating that the resultant has a variation of frequency as well as a variation of amplitude. For example, in Fig. 1, the time taken to complete the first cycle of the resultant signal is somewhat greater than that required for the completion of the first cycle of the desired signal. To the lag acquired by the resultant during its first cycle is added a smaller amount of lag acquired during its second cycle, and so forth, until at instant T_1 a maximum amount of lag has accumulated. Thereafter, and until instant T_2, the resultant signal shortens its time period per cycle, first diminishing the lag to zero and then causing the accumulation of a lead. At instant T_2 the lead is at a maximum, and for the remainder of the wave shown in the diagram, the periods of the cycles increase, diminishing the lead to zero.

The amount of the *maximum* accumulated lead or lag of the resultant with respect to the predominant (desired) signal is called its *peak phase deviation*. The amount of the deviation is of interest because it plays a part in determining the effectiveness of the reduction of interference in the FM receiver, as will be shown presently. The amount of the deviation depends upon the ratio of the amplitude of the desired signal B to that of the interfering signal A; in the present case, the ratio B/A is 2 to 1. It will be noted at instant T_1 in Fig. 1 that with $B/A = 2$, the maximum lag occurs when the desired signal B has completed 120° more of its cycle than has the interfering signal A of *its* cycle. This agrees with the angular relationship of A to B in the vector diagram for instant T_1, also shown in Fig. 1, for readers interested in the mathematical procedure of determining the amount of peak phase deviation. It is found that the maximum lag or lead occurs when the resultant $A + B$ is tangent to the circle described by the terminal point of vector A as it rotates about the terminal point of vector B as a center. In the present case, the side A opposite the deviation angle is equal to one-half the hypotenuse B, which makes the phase deviation equal to 30°, measured in terms of a cycle of the predominant (desired) signal as 360°. When the ratio of the amplitude of the desired signal B to that of the interfering signal A is greater than 2 to 1, the peak phase deviation is less than 30°.

It should be noted particularly that the amount of deviation depends solely upon the ratio of the amplitude of the desired signal to that of the interfering signal, and is independent of the frequencies of the two signals. As the difference between the frequencies of the two signals is made greater, the amplitude of the resultant pulsates at a higher frequency and the interval between the successive instants of maximum lag or lead is reduced; however, the *amount* of the deviation at these instants remains unchanged. For example, if the amplitude of the desired signal is twice that of the interfering signal, the resultant signal will alternately acquire

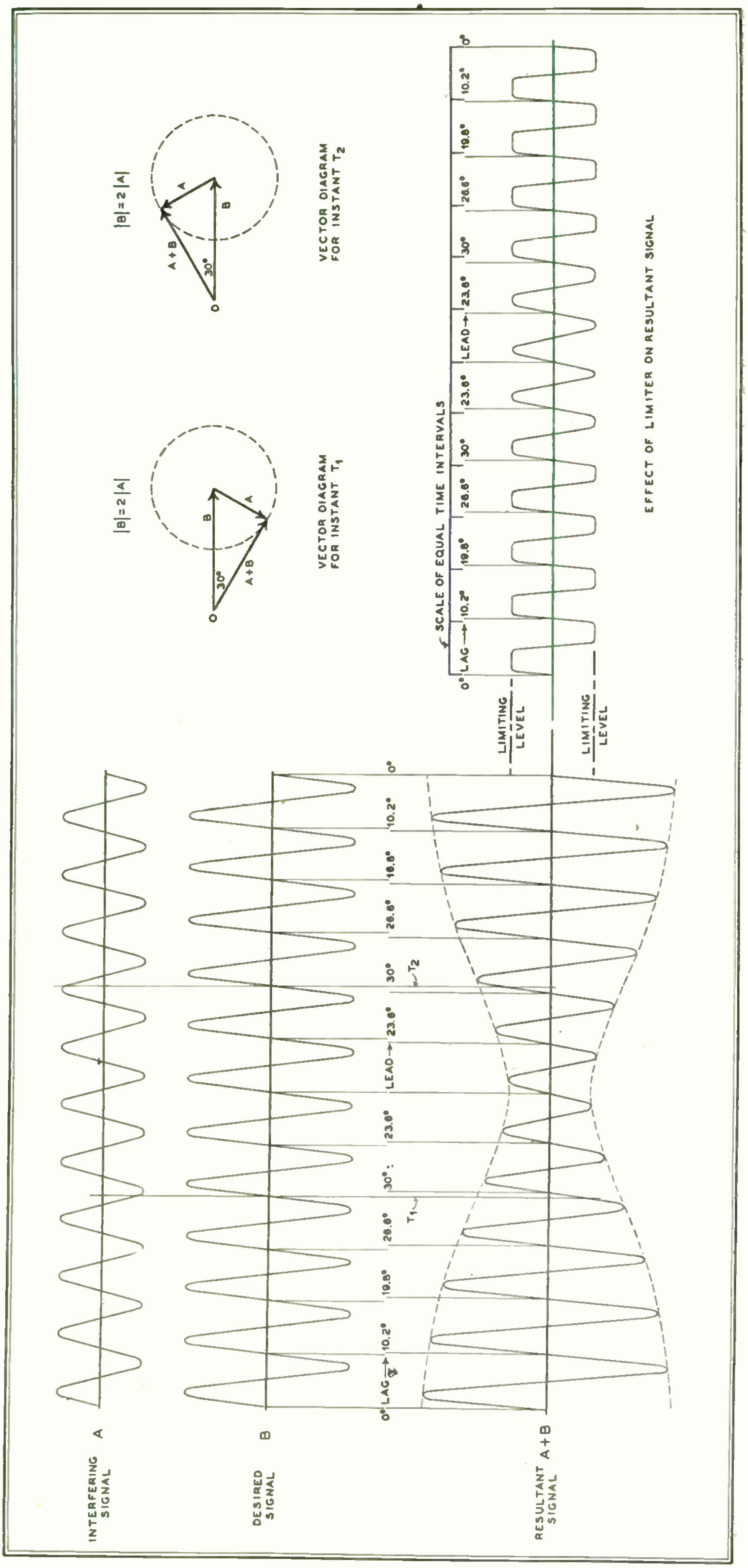


FIG. 1. EFFECT OF INTERFERING SIGNAL A UPON DESIRED SIGNAL B IS TO CREATE RESULTANT HAVING AMPLITUDE AND FREQUENCY VARIATIONS; THE LIMITER REMOVES THE AMPLITUDE VARIATIONS BUT THE FREQUENCY VARIATIONS ARE STILL PRESENT IN THE LIMITER OUTPUT

lags and leads of only 30° with respect to the predominant (desired) signal, regardless of what the difference in frequency of the desired and interfering signals may be. This fact has an important bearing on the matter of how the effects of interference are overcome in the FM receiver, as will be explained later.

It has been mentioned previously that while the average frequency of the resultant is equal to the frequency of the predominant (desired) signal, the resultant is continually varying in frequency alternately above and below its average frequency value. The maximum amount of the frequency variation is called the *frequency* deviation. Unlike the phase deviation, the frequency deviation depends, in part, upon the frequencies of the desired and interfering signals. As a matter of fact, the frequency deviation is directly proportional to the amount of phase deviation, and also directly proportional to the rate at which the instants of maximum lag or lead recur, that is, to the difference of the two signal frequencies. This relationship is to be expected, for the extent to which the time periods of the cycles must be lengthened and shortened depends not only upon how much lag or lead is to be accumulated but also upon how many cycles occur during the process of accumulation.

For example, if the signal frequencies differ only slightly, then the amplitude of the resultant pulsates quite slowly and there is a long time interval between the instants of maximum lag or lead. Many cycles of the resultant wave occur during the process of accumulating the maximum lag or lead, and the amount by which the time period of any individual cycle is lengthened or shortened is quite small. Consequently, the frequency of the resultant is varied over a narrow range. On the other hand, if the signal frequencies differ considerably, the amplitude of the resultant pulsates rapidly, the time interval between the instants of maximum lag or lead is much shorter, and greater frequency deviation is required to give the same amount of phase deviation.

Overcoming Effects of an Interfering Wave ★ It has been noted that an interfering signal acts upon a desired signal of greater amplitude to create a resultant which differs from the desired signal by having variations of amplitude and frequency. It follows that to reduce the effects of the interfering signal, steps should be taken to minimize the amplitude and frequency variations of the resultant.

In the FM receiver, the amplitude variations are removed by the action of a limiter stage, located immediately after the last IF amplifier stage, as shown in the block diagram of Fig. 2. Previous to the limiter, the general arrangement of the receiver is like that of the conventional AM superheterodyne broadcast receiver, except that the tuned circuits are designed for higher RF and IF frequencies, and greater band width. Thus the amplitude and frequency variations of the resultant signal voltage at the grid of the first tube of the receiver are transferred to the IF voltage at the input of the limiter.

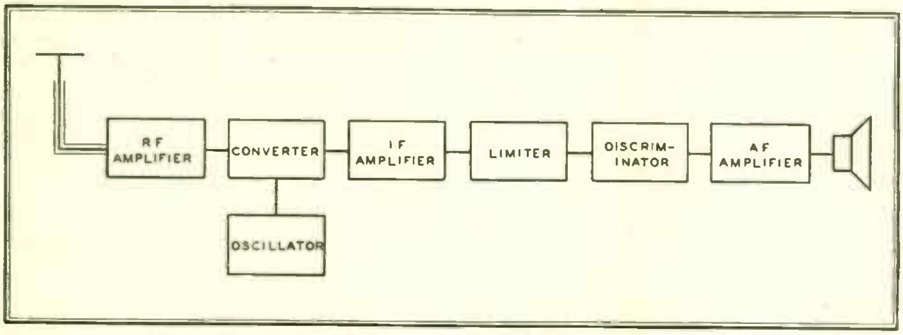


FIG. 2. BLOCK DIAGRAM OF A CONVENTIONAL FM RECEIVER

If, for purposes of explanation, the voltage at the input of the limiter is assumed to have the wave form shown at the lower left in Fig. 1, then the output voltage of the limiter will have the wave form shown at the lower right in Fig. 1 (assuming that the limiter output impedance is constant at all frequencies). It will be observed that whenever the instantaneous voltage applied at the input of the limiter begins to exceed a predetermined level, the limiter operates to prevent its output voltage from increasing in a like manner. If the limiting action begins at a level below the least amplitude of the applied voltage at the limiter input, then the amplitude variations are practically absent in the limiter output. Thus the limiter overcomes one of the effects of the interfering wave. The use of a circuit that minimizes the effects of the amplitude variation of the resultant wave, such as a limiter, is necessary for the reduction of interference in the FM receiver.

The *frequency* variations of the input voltage to the limiter, however, are carried over into the output, as indicated by the fact that the intercepts of the limiter output voltage curve with its axis (Fig. 1, lower right) occur at unequal time intervals.

While the amount of frequency variation due to the interfering signal is not reduced in the limiter, the effects of such frequency variation can be minimized if *wide band* frequency modulation is used for conveying intelligence on the desired signal. For example, if a sound wave striking the microphone at the studio causes the radio wave emitted by the FM transmitter to vary in frequency by thousands of cycles, then a supplementary frequency variation of, say, fifty cycles, introduced by the interfering signal at the receiver, is of negligible effect.

Consider the case of an FM broadcast transmitter. The maximum frequency swing away from the center frequency amounts to 75 kc., which is five times the highest modulation frequency of 15 kc. This is a wide band FM system. Suppose that a 1,000-cycle note of sine wave form is sounded at the microphone with an intensity sufficient to cause the transmitter to be fully modulated. The frequency swing of the transmitter will be 75 kc. The modulation index is 75000/1000 or 75. The angle of phase deviation of the transmitter in radians is equal to its modulation index. Since one radian is equivalent to approximately 57.3 degrees, the phase deviation of the transmitter amounts to 75 × 57.3 or about 4300° in this case!

Assume that at the receiver an interfering signal is present, having a frequency 100 cycles higher than the center frequency of the desired signal, and an amplitude one-half that of the desired signal. The ratio of the amplitude of the desired signal to that of the undesired signal is 2 to 1, making the phase deviation of the resultant with respect to the desired signal equal to 30°, regardless of the frequency of the desired signal, as explained previously.

The ratio of the phase deviation due to modulation to that caused by the interfering wave is 4300/30 or about 143 to 1. However, it must not be concluded from this that the intensities of the 1,000-cycle and 100-cycle tones at the speaker of the receiver will be in the ratio of 143 to 1. The discriminator stage which follows the limiter in Fig. 2 produces a voltage for exciting the audio amplifier that is proportional to the frequency deviation (and not the phase deviation) of the limiter output voltage.

When the variation of frequency is sinusoidal, the frequency deviation in cycles is equal to the product of the phase deviation in radians and the number of times that a complete cycle of frequency variation recurs in one second. In the case of the FM wave mentioned above, having a phase deviation of 75 radians and a modulation frequency of 1,000 cycles, the frequency deviation due to modulation is 75 × 1000 or 75,000 cycles.

In the case of the resultant of the interfering wave and the FM wave, whatever the frequency of the latter, the supplementary phase deviation caused by an interfering wave having one-half the amplitude of the desired FM wave is 30° or .52 radian. If the frequency variation of the resultant caused by the interfering signal is assumed to be sinusoidal, then the supplementary frequency deviation caused by the interfering signal is .52 × 100 or only 52 cycles!

(Strictly speaking, the value of 52 cycles must be regarded as an approximation, since neither the amplitude nor the frequency variation of the resultant caused by the interfering signal is sinusoidal. However, the variation of frequency caused by the interfering signal is sufficiently close to a sinusoidal form to justify the above assumption in making a rough estimate of the frequency deviation.)

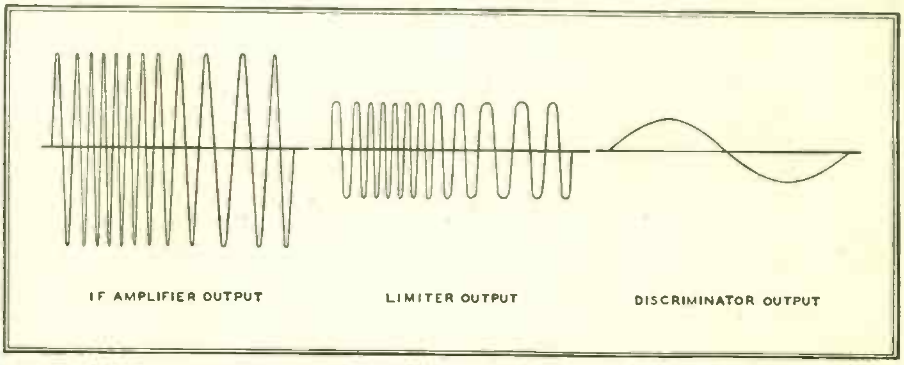


FIG. 3. WAVE FORMS OF LIMITER AND DISCRIMINATOR VOLTAGES IN RECEIVER

A comparison of the frequency swing of 75,000 cycles caused by modulation to a swing of 50 or 100 cycles caused by the interfering wave emphasizes the effectiveness of the reduction of interference, especially when it is remembered that the amplitudes of the desired and interfering signals are in the ratio of 2 to 1. If the ratio were greater than 2 to 1, the disturbance of reception by the interfering wave would be even less.

Fig. 3 shows, from left to right, the voltage at the limiter input, at the limiter output, and at the discriminator output when a wide-band frequency-modulated signal is being received in the absence of interference. Any amplitude variations caused by interfering signals are removed by the limiter and any frequency variations caused by interfering signals are rendered negligible by the fact of the much greater frequency variations caused by modulation. The discriminator creates a voltage whose amplitude at any instant is proportional to the amount by which the frequency of the output voltage of the limiter differs from the frequency to which the discriminator as well as the limiter and IF amplifier tuned circuits is aligned. The polarity of the discriminator output voltage at any instant depends upon whether the frequency at the limiter output is greater or less than the alignment frequency of the discriminator tuned circuits. When the variation of the frequency of the limiter output voltage is sinusoidal about its center frequency, the discriminator furnishes a sinusoidal alternating voltage for excitation of the audio amplifier, as shown in Fig. 3.

While the essential function of the discriminator is the demodulation of the FM signal, it also serves to supplement the action of the limiter. The discriminator tends to balance out the effects of any amplitude variations that are not completely removed in the limiter, providing the discriminator is correctly tuned. A properly aligned limiter and discriminator give a very marked reduction of the effects of amplitude variation of the signal, whether such variation be the result of noise, AM hum modulation in the early stages of the receiver, or an interfering wave.

It should be noted that the suppression of the *frequency* variation of an interfering wave is not always as effective as in the case for which figures were cited above. For example, if the frequency of the interfering signal differs from the frequency of the desired signal by a greater amount, the phase swing remains unchanged but the frequency swing of the resultant is increased. Also, during much of the time when a program is on the air, the transmitter is not fully modulated, so that its frequency swing does not overshadow the frequency deviation caused by interference at the receiver to as great an extent.

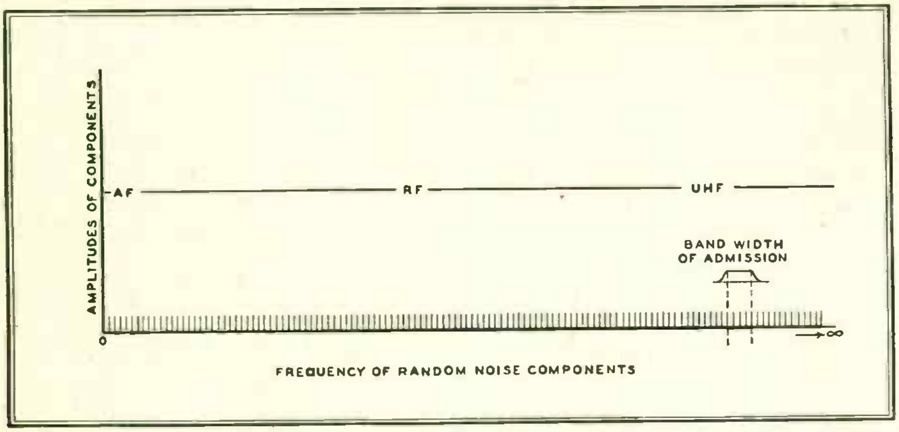


FIG. 4. APPROXIMATE REPRESENTATION OF SPECTRUM DISTRIBUTION OF RANDOM NOISE

For example, if the difference in frequency of the desired and the interfering signals is increased from 100 to 10,000 cycles, the phase swing caused by the interfering signal remains at 30° or .52 radian, but the frequency swing caused by the interfering signal is increased to .52 × 10,000 or 5,200 cycles. Such a swing is appreciable compared to a transmitter swing of 75,000 cycles. The situation is even less favorable at lower degrees of modulation where the swing of the FM wave is in the order of, say, 15,000 or 20,000 cycles. Since the higher frequency components of program material are generally of less amplitude than the lower frequency components, this characteristic might appear to be a serious obstacle to the achievement of high fidelity FM reception. However, the situation can be easily remedied by the use of pre-emphasis and de-emphasis, as will be explained later. Even without the use of emphasis networks at the transmitter and receiver, the interference is less noticeable than with AM.

When the frequency of the interfering wave differs from that of the desired signal only slightly, the disturbance is suppressed by the FM receiver more effectively than ever. This is in marked contrast to AM, where it becomes increasingly difficult to tune out the interfering signal as its frequency approaches that of the desired signal.

In the above discussion it was assumed that the interfering signal was unmodulated. Equally effective suppression of interference in the FM receiver occurs when the interfering wave is amplitude- or frequency-modulated, provided the same conditions are met, namely that: 1) The amplitude of the desired signal is two or more times the peak amplitude of the interfering signal, so that the supplementary phase swing caused by the interfering signal is never more than 30° or .52 radian. 2) The least amplitude of the voltage at the limiter input is in excess of the voltage at which limiting action starts, so that amplitude variations are removed in the limiter. (This explains the

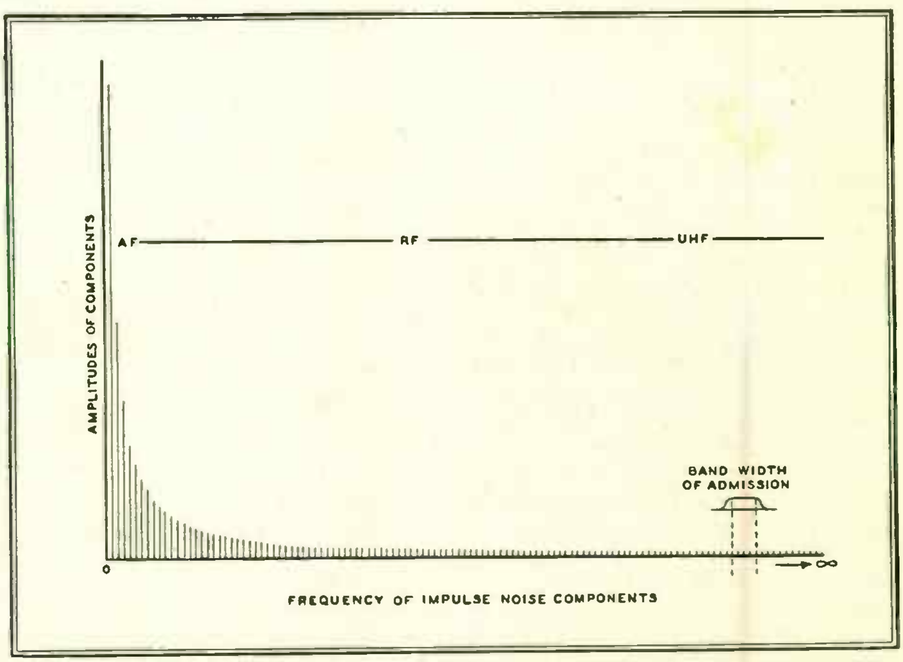


FIG. 5. APPROXIMATE REPRESENTATION OF SPECTRUM DISTRIBUTION OF IMPULSE NOISE

importance of high gain RF and IF amplifiers in the FM receiver.) 3) The intelligence is conveyed on the desired signal by the use of wide-band frequency modulation, so that the frequency variations due to modulation will greatly overshadow the frequency variations due to the interfering signal.

Noise Disturbances ★ In addition to the interference caused by continuous signals picked up from undesired radio transmitters, there may be interference from voltages of a discontinuous nature arising from sources other than radio transmitters. The general term applied to such disturbances is *noise*.

Noise voltages are made up of sharp pulses of various amplitudes occurring at irregular intervals. When the voltage peaks are infrequent and sharply defined, with successive peaks clearly separated, the noise is described as being of the *impulse* type. When the peaks follow one another in such rapid succession that there is overlapping, the noise is described as being of the *random* type. Both types of noise are usually present in varying degrees at the receiver.

Impulse noises usually originate in sources external to the receiver, such as automobile ignition systems, faulty power lines, and the sparking brushes of electric motors.

Random noise can be caused by the usual form of static, arising from a more or less continuous series of electrical discharges in the atmosphere. In addition, there is always an appreciable amount of random noise originating in the early stages of all radio receivers.

One source of such random noise is the thermal agitation voltage which is developed in all conductors at temperatures above absolute zero. It is the result of the haphazard motion of free electrons in the conductors, and depends upon the temperature as well as the resistance of the conductors. While thermal agitation is present in all the conductors of a receiver, only that present in the input circuit preceding the first tube is usually important because the signal voltage is at its lowest level at this point.

Another source of random noise within every receiver is a slight fluctuation in the rate at which the electrons arrive at the plates of the tubes. This fluctuation occurs continuously, regardless of whether or not there are larger variations of plate current caused by the incoming signal. A certain amount of random fluctuation is inherent in the nature of plate current, which is a bombardment of the plate by a hail of separate particles rather than the smooth flow of a continuous fluid. This fluctuation creates a noise voltage across the output load of the tube, which is termed *shot effect*. Additional slight fluctuations of plate current are caused by variations in the rate at which electrons are emitted from the cathode of each tube and by variations of the ratio in which the electrons are divided among the collecting elements of the tube. The resultant of all these effects is called tube noise, and is of importance in the early stages of the receiver, where the signal voltage is still of relatively low amplitude.

Analysis of Noise Voltages ★ Since random noise voltages come from forces which act in an uncontrolled and haphazard manner, it is to be expected that they will have no particular frequency. As a matter of fact, the energy of random noise is almost uniformly distributed over the spectrum from zero frequency to the highest of radio frequencies. True random noise voltage may be regarded, therefore, as consisting of an infinite number of components at different frequencies, each frequency differing from the next higher or lower frequency by an infinitesimal amount. The individual components have no specific time or phase relation with respect to each other, and the average amplitude of all the components in a frequency band in one portion of the spectrum is equal to the average amplitude of the components in a frequency band of the same width in any other portion of the spectrum. An approximation of the spectrum distribution characteristics for random noise is shown in Fig. 4.

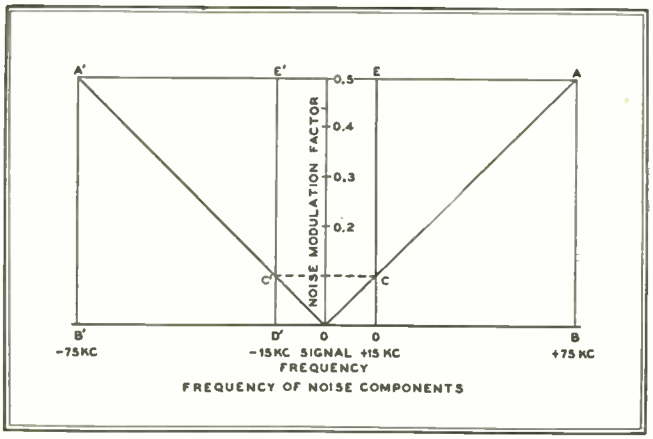


FIG. 6. CONSTRUCTION DIAGRAM OF AM AND FM RECEIVER NOISE

Impulse noises are in the form of sharp peaks, occurring at irregular intervals. To analyze the spectrum distribution of energy received from a single pulse, the pulse may be regarded as one of a series of pulses recurring at a very low frequency. When a recurrent pulse of exceedingly short time duration is analyzed, it is found to be equal to the sum of a component at the fundamental frequency, a component at twice the fundamental frequency having one-half the amplitude of the fundamental frequency component, a component at three times the fundamental frequency with one-third the amplitude of the fundamental, and an infinite series of higher harmonics each having an amplitude inversely proportional to the order of the harmonic. The spectrum distribution for impulse noise is approximately depicted in Fig. 5.

While noise voltages are made up of components at all frequencies, a radio receiver at any particular setting of the tuning dial responds only to frequencies within a comparatively narrow band of the spectrum. The center frequency of the band is the assigned frequency of the station to which the receiver is tuned; the width of the band, that is, the difference between the highest and lowest frequencies of the band, is largely determined by the adjustments of the tuned circuits of the IF amplifier. In practice, the width of the frequency band to which the receiver responds at any particular dial setting is quite small compared to the center frequency of the band. For example, in FM broadcast reception, the band of frequencies to which the receiver is responsive when the receiver is tuned to a station is in the order of 200 kc. wide, while the frequency of the station (that is, the center frequency of the band) is in the order of tens of thousands of kilocycles. Thus the receiver band widths indicated in Figs. 4 and 5 are shown as narrow portions of the spectrum located well up the frequency scale. Note particularly that under such conditions, the amplitudes of components at different frequencies *within* the receiver response band are practically uniform. This is to be expected in the case of random noise, Fig. 4, but in the case of impulse noise, Fig. 5, the practically uniform amplitudes are the result of the location of the band in a region of the spectrum where the limiting frequencies of the band differ by only a small percentage from the frequency at the center of the band.

From alternating current theory, it will be remembered that when two or more components of voltage, or current, at different frequencies are present in a circuit, the root mean square or RMS value of the resultant is equal to the square root of the sum of the squares of the RMS values of the components. If the components are all of equal amplitude, then the RMS value of the resultant is proportional to the square root of the number of components present. It was shown above that under conditions encountered in practice, the amplitudes of the components at different frequencies of both impulse and random noise tend to be uniform within the response band of the receiver. Thus the RMS values of random noise and of impulse noise can be expected to be proportional to the square root of the width of the radio frequency band to which the receiver is responsive at any particular dial setting. That such is the case has been confirmed experimentally.

It is the peak value of a noise voltage rather than its RMS value, however, that largely determines the extent to which noise irritates the listener. In the case of random noise arising from thermal agitation, the ratio of the peak to the RMS value, called *crest factor*, is about 4 to 1. When random noise voltage arises from sources other than thermal agitation, the crest factor can assume a somewhat higher value, but will tend to be constant at that value in the presence of a strong signal. Thus the peak as well as the RMS value of random noise at the IF output of the receiver is approximately proportional to the square root of the band width of the receiver.

The peak value of the impulse noise voltage, however, varies directly as the band width, and not as the square root of the band width. The reason for this relationship is to be found in the fact that the components of the impulse noise are all in harmonic relation to the fundamental, and so timed with respect to each other that they are all in phase at the instants when the pulse starts or stops. Thus the peak value of the impulse noise voltage is the arithmetical sum of the amplitudes of the components. In a receiver whose response band is located well up in the frequency spectrum, where the amplitudes of the impulse noise components are nearly uniform, the peak voltage is proportional to the number of components added. The number of components added varies, in turn, as the band width, since the components are located in the frequency spectrum at intervals equal to the fundamental frequency of the impulse. Therefore, the peak value of the impulse noise voltage is proportional to the frequency band passed by the receiver.

The distinction between the relationships of peak random and peak impulse noise to the band width accounts for a difference in the effectiveness of the FM receiver in reducing the noise, which will be explained presently.

Comparative Noise in AM and FM Receivers ★ In the discussion of Fig. 1, it was noted that the effect of an interfering signal upon a stronger desired signal is to create a resultant which has varying amplitude and varying frequency. The amplitude variation is largely removed in the limiter and the effects of any remaining amplitude variation in the limiter output are minimized in the discriminator. The frequency variation, caused by the interfering wave is not reduced in the limiter, but is rendered negligible by the much greater frequency swing of the desired signal during modulation. However, it was noted that as the frequency of the interfering signal differs from the frequency of the desired signal by an increasing amount, the frequency swing caused by the interfering wave (and hence the amount of interference in the receiver output) increases in direct proportion.

The above observations for the case of one interfering signal also hold with respect to two or more interfering signals. provided the peak value of the resultant of the interfering signals is not greater than one-half the amplitude of the desired signal. Since impulse noise can be analyzed as consisting of a series of components of practically uniform amplitude spaced at equal frequency intervals in the response band of the receiver, it follows that reduction of this noise as well as of the interfering signals can be expected in the FM receiver. Also, it is to be expected that the noise components at frequencies nearest the signal frequency will be most effectively suppressed while those components whose frequencies are more remote from the signal frequency will cause more disturbance in the receiver output.

These anticipated effects are found in practice, so that in Fig. 6 the curve $A'OA$ shows how the radio frequencies of the noise components at the receiver input determine the amplitudes of the audio frequency components of noise at the receiver output. The diagram applies to the case of peak impulse noise and assumes that the ratio of carrier-to-noise is 2 to 1. While the amplitudes of the components of impulse noise are known to be practically uniform within the width of the receiver response band at the source, it is observed that the frequency modulation due to noise increases in direct proportion to the amount by which the noise components are higher and lower in frequency than the signal.

The areas of triangles OAB and $OA'B'$ therefore represent noise in the discriminator output. However, all of this noise may not be passed through the audio amplifier. For example, in FM broadcasting the maximum frequency swing, as represented by OB and OB' is 75 kc., whereas the highest frequency that is passed through the audio system is in the order of 15 kc. The noise created in the discriminator output by noise components differing in frequency from the signal by more than 15 kc. is therefore prevented from reaching the receiver output. Thus, in the diagram of Fig. 6, the noise reaching the FM receiver output is represented by triangles OCD and $OC'D'$, whose bases OD and OD' are proportional to the highest frequency passed by the audio system of the receiver. These triangles are shown as shaded areas in Fig. 7, which represents the noise output of the FM broadcast receiver. As will be explained later, by

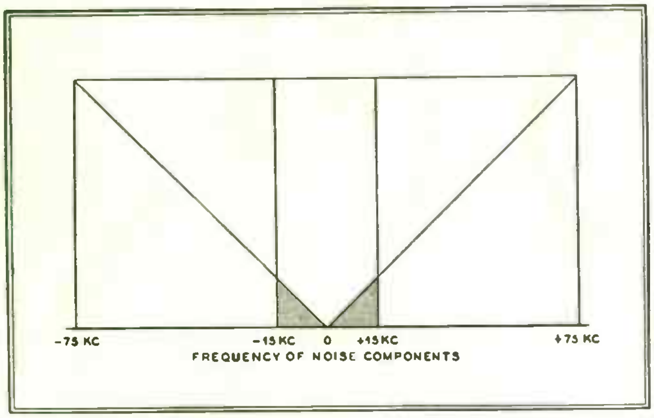


FIG. 7. SPECTRUM DISTRIBUTION OF FM RECEIVER NOISE, INDICATED BY THE SHADED AREA

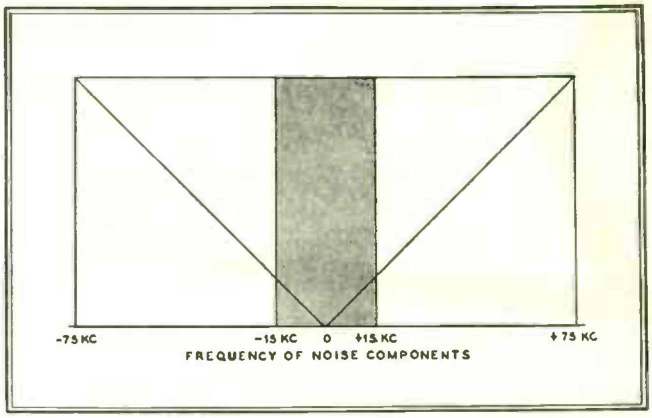


FIG. 8. SPECTRUM DISTRIBUTION OF AM RECEIVER NOISE, INDICATED BY SHADED AREA

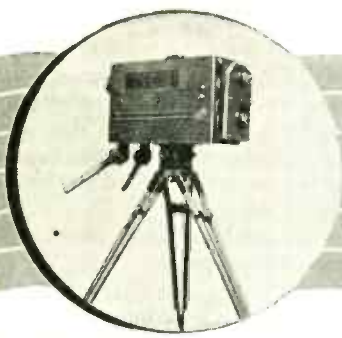
In Equipment for

RCA engineers developed the modern "all-electronic" system of television and introduced it to the public more than ten years ago. Practically all of the chief components of the television system in use today were devised by RCA engineers and first demonstrated in RCA equipment.

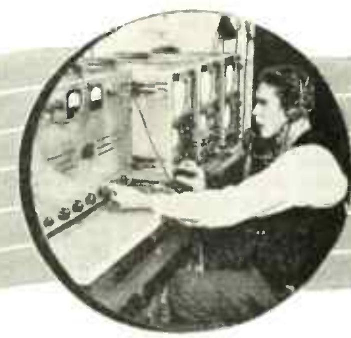
Before the war, RCA was the main builder of commercial television transmitting equipment — including cameras, control equipment, film scanners, audio and video transmitters, relay transmitters, antennas and field pickup equipment. A considerable number of these equipments are in use today in stations in this country and abroad.

RCA HAS EVERYTHING FOR TELEVISION

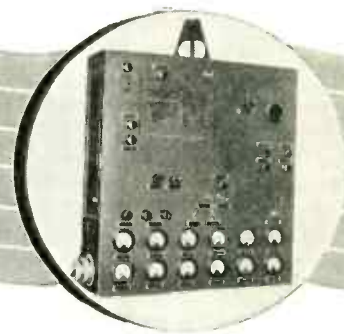
1.* *THE ICONOSCOPE — The "electric eye" of the television camera. Developed by Dr. V. K. Zworykin, RCA scientist, and brought to a high degree of perfection by RCA engineers.



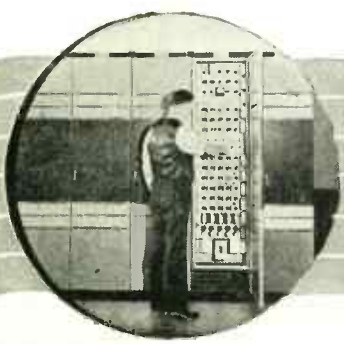
5.* *THE FIELD CAMERA — The RCA field pickup camera shown here is the first camera to use the "orthicon" pickup tube—by far the most satisfactory for "outside" pickups.



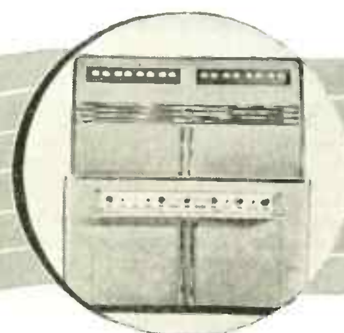
6.* *REMOTE PICKUP EQUIPMENT — RCA engineers built the first television equipment for field pickups—and the first such equipment (shown here) for use with the "orthicon" camera.



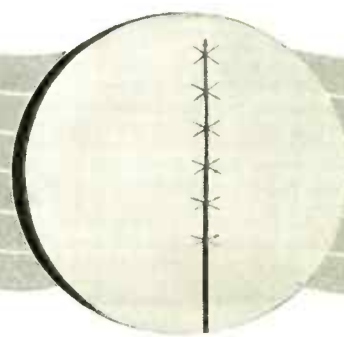
7.* *THE RELAY TRANSMITTER — The first transmitters to be used for television relaying were built by RCA engineers—the one shown here is for relaying from a remote pickup point.



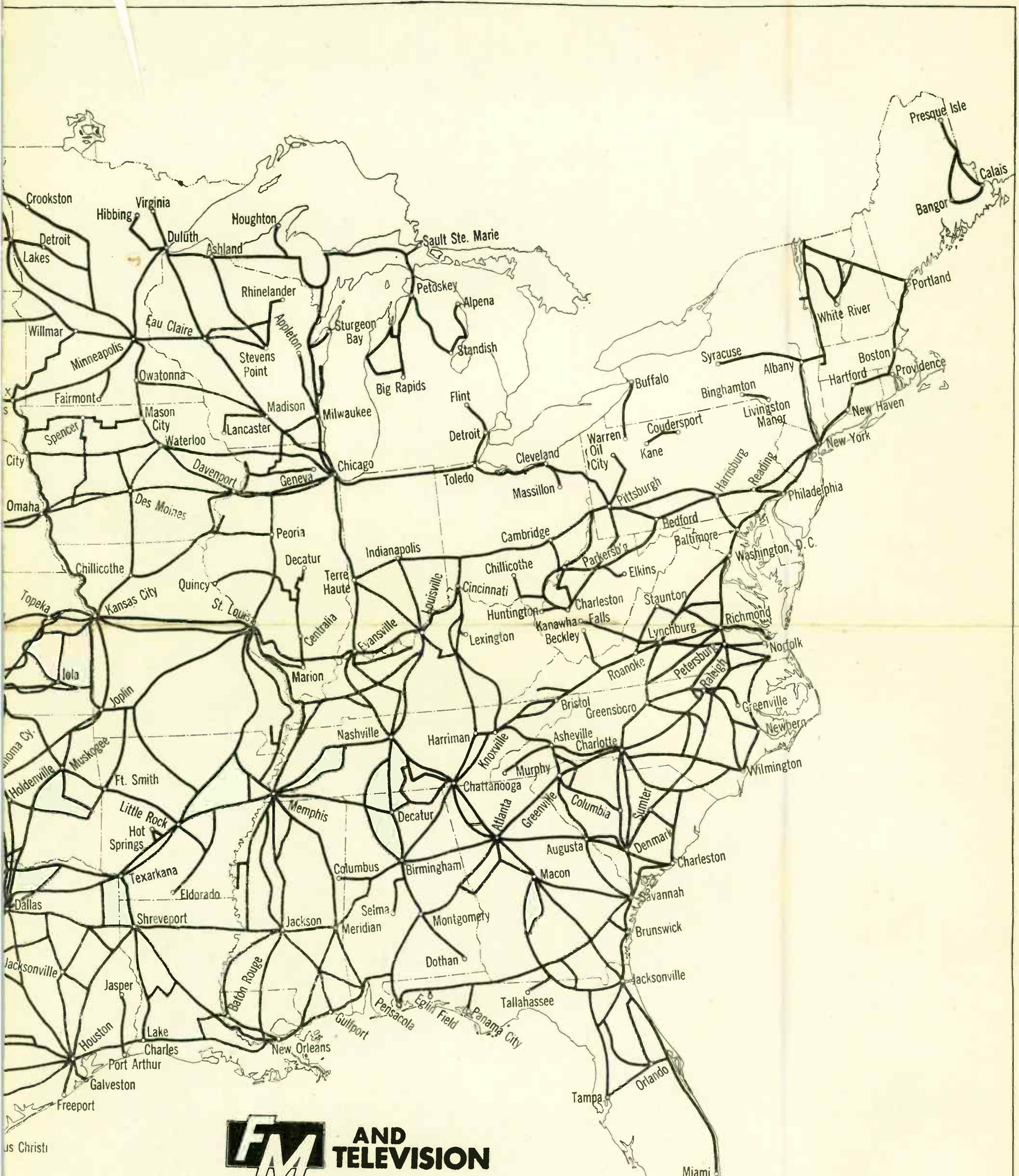
11.* *THE SYNCHRONIZING GENERATOR — Furnishes the signals that key transmitter and receiver together. This type of synchronizing, now almost universally used, was developed by RCA.



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.



FM AND TELEVISION

511 Fifth Avenue New York 17, N. Y.

BELL SYSTEM ROUTES

over which frequencies of 15,000 cycles or more are now transmitted for telephone purposes. Such lines can be used for 15,000-cycle program circuits by adding suitable terminal equipment. In addition to the routes shown, there are numerous other long distance telephone routes now in service which cover many points not shown here and which can be equipped to become a part of FM networks.

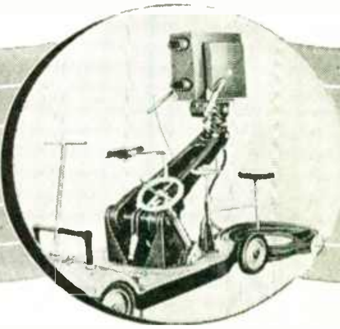
Television Broadcast Stations

Moreover, RCA engineers, having had actual experience in designing and building commercial television transmitting equipment, have, during the war, been adding to their experience by building for the services the most advanced type of radio and other electronic equipment.

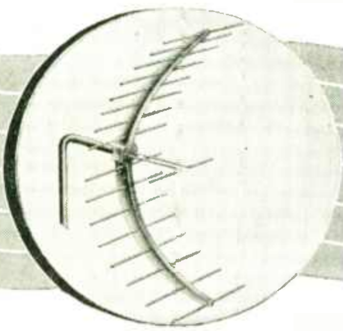
After the war, as before, RCA will be the leader in building television transmitting equipment. For television broadcast stations, RCA will offer a complete new line of equipment—highly efficient, simple to operate, and requiring minimum maintenance.

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.

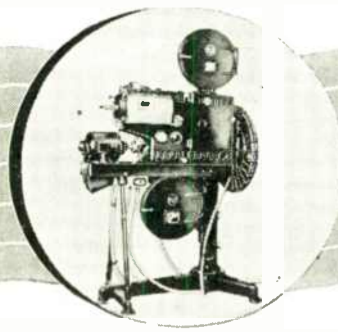
3. THE "ORTHICON" — The high-sensitivity pickup tube, which requires much less light and hence makes outside pick-ups practical. Developed by Dr. Rose and Dr. Iams of RCA Laboratories.



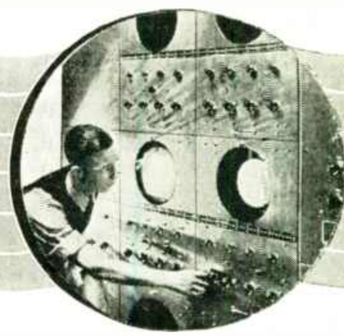
4. THE STUDIO CAMERA — Deluxe-type studio cameras shown here were first designed and built by RCA. Cameras of generally similar design are now used in nearly every television studio.



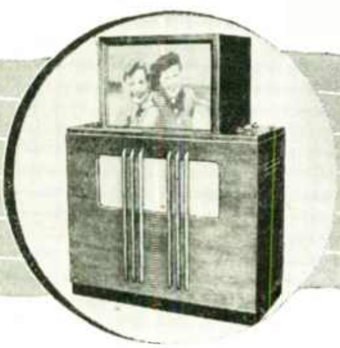
8. BEAM ANTENNAS — Beam antennas such as the one shown here, which may be used with the relay transmitter shown at left, are largely based on original RCA research.



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.



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.

BUY MORE WAR BONDS

For Everything in Television

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION · CAMDEN, N. J.

the use of pre-emphasis and de-emphasis circuits at the FM transmitter and receiver, it is possible to reduce the already small amount of FM receiver noise represented by the shaded triangles still further.

In Fig. 6, if the perpendiculars CD and $C'D'$ are extended upward until they intersect the horizontal line AA' at EE', a means is afforded for visualizing the improvement in the signal-to-noise ratio that is effected in the FM receiver.

In an AM receiver, all the noise components at radio frequencies differing from the signal frequency by less than the highest audio frequency are amplified in the receiver equally as well as the intelligence of the signal being received. The peak impulse noise at the AM receiver output is therefore proportional to the area of rectangle $E'EDD'$ of Fig. 6. This rectangle is shown as the shaded area of Fig. 8. The ratio of the area of the AM receiver noise rectangle of Fig. 8 to the total area of the FM receiver noise triangles of Fig. 7, called the *improvement ratio*, is the figure of merit of the FM system. The improvement ratio tells how many times the signal-to-noise ratio in the output of the FM receiver is increased over that in the output of an AM receiver, where both receivers have the same carrier strength and the same carrier-to-noise ratios at their inputs.

What determines the magnitude of the improvement ratio for peak impulse noise reduction in the FM receiver? In other words, what determines the ratio of the area of rectangle $E'EDD'$ in Fig. 6 to the area of the triangles OCD and $OC''D'$? The construction line $C'C$ aids in evaluating the ratio. The area of the large rectangle $E'EDD'$ is greater than the area of the small rectangle $C'CDD'$ by as many times as dimension ED is greater than CD, or as AB is greater than CD, or as BO is greater than DO. The ratio BO/DO makes the more useful reference, since it represents the ratio of the peak frequency swing of the transmitted signal to the highest audio frequency handled by the audio channel of the receiver. This ratio is commonly called the *deviation ratio of the FM system.*

The ratio of the area of the large rectangle $E'EDD'$ to the small rectangle $C'CDD'$ is equal to BO/DO or to the deviation ratio of the FM system. The small rectangle $C'CDD'$ in turn has twice the total area of the triangles OCD and $OC''D'$. Thus the improvement ratio of the FM system in the case of peak impulse noise is equal to twice the deviation ratio of the FM system. In Fig. 6 the deviation ratio BO/DO is 5 to 1, making the improvement ratio for the FM receiver on peak impulse noise equal to 2×5 or 10 to 1. Thus the area of the shaded rectangle in Fig. 8 is 10 times the area of the shaded triangles in Fig. 7. The signal-to-noise ratio for peak impulse noise is ten times as great in this case at the FM receiver output than in the AM receiver output, assuming that both receivers operate with the same carrier strength and the same carrier-to-noise ratio at their inputs, and that the full noise reducing potentialities of the FM system are realized through careful design.

In the case of peak random noise, the diagram of Fig. 5 does not apply, because the components of random noise have no particular timing with respect to each other, and the peak value of random voltage is proportional to the square root of the band width, rather than to the width of the band. The improvement ratio for peak random noise is equal to the square root of the ratio of the areas that are created when each of the noise amplitudes of the triangles and rectangle is squared before plotting. By the use of calculus, the value of the improvement ratio for peak random noise is found to be the square root of 3 or approximately 1.73 times the deviation ratio of the system. Thus the improvement in the case of peak impulse noise is 2/1.73 or 1.16 times greater in the case of peak random noise. In both cases, however, the respective improvements are proportional to the deviation ratio of the FM system. That is why it is desirable to have as large a frequency swing at the FM transmitter as feasible with a due regard for the fact that the spectrum must be shared with other stations. It is why the audio channel of the receiver should accept and amplify frequencies up to the highest necessary in the particular type of FM service involved, and should reject frequencies that are higher. When these precautions are observed in setting up the FM transmitting and receiving system, the largest possible deviation ratio will be obtained and the greatest improvement in the signal-to-noise ratio can be achieved in a well designed receiver.

For example, in the FM broadcast service, for realistic reproduction of the studio program in the home, it is desirable that the full range of audio frequencies up to 15,000 cycles be amplified in the audio system and converted to sound at the speaker. Frequencies higher than about 15,000 cycles are inaudible to the average human ear and the audio channel should therefore cut off at about 15,000 cycles. The frequency swing of the transmitter should be sufficiently in excess of the highest audio frequency of 15,000 cycles to give a satisfactory deviation ratio. Present practice is to provide for a frequency swing of ±75 kc. at full modulation. This gives a deviation ratio of 75/15 or 5 to 1 with full modulation at the highest modulating frequency. Since the improvement ratio is from 1.73 to 2 times the deviation ratio, depending upon the type of noise, the signal-to-noise ratio in the FM receiver output will be 9 or 10 times greater in the FM receiver than in the AM receiver where both receivers have the same carrier-to-noise ratios and the same carrier strengths at their inputs. The background noise in the FM receiver will be of such low level as to be inaudible and the full quality of 15,000-cycle reproduction is enjoyed by the listener.

No such improvement of the signal-to-noise ratio is inherent in the AM receiver circuits. Even if AM broadcast stations transmitted with modulation frequencies as high as 15,000 cycles (most AM stations do not), the average listener could not enjoy 15,000-cycle reception, for he would be forced to use his tone control to bring the audio channel down to the order of 5,000 cycles or less in order to reduce the noise to a tolerable, but certainly not enjoyable, level!

Equally important as the frequency swing, in determining the deviation ratio, is the highest audio frequency which the receiver audio system is designed to handle. Suppose that while keeping the same frequency swing, the highest frequency transmitted by the audio system is reduced from 15,000 cycles to 5,000 cycles or in the ratio 3 to 1. The base of the AM

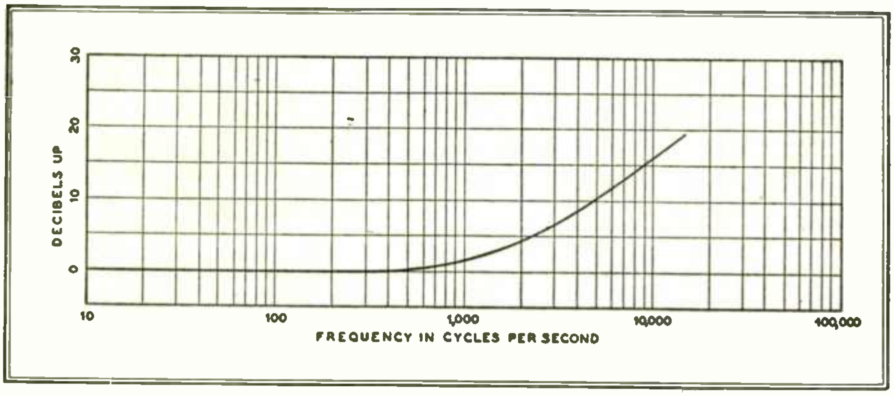


FIG. 9. STANDARD PRE-EMPHASIS CHARACTERISTIC FOR FM TRANSMITTERS

noise rectangle $E'EDD'$ will be narrowed in the ratio 3 to 1, but its altitude will remain unchanged. The area of the rectangle representing the AM receiver noise will have been reduced in the ratio 3 to 1. In the case of the triangles OCD and $OC'D'$ however, both the bases and the altitudes will be reduced in the ratio 3 to 1, indicating that the areas of the triangles representing the FM receiver noise will have been reduced in the ratio 9 to 1. Thus narrowing the audio channel to one-third in both the AM and FM receivers reduces the noise in both receivers, but the improvement in 9/3 or 3 times as great with FM as with AM.

The increase of the improvement ratio with larger deviation ratios is of particular interest in FM communications work. Here the fact than an audio channel of 4,000 cycles or less will suffice for the transmission of intelligible speech permits operation with a signal frequency swing of only 40 kc., maintaining a deviation ratio for the system of 40000/4000 or 10 to 1, which yields an improvement ratio in the order of 20 to 1 for FM over AM. It is not surprising that field tests of mobile FM communications equipment have exploded the idea that "AM can do everything that FM can do at the same frequency."

Pre-emphasis and De-emphasis ★ In the above discussion of the effects of interfering signals and noise components, it was observed that the noise and interference effects in FM systems are very much less than in AM systems. However, it was also noted that the residue of these disturbances that appears in the FM receiver output is concentrated in the upper audio frequency range. Since noise frequencies in the upper register are more irritating to the human ear, the noise concentrated at high frequencies is more objectionable than the same amount of noise energy uniformly distributed over the whole audio frequency range. This unfavorable situation can be easily corrected in FM circuits by the use of pre-emphasis and de-emphasis.

Pre-emphasis refers to the use of a simple network in the audio system of the transmitter for the purpose of causing the higher frequency components of the program to be amplified much more than the lower frequency components. The R.M.A. standard of pre-emphasis calls for a gain-versus-frequency characteristic that is flat to 500 cycles, then rising to +20 db at 15,000 cycles, as shown in Fig. 9. Since a 20 db increase represents a tenfold voltage step-up, the frequency swing of the transmitter on a soft 15,000-cycle sound is ten times as great as without pre-emphasis, so that the intelligence of the modulation overshadows noise in the receiver output far more effectively. There is no danger of overmodulating the transmitter seriously on the high frequencies with pre-emphasis because the energy content of the high frequency components of program material is much smaller than that of the low frequency components.

In the receiver, a simple de-emphasis network is used to bring the highs down to proper relation with respect to the lows. Its gain-frequency characteristic is the inverse of that of the pre-emphasis network. For example, whereas pre-emphasis causes the amplitude of a 15,000-cycle component to be stepped up ten times prior to modulation of the transmitter, the de-emphasis network following the detector in the receiver reduces the 15,000-cycle component to one-tenth, thus restoring it to a proper proportion with respect to the low frequency components. At the same time, the high frequency noise is reduced to one-tenth of the amplitude that it would have without pre-emphasis and de-emphasis.

The marked benefit obtained by the use of the emphasis networks is shown by a comparison of Figs. 10 and 11. In Fig. 10, the triangular area under the curve represents the amount and the frequency-distribution of the noise in an FM system not employing emphasis, corresponding to the sum of the triangular areas of Fig. 7. The area under the curve of Fig. 11 represents the noise in the FM receiver when standard pre-emphasis and de-emphasis is employed. Note particularly that the greatest noise reduction occurs at the highest noise frequencies; in other words, the pre-emphasis and de-emphasis is most effective in reducing the amplitudes of the noise components at the frequencies where the noise is most likely to be annoying.

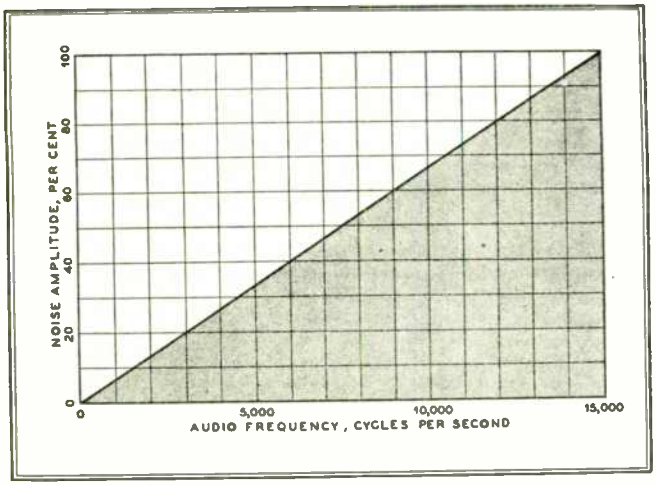


FIG. 10. FM RECEIVER OUTPUT NOISE WHEN DE-EMPHASIS IS NOT EMPLOYED

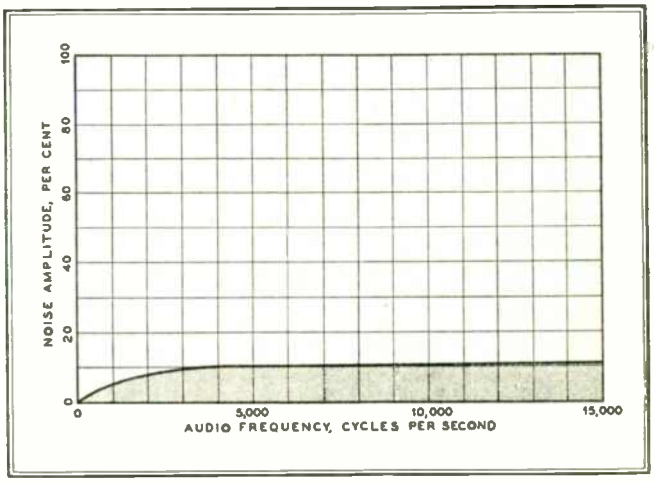


FIG. 11. REDUCTION OF NOISE INDICATED IN FIG. 10 WHEN DE-EMPHASIS IS EMPLOYED

High Fidelity ★ In the discussion of noise reduction above, a typical value of 15,000 cycles was used for the highest frequency accepted by the audio amplifier of the FM receiver. This is in contrast to a value of the order of 5,000 cycles or less which is found in the typical AM receiver.

When it is remembered that the overtones of musical instruments such as the violin and flute are of appreciable amplitude in the frequency range from 10,000 cycles upward to the limits of human hearing, the importance of having noise-free reproduction of frequencies up to 15,000 cycles is evident. Why is it feasible to have an audio amplifier of greater frequency range with FM?

The reason is two-fold: 1) AM receiver circuits are not capable of increasing the signal-to-noise ratio at the receiver output over that at the input. The way in which noise can be reduced in an AM receiver is by narrowing the audio channel. In other words, the loss of the higher audio frequencies, which add so much realism to the reproduction, is the price that is paid for keeping the noise within tolerable levels. 2) AM receivers do not use a system which inherently reduces interference on frequencies very near to the frequency of the desired signal. In the AM service, the strength of the desired signal must be at least 100 times the strength of the interfering signal, if the effects of the interference are to be negligible in the receiver output. This means that AM stations assigned to the same frequency must have a considerable geographical separation, and that adequate service to a continental area like the United States requires a large number of stations assigned to many different frequencies. As it has worked out, the separation between adjacent frequencies assigned to broadcast stations in the United States is only 10 kc., so that modulation at frequencies higher than 5,000 cycles produces sidebands outside of the assigned channel of the station. Receivers whose IF band width appreciably exceeds 10 kc. are therefore subject to interference whiskers from the sidebands of other stations.

The FM system, on the other hand, inherently reduces noise. It is possible therefore to widen the audio channel to 15,000 cycles and to obtain the resulting realism without raising the noise to an objectionable level. Also, in the case of FM, a 2 to 1 instead of a 100 to 1 ratio of the desired signal to the interfering signal overcomes the effects of interference, provided the FM receiver is well designed, so that the full potentialities of the FM system are realized. Thus in FM more stations can be operating simultaneously with wider (200 kc.) channels assigned to each, without creating a serious interference problem.

Dynamic Range ★ The term *dynamic* range refers to the difference in sound levels between the loudest and softest portions of program material. For symphonic music, the range may be in the order of 70 db, corresponding to a voltage ratio of about 3,000 to 1. The transmission of the full volume range makes it possible to reproduce at the receiving set the same relation between the loud and soft passages as would be heard at the studio — the relation, for example, between the spoken word and a pistol shot, or between a violin solo and the brilliant finale of a symphonic orchestra.

In AM broadcasting, the volume range is reduced by the control operator to the order of 35 db. This is done by advancing the amplifier gain control on weak passages and reducing the gain on the strong passages. Such compression of the volume range is necessitated by the inherent signal-to-noise ratio in AM which, in best practice, seldom exceeds 40 db.

Even where the line characteristics are such that the full dynamic range of a symphonic program can be transmitted, the average AM receiver is incapable of giving a satisfactory reproduction of the full dynamic range because of the presence of hum and noise. If the volume control is adjusted to a setting where the loudspeaker is not overloaded on the loud passages, reception can be satisfactory at the high and medium levels of the music in spite of the presence of noise because the program energy greatly exceeds the noise energy and thereby renders the noise unnoticeable to the human ear. On the soft passages of the music, however, where the average amplitude of the music is about 1/3000th of that on the loudest passages, the hum and noise will be very apparent; in fact, the music amplitude may be well below the amplitude of the disturbances, so that the music is not even heard during the soft passages and the noise level appears to have risen. Only by narrowing the audio channel of the AM receiver to reduce the noise, and by operating with a reduced dynamic range at the AM transmitter so that the average amplitude on the weakest passages is not less than 1/50th or 1/100th of that on the strong passages, can tolerable reception be achieved in the AM receiver. Tolerable, perhaps, but not realistic!

In the FM system, the noise in a well-designed broadcast receiver is at such a low level that it is possible to hear the softer sounds satisfactorily without having the volume control advanced to the point where the speaker is overloaded on the stronger passages. Also, by employing a wide frequency swing at the transmitter, a sufficiently high deviation ratio for the FM system can be obtained to give a good improvement in the signal-to-noise ratio even with an audio channel extending as high as 15,000 cycles. The inherent signal-to-noise ratio for best practice is 70 to 75 db. Thus full realism of reproduction can be achieved in the FM receiver.

The reproduction of the full dynamic range also adds *presence* to the program at the receiver output. The overtones of musical instruments in the frequency range above 10,000 cycles have already been mentioned. Most instruments have important overtones at lower frequencies, also — even at frequencies of less than 1,000 cycles. A listener seated near the orchestra in the studio hears these overtones better than a listener who is at a greater distance, because the soft overtones have a more favorable ratio with respect to the room noise when the listener is close to the orchestra. Similarly, a system which does not reduce the dynamic range appreciably in the course of transmission and reproduction makes the listener feel that he is present at the studio in a way that mere loudness of the reproduced sound can not accomplish.

The factor of dynamic range and high fidelity are so noticeable to the owners of well-designed FM receivers that they are able to state immediately whether a program is being originated and transmitted under circumstances that permit the realization of the full capabilities of the FM system, or whether the program has undergone a compression of its dynamic range and frequency range, as when it has been passed over an AM network line.

Duplex Operation ★ Another operational advantage of the FM system is the possibility of conducting two or more services to the public simultaneously over the same station while operating within its assigned channel width. While multiplexing of various unrelated transmissions is feasible, the most frequent application of this feature of FM will probably come in the form of duplex operation, where a second service is offered that is complementary to the first.

For example, facsimile, the transmission of printed material and pictures, may complement the sound transmission. The broadcast receiver owner may receive his newspaper, complete with pictures, from facsimile equipment attached to his receiver, without interference to his favorite programs. Many newspaper publishers have already taken steps toward the establishment of facsimile services at a yearly cost to the listener comparable to that of a newspaper subscription.

Facsimile duplexed with sound may become an important auxiliary to the police radio systems. It is possible, for example, to transmit photographs and fingerprints rapidly, thus speeding the identification and apprehension of criminals.

Many other applications of duplex operation in connection with FM communication systems will undoubtedly be developed in the course of time. The basic theory of duplex operation will be taken up in a later chapter.

NOTE TO READERS

Chapter 3 of the FM HANDBOOK series will explain in detail the propagation and coverage characteristics of FM broadcast transmitters.

Also explained in Chapter 3 is the relation between coverage and the frequency swing of FM transmitters.

This is basic information, and forms a necessary background for the subsequent chapters dealing with receiver and transmitter circuits, operation, maintenance, and service, and tests and measurements.

A few copies of the February, 1945 issue, containing Chapter 1 of the FM HANDBOOK are still available at 25¢ each, postpaid. If you missed that issue, by all means order it at once, before the supply is exhausted.

RADIO DESIGNERS' ITEMS

Notes on Methods and Products of Importance to Design Engineers

Toroidal Coils: One of the few companies equipped to manufacture toroidal coils is D-X Radio Products Company, 1212 N. Claremont Street, Chicago, 22. They are producing cores and windings to specification, using cores of hydrogen-annealed, high-permeability material. This is in addition to their standard line of UHF slug-tuned IF transformers.

Variable Condensers: An interesting review of developments in the design of variable condensers is given in a 32-page brochure just published by Hammarlund Manufacturing Company, Inc., 460 W. 34th Street, New York City. Although the types illustrated were developed for military equipment, they will have varied applications in the new broadcast, television, and communications transmitters and receivers, and test equipment. Copies are available on request.

Isolation Transformer: For use where laboratory and test installations must be isolated from the power lines, the New York Transformer Company, 26 Waverly Place, New York 3, has brought out a shielded transformer of portable design, rated at 250 VA, 115 volts, 1-to-1 ratio. Operating on 60 to 400 cycles, it is wound for 3-phase circuits, but it can be used on a single-phase line. The unit measures 8½ by 4 by 5½ ins. high, and weighs 16½ lbs.

1½-In. Panel Meters: A new line of 1½-in. panel instruments is offered by Roller-Smith, Bethlehem, Pa. Designed primarily for aircraft use, they are applicable to other purposes where extremely small size is required. Service accuracy of 2% is guaranteed. Under immersion tests, the cases have withstood hydrostatic pressure of 14.7 lbs. per square inch. They are made as DC voltmeters in ranges above 50 millivolts, and as DC ammeters in ranges above 500 microamperes.

Manual on Mica: A manual giving complete tables and data on sheet and built-up mica has been published by Mica Insulator Company, 200 Varick Street, New York 14. Included is information on laminated plastics, varnished cloth and tape, varnishes, and fibreglas. Copies are available on request.

Amplifier Units: To meet the requirements of continuous commercial service, Langevin Company, Inc., 37 W. 65th Street, New York City, has announced a new type 101 series of rack-mounted amplifiers. Used as medium-gain, high-power bridging amplifiers, they can be connected in any desired number across busses from 1 to 1,000 ohms. They are designed to operate with program or line amplifiers such as the Langevin 102 series.

All type 101 units are designed to deliver 50 watts to a nominal load impedance with less than 3% RMS harmonic distortion at 400 cycles. The gain control provides adjustment over a 40-db range and bridging connections. Chassis is 16-gauge welded steel, zinc plated and bonderized, and finished in light gray enamel. Weight is 45 lbs.

Insert Chart: To facilitate the selection of A-N insert arrangements for cable connectors, American Phenolic Corporation, 1830 S. 54th Avenue, Chicago 50, has prepared a unique chart. All standard inserts, from 1 to 100 contacts, are shown in full size, grouped by total number of contacts, and in numerical order. All wire sizes of sockets or pin arrangements are indicated, as well as coaxial cable connections and grounded or shorted inserts. Exploded views are given where extra information is required. The entire chart measures 50 by 38 ins.

In addition, a chart of A-N and Amphenol 97 shell types and styles is provided, showing special pressure-tight, moisture-seal, explosion-proof, and light-proof designs. Another chart diagrams the system of numbers used to specify connectors. With its aid, such a designation as AN 3100-16-11-PY(1015-8M) is made clear. Even the proper designation for tropicalization is included. These charts are available to engineers on request.

Sound Level Meters: A new standard for sound level meters has been approved by the American Standards Association. Now included are design-objective and tolerance curves for flat response-frequency characteristics of sound level meters, and slight revisions in the curves previously agreed upon for 40 and 70-decibel equal-loudness contours. These last are used to weight meter readings to correspond more closely with the actual effect of noise upon the ear at different levels of sound loudness.

To facilitate calculations in making measurements of special types of noises, the data from which the design-objective response curves of sound level meters have been plotted are also given in the new standard. Copies of this standard Z24.3-1944 can be obtained from the American Standards Association, 70 E. 45th Street, New York 17, at 25¢ per copy.

Dry Batteries: A military development which will probably have an important effect on postwar portable radio designs is the Tropical Dry Cell, an invention credited to Samuel Rubin, and developed commercially by P. R. Mallory & Co., Inc., Indianapolis. Used now in two types of battery packs, the new cells provide 4 to 6 times the operating life of the batteries they replace. Shelf life has been increased correspondingly, and the batteries are able to withstand high temperatures which cripple conventional cells.

Voltage in the new cells remains substantially constant during their operating life and, within the rated current range, the ampere-hours service is the same whether the battery is operated continuously or intermittently. Under normal conditions, no recovery time is required. Manufacturing licenses have been granted by Mallory to Magnavox Corporation, Ray-O-Vac, and Sprague Electric Company.

Ground Resistance Meter: A 4-range meter for testing the resistance of ground connections has been developed by Associated Research, Inc., 231 S. Green Street, Chicago 7. This instrument, called the Vibroground, has a self-contained power supply which eliminates the need of hand cranking. It is direct-reading, with ranges of 0 to 3, 30, 300, and 3,000 ohms. Reverse readings, according to the manufacturers, are unnecessary, and polarization errors cannot occur. The one-piece welded metal case is water-tight, so that accurate readings can be taken even on sodden ground. Descriptive literature is available on request.

Tube Data: A new catalog from General Electronics, 1819 Broadway, New York 23, presents operating data on 8 transmitting triodes, 5 mercury-vapor rectifiers, 5 high-vacuum rectifiers, 2 grid-control mercury-vapor rectifiers, 4 power amplifiers, and 2 voltage regulators. These tubes, now being produced for the Army and Navy, will be released later through distributors for sale to broadcast stations and amateurs.

Midget Transformers: A new type of design, coupled with newly-developed materials and manufacturing methods, are being used by Permoflux Corporation, 4900 W. Grand Avenue, Chicago 99, to produce transformers of amazingly small dimensions. Four of these transformers can be contained in a cubic inch.

FM, AM & TELEVISION STATION DIRECTORY

Under Station Call Letters, Names of General Managers Are at Left, Chief Engineers at Right

U. S. Television Stations

WABD New York N Y	S H Cuff	S Patremio
WBKB Chicago Ill		A H Brolly
WCBW New York N Y	W Miner	P Goldmark
WMJT Milwaukee Wis	W J Damm	P B Laeser
WNBT New York N Y	J F Royal	O B Hanson
WPTZ Philadelphia Pa	W W Merkle	
WRGB Schenectady N Y	H Bettinger	R L Smith
WTZR Chicago Ill	J E Brown	J E Brown
W2XMT New York N Y	L L Thompson	T B Grenier
W6XAO Los Angeles Calif	L A Weiss	H R Lubcke
W6XLA Los Angeles Calif	K Landsberg	K Landsberg
W6XYZ Hollywood Calif	K Landsberg	K Landsberg

U. S. FM Broadcasting Stations

— K —

KDKA-FM Pittsburgh Pa	J E Baudino	T C Kenney
KHJ-FM Hollywood Calif	L A Weiss	F Kennedy
KLAW San Francisco Calif	J C Morgan	K Nielson
KMBC-FM Kansas City Mo	A B Church	A R Moler
KOZY Kansas City Mo	E L Dillard	M W Woodward
KSL-FM Salt Lake City Utah	I Sharp	C R Evans
KYW-FM Philadelphia Pa	L W Joy	E H Gager

— W —

WAAW Newark N J	I R Rosenhaus	F V Bremer
WABC-FM New York N Y	A H Hayes	W Lodge
WABF New York N Y	L L Thompson	T B Grenier
WBAM New York N Y	T C Streibert	J R Poppele
WBBM-FM Chicago Ill	J L VanVolkenburg	J J Beloungy
WBCA Schenectady N Y	L L Asch	D S Hoag
WBEZ Chicago Ill	G Jennings	E H Andresen
WBKY Lexington Ky	E G Sulzer	
WBOE Cleveland O	W B Levenson	N Neal
WBRL-FM Baton Rouge	J R Dabadie	D K Allen
WBZ-FM Boston Mass	C S Young	W H Hauser
WBZA-FM Springfield Mass	C S Young	H E Randol
WCAU-FM Philadelphia Pa	N West	G Lewis
WDLM Chicago Ill	H C Crowell	A P Frye
WDRC-FM Hartford Conn	F M Doolittle	I Martino
WDUL Duluth Minn	W C Bridges	W H Lounsberry
WEAF-FM New York N Y	F Mullen	O B Hanson
WELD Columbus O	L H Nafzger	L H Nafzger
WENA Detroit Mich	E K Wheeler	C H Wesser
WEW St Louis Mo	N Pagliara	G E Rueppel
WFIL-FM Philadelphia Pa	R W Clipp	L E Littlejohn
WGFM Schenectady N Y	G E Markham	W J Purcell
WGNB Chicago Ill	F P Schreiber	G W Lang
WGTR Boston Mass	J Shepard	I B Robinson
WGYN New York N Y	C J Schaefer	H Anhalt
WHEF Rochester N Y	G O Wilg	B C O'Brien
WHFM Rochester N Y	W Fay	K J Gardner
WHNF New York N Y	H L Pettey	P Fuelling
WIP-FM Philadelphia Pa	B Gimbel Jr	J M Tisdale
WIUC Urbana Ill	J F Wright	A J Ebel
WLBG Philadelphia Pa	E D Clery	J H Henninger
WLOU Detroit Mich	H M Gray	E H Clark
WMFM Milwaukee Wis	W J Damm	D W Gellerup
WMIT Winston-Salem N C	H Essex	P Dillon
WMLL Evansville Ind	C Leich	J B Caraway
WMTW Gorham N H	J Shepard III	I Robinson
WNBF-FM Binghamton N Y	C D Mastin	L Gilbert
WNYC-FM New York N Y	M S Novik	B Arnow
WOWO-FM Fort Wayne Ind	P E Mills	B H Ratts
WPEN-FM Philadelphia Pa	R W Slocum	C Burtis
WQXQ New York N Y	E M Sanger	R D Valentine
WSBF South Bend Ind	F D Schurz	H G Cole
WSM-FM Nashville Tenn	M Cooney	G Reynolds
WTAG-FM Worcester Mass	E E Hill	E A Browning
WTIC-FM Hartford Conn	P W Morency	H D Taylor
WTNT Pittsburgh Pa	F R Smith	J R Harlow
WWZR Chicago Ill	E H Herrmann	R Utter
WYNE Brooklyn N Y	J F Macandrew	H O Haverkamp
W2XMN Alpine N J	E H Armstrong	P H Osborn
W8XFM Cincinnati O	J D Shouse	R J Rockwell
W9XEK Louisville Ky	W L Coulson	D C Summerford

U. S. AM Broadcasting Stations

— KA —

KABC San Antonio Tex	B Michaels	P Wolf
KABR Aberdeen S D	A A Fahy	D T Hunt
KADA Ada Okla	H W Stamps	H Walker
KALB Alexandria La	E R Cappellini	J Sexton
KALE Portland Ore		
KAND Corsicana Tex	A H Escoe	E R Hellums
KANS Wichita Kans	J Todd	
KARK Little Rock Ark	G E Zimmerman	D L Winn
KARM Fresno Calif	C F Coombs	R M Dorothy
KASA Elk City Okla		
KAST Astoria Ore	L E Parsons	J Titus
KATE Albert Lea Minn	E L Hayek	L Lawson
KAVE Carlsbad N M		C C Cook

— KB —

KBIX Muskogee Okla	J Barry	G Barnett
KBIZ Ottumwa Ia	J J Conroy	A P Johnson
KBKR Baker Ore	L Jacobs	S Williams
KBND Bend Ore	F H Loggon	W Guthrie
KBON Omaha Neb	P Fry	R Wina
KBPS Portland Ore	M E Gilmore	C Weagant
KBST Big Spring Tex	L O Seibert	A M Jones
KBTM Jonesboro Ark	Mrs J P Beard	J E Douglas
KBUR Burlington Ia	G B McDermott	J F Gallino
KBWD Brownwood Tex	W Mayes	A W Stewart

— KC —

KCKN Kansas City Kans	B Ludy	M Williams
KCMC Texarkana Tex	F O Myers	C Mathis
KCMO Kansas City Mo		
KCRC Enid Okla	L D Lindsey	M D Coleman

— KD —

KDAL Duluth Minn	D LeMasurier	R A Dettman
KDB Santa Barbara Calif	F Hollinger	W C Buckley
KDFN Casper Wyo	D L Hathaway	D L Hathaway
KDKA Pittsburgh Pa	J E Baudino	
KDLR Devils Lake N D	B Wick	R Moritz
KDNT Denton Tex	H V Shepard	H V Shepard
KDON Monterey Calif	R Pollock	E C Duty
KDRO Sedalia Mo	M J Hinlein	W Pash
KDTH Dubuque Ia	K S Gordon	C M Cain
KDYL Salt Lake City Utah	S S Fox	J M Baldwin

— KE —

KECA Los Angeles Calif	C Scott	R Denechaud
KEEW Brownsville Tex	T F Smith	W R Carmean
KELA Centralia-Chehalis Wash	J Chytil	E Lippencott
KELD El Dorado Ark	L M Sipes	A W Hearin
KELO Sioux Falls S D	M Henkin	M Staley
KENO Las Vegas Nev	M Kelch	M Kelch
KERN Bakersfield Calif		L Shatto
KEUB Price Utah		
KEVR Seattle Wash	B Sims	A Shultz
KEX Portland Ore	J B Conely	T T Ely
KEYS Corpus Christi Tex	B Hughes	E C Dunn

— KF —

KFAB Lincoln Neb	E Williams	M W Bullock
KFAC Los Angeles Calif		
KFAM St Cloud Minn	F Schilplin	R B Witschen
KFAR Fairbanks Alaska	A O Bramstedt	A G Helbert
KFBB Great Falls Mont	J P Wilkins	W L Myhre
KFBC Cheyenne Wyo	W C Grove	W C Grove
KFBI Wichita Kans	R K Lindsley	K W Pyle
KFBK Sacramento Calif		
KFDA Amarillo Tex	H P Roberson	J R Thomas
KFDM Beaumont Tex	C B Locke	L M Sanders
KFEL Denver Colo	G O'Fallon	T Atherstone
KFEQ St Joseph Mo	B Pitts	F H Damm
KFFA Helena Ark	J C Warren	J C Warren
KFGQ Boone Ia	L Crawford	L L Lewis
KFH Wichita Kans	P S Clark	A C Dadisman
KFI Los Angeles Calif	W B Ryan	C Mason H L Blatterman
KFIO Spokane Wash	R G McBroom	D Waymire
KFIZ Fond du Lac Wis	L A Fairbanks	W S Meyers
KFJB Marshalltown Ia		E Peak
KFJI Klamath Falls Ore	W D Miller	L Hunt
KFJM Grand Forks N D		
KFJZ Ft Worth Tex	G L Cagle	T Kimzey
KFKA Greeley Colo	F Price	K H Cooper
KFKU Lawrence Kans		
KFMB San Diego Calif	J O Gross	C C Frisk
KFNF Shenandoah Ia	T F Stubbs	R N Barkman
KFOR Lincoln Neb	M Drake	C Winkler
KFOX Long Beach Calif	H G Nicols	L W McDowell
KFPW Ft Smith Ark	J A England	J M VanHorn
KFPY Spokane Wash	F Symons	G E Langford
KFQD Anchorage Alaska		
KFRC San Francisco Calif	W D Pabst	J J McArdle
KFRE Fresno Calif	P R Bartlett	S W Anderson
KFRO Longview Tex	J R Curtis	J R Curtis
KFRU Columbia Mo	F H Brown	R H Haigh
KFSD San Diego Calif	T E Sharp	
KFSG Los Angeles Calif	J Carmaine	C H Haas
KFUN Las Vegas N Mex	E N Thwaits	A F Schultz
KFUO Clayton Mo	H H Hohenstein	
KFVD Los Angeles Calif	J F Burke	W Gass
KFVS Cape Girardeau Mo	O C Hirsch	O C Hirsch
KFWB Hollywood Calif	H Maizlish	H Myers
KFXD Nampa Idaho	F E Hurt	E Hurt
KFXJ Grand Junction Colo		
KFXM San Bernardino Calif	M A Vroman	G Ewing
KFYO Lubbock Tex	L Landis	W S Bledsoe
KFYR Bismarck N D	F E Fitzsimonds	I Nelson

— KG —

KGA Spokane Wash	H Wixon	C W Evans
KGB San Diego Calif	F D Ide	W G Collins
KGBS Harlingen Tex	T McDaniel	S Spencer
KGBX Springfield Mo	J G Wardell	D White
KGCU Mandan N D	M J Reichert	L Gunderson
KGCX Sidney Mont	E E Krebsbach	F A Toomey
KGDE Fergus Falls Minn	C L Jaren	C L Jaren
KGDM Stockton Calif	E F Peffer	B Greene
KGEK Sterling Colo		E G Beehler
KGER Long Beach Calif	M Dobyns	R Oakley
KGEZ Kalispell Mont	D C Treloar	O G Coburn
KGFF Shawnee Okla	M Eddy	S Ricciotti
KGFJ Los Angeles Calif	T Kirchner	H Obuchon
KGFL Roswell N M	W E Whitmore	
KGFW Kearney Neb	E A Thomas	J Lewis
KGFX Pierre S D	I A McNeil	R H Dye
KGGF Coffeyville Kans	H J Powell	
KGGM Albuquerque N M	G C Hoffman	L T Dodds
KGHF Pueblo Colo		P Gundy
KGHI Little Rock Ark	S C Vinsonhaler	V O VanDusen
KGHL Billings Mont	F Robischon	J Kilchli
KGIR Butte Mont	E B Craney	J Provis
KGIW Alamosa Colo	E L Allen	R Lewis
KGKB Tyler Tex	J G Ulmer	J B Sheppard
KGKL San Angelo Tex	L O Seibert	F Jones
KGKO Ft Worth Tex		
KGKY Scottsbluff Neb	L L Hilliard	H Morrison
KGLO Mason City Ia	F C Eighmey	R Sawyer
KGLU Safford Ariz	P Merrill	H Hartman
KGMB Honolulu T H		
KGNC Amarillo Tex	R Hollingsworth	W Torrey
KGNO Dodge City Kans	N C Petersen	R Hickman
KGO San Francisco Calif	T B Palmer	A E Evans
KGU Honolulu T H	M A Mulrony	M A Mulrony
KGVO Missoula Mont	A J Mosby	M F Chapin
KGW Portland Ore	A X Pangborn	H Singleton
KGY Olympia Wash	T Olsen	C A Roark

— KH —

KHAS Hastings Neb	D L Watts	
KHBC Hilo T H		
KHBG Okmulgee Okla	P Buford	C Ludwick
KHJ Los Angeles Calif	L A Weiss	F M Kennedy
KHMO Hannibal Mo	W W Cribb	T M Schenke
KHQ Spokane Wash	H Wixon	C W Evans
KHSL Chico Calif		E P Milburn
KHUB Watsonville Calif	R R Hunt	G Kenville

— KI —

KICA Clovis N Mex		
KICD Spencer Ia	L W Andrews	J Eckerman
KID Idaho Falls Idaho	F C McIntyre	C N Layne
KIDO Boise Idaho	W E Wagstaff	J Johntz
KIEM Eureka Calif	W B Smullin	A E Olson
KIEV Glendale Calif	L W Peters	L Gustafson
KILO Grand Forks N D	D LeMasurier	A Petrich
KINY Juneau Alaska		
KIRO Seattle Wash	L B Stone	J B Hatfield
KIT Yakima Wash	J A Murphy	H B Murphy
KIUL Garden City Kans	A Pyatt	W Pash
KIUN Pecos Tex	J W Hawkins	H Jaffe
KIUP Durango Colo	R M Beckner	J L Antic

— KJ —

KJBS San Francisco Calif	E P Franklin	C Dutton
KJR Seattle Wash	B F Fisher	F J Brott

— KL —

KLBM LaGrande Ore	G Capps	G Capps
KLCN Blytheville Ark	H Sudbury	B Conner
KLO Ogden Utah	G B Morgan	W D'Orr Cozzens
KLPM Minot N D	J B Cooley	C W Baker
KLRA Little Rock Ark	R Judge	K F Tracey
KLS Oakland Calif	S W Warner	F W Morse
KLUF Galveston Tex	L Clough	L Clough
KLX Oakland Calif	G Shaw	R S Smith
KLZ Denver Colo	H B Terry	H Wehrman

— KM —

KMA Shenandoah Ia	J C Rapp	R J Schroeder
KMAC San Antonio Tex	H W Davis	C F Harris
KMBC Kansas City Mo	A B Church	A R Moler
KMED Medford Ore	W J Virgin	D H Rees
KMJ Fresno Calif	K B Collins	W N Wallace
KMLB Monroe La		O L Morgan
KMMJ Grand Island Neb	W Heath	D Swanson
KMO Tacoma Wash	J A Murphy	J D Kolesar
KMOX St Louis Mo	F B Falknor	H Harvey
KMPC Los Angeles Calif	R O Reynolds	L Sigman
KMTR Hollywood Calif	K O Tinkham	P Wilson
KMYC Marysville Calif	J D Carroll	J D Carroll
KMYR Denver Colo	A G Meyer	G James

— KN —

KNEL Brady Tex	G L Burns	A D Patton
KNET Palestine Tex	B Laurie	B Laurie
KNOE Monroe La		
KNOW Austin Tex	H C Harvey	J E Lewis
KNX Los Angeles Calif	D W Thornburgh	L H Bowman

Of course it uses Eimac tubes

This compact Thermex unit measures 28 inches by 28 inches, stands 47 inches high, and weighs only 614 pounds. It is a practical and flexible piece of equipment with built-in heating cabinet and removable 12 inch by 15 inch drawer-electrode.

Being completely automatic, there is nothing to do but plug this Thermex in and load and unload the preform drawer. No dials, no tuning, not even a button to push. Closing the preform drawer all the way in, turns on the high frequency power and timer. At the end of the prescribed time, which may be anywhere from 5 to 10 seconds up to 2 minutes, the red indicating light goes out, the operator removes the tray and unloads the preforms into the mold cavities.

The Thermex Model No. 2-P, which is illustrated, operates at a frequency of 25 to 30 megacycles using 230 volt 60 cycle single phase current. It has an output in excess of 3400 BTUs per hour, and it uses a pair of Eimac 450-TH tubes. The use of electronic heating has increased production for many plastic manufacturers who have been leaders in utilizing the science of electronics.

The Thermex Division of the Girdler Corporation of Louisville, Ky., is a leader in supplying equipment for this and other industrial applications. It's natural that Eimac tubes are used, since these tubes are first choice of leading electronic engineers throughout the world.

Follow the leaders to

Eimac REG. U.S. PAT. OFF. **TUBES**

EITEL-McCULLOUGH, Inc.
985 San Mateo Avenue, San Bruno, California
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, California, U. S. A.

Eimac has received 7 ARMY-NAVY "E" AWARDS for production efficiency • San Bruno 5, Salt Lake City 2

U. S. AM Stations, Cont.

— KO —

KOA Denver Colo	J R MacPherson	R H Owen
KOAC Corvallis Ore	A Miller	G S Felkert
KOAM Pittsburg Kans	R E Wade	L S Stafford
KOB Albuquerque N M		G S Johnson
KOCA Kilgore Tex	H A Degner	A Mason
KOCY Oklahoma City Okla	M H Bonebrake	H Durham
KODL The Dalles Ore		
KODY North Platte Neb	J Alexander	B Eaves
KOH Reno Nev	R L Stoddard	T Boland
KOIL Omaha Neb	G Gray	C Winkler
KOIN Portland Ore	C W Myers	L S Bookwalter
KOKO La Junta Colo		
KOL Seattle Wash	A Taft	P C Lind
KOLR Devils Lake N D	B Wick	R Moritz
KOMA Oklahoma City Okla	K Brown	M W Thomas
KOME Tulsa Okla	H Grimes	R Brown
KOMO Seattle Wash		
KONO San Antonio Tex	J M Brown	G Ing
KOOS Marshfield Ore	B E Stone	H Shade
KORE Eugene Ore	L W Trommlitz	S Miller
KORN Fremont Neb	L Urban	H G Alexander
KOTA Rapid City S D	R J Dean	A E Griffiths
KOTN Pine Bluff Ark	B J Parrish	B J Parrish
KOVC Valley City N D	R E Ingstad	C J Sjostrom
KOVO Provo Utah	C A Tolboe	P Rasmussen
KOWH Omaha Neb	B C Corrigan	O E Weimer
KOY Phoenix Ariz	A Johnson	P Zeigler

— KP —

KPAB Laredo Tex	Mrs D Chapman	T R Chapman
KPAC Port Arthur Tex *	S Leavitt	G Boatwright
KPAS Pasadena Calif	L K King	J Fredericks
KPDN Pampa Tex	J Hanna	J R Thomas
KPFA Helena Mont		
KPHO Phoenix Ariz	C Garland	W Fernyhough
KPLC Lake Charles La	D Wilson	E C Moses
KPLT Paris Tex	E T Jones	A W Auglin
KPMC Bakersfield Calif		
KPO San Francisco Calif	J W Elwood	G Greaves
KPOF Denver Colo	A K White	P H Schissler
KPOW Powell Wyo	D Brandt	D Brandt
KPPC Pasadena Calif	L Hall	V Parsons
KPQ Wenatchee Wash	R Jones	R B Sutton
KPRC Houston Tex	K Tips	H Wheeler
KPRO Riverside Calif	W L Bleeson	A Dolde

— KQ —

KQV Pittsburgh Pa		
KQW San Jose Calif		

— KR —

KRBA Lufkin Tex	D E Yates	G Perry
KRBC Abilene Tex	H Barrett	J B Casey
KRBM Bozeman Mont	E A Neath	J J Provis
KRE Berkeley Calif	A Westlund	P McKernan
KRGV Weslaco Tex	A J Taylor	L Hartwig
KRIC Beaumont Tex	J Neil	B Hughes
KRIS Corpus Christi Tex	T F Smith	R S Bush
KRJF Miles City Mont	W F Flinn	I A Elliot
KRKD Los Angeles Calif	N Connor	W O Freitag
KRKO Everett Wash	W R Taft	R C Towne
KRLC Lewiston Idaho	D A Wike	M L MacLafferty
KRLD Dallas Tex	C W Rembert	R M Flynn
KRLH Midland Tex	R M McDonald	J Cecil
KRMD Shreveport La	T B Lanford	J C Irby Jr
KRNR Roseburg Ore	M H Pengra	H J Chandler
KRNT Des Moines Ia	P Hoffman	D E Burrichter
KROC Rochester Minn	G Wing	F C Clarke
KROD El Paso Tex	V Lawrence	E P Talbott
KROS Clinton Ia	M Sexton	G Andrew
KROW Oakland Calif	P G Lasky	C E Downey
KROY Sacramento Calif		
KRRV Sherman Tex	L L Hendrick	T John
KRSC Seattle Wash	R E Priebe	G A Freeman

— KS —

KSAC Manhattan Kans	H Umberger	V B P Holbert
KSAL Salina Kans	O H Balch	N E Vance
KSAM Huntsville Tex		
KSAN San Francisco Calif	J Akers	N J Patterson
KSCJ Sioux City Ia	E T Flaherty	A H Smith
KSD St Louis Mo	G M Burbach	C R Yarger
KSEI Pocatello Idaho	H H Fletcher	H H Fletcher
KSFO San Francisco Calif	L Dellar	R V Howard
KSJB Jamestown N D	L R Amoo	L R Amoo
KSKY Dallas Tex	A L Chilton	M M Ming
KSL Salt Lake City Utah	I Sharp	C R Evans
KSLM Salem Ore		
KSO Des Moines Ia	G J Higgins	F E Bartlett
KSOO Sioux Falls S D	M Henkin	M Staley
KSRO Santa Rosa Calif	E Handley	H McCauley
KSTP St Paul Minn	S E Hubbard	B R Hilker
KSUB Cedar City Utah	L Murdock	H Urie
KSUN Lowell Ariz		
KSWO Lawton Okla	B Ross	W E Billington

— KT —

KTAR Phoenix Ariz	R O Lewis	J H Haughaowt

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	Radio Products Directory, listing manufacturers of equipment, components, materials, and supplies. 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	Radio Products Directory, listing manufacturers of equipment, components, materials, and supplies. 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

KTBC Austin Tex	P Adelman	M W Jeffus
KTBI Tacoma Wash	B W Ormsby	G Cole
KTBS Shreveport La	J C McCormack	C H Maddox
KTEM Temple Tex	F W Mayborn	P Shaw
KTFI Twin Falls Idaho	F M Gardner	F V Cox
KTHS Hot Springs Ark	K K Kellam	C L Suitt
KTHT Houston Tex		
KTKC Visalia Calif	C P Scott	B Williamson
KTKN Ketchikan Alaska	H M Hogue	M M Durham
KTMS Santa Barbara Calif	L F Kroeck	A Nickolay
KTNM Tucumcari N M		
KTOH Lihue T H	C J Fern	J C Wada
KTOK Oklahoma City Okla	R D Enoch	C Easum
KTRB Modesto Calif	W H Bates	W H Bates
KTRH Houston Tex	B F Orr	K H Robinson
		T Hiner
KTRI Sioux City Ia	D Dirks	R Beck
KTSA San Antonio Tex	G W Johnson	W G Egerton
KTSM El Paso Tex	K O Wyler	E L Gemoets
KTSW Emporia Kans	J N Rupard	H C Davis
KTTS Springfield Mo	G P Ward	W F Curry
KTUC Tucson Ariz	L Little	C A Livingston
KTUL Tulsa Okla	J Esau	R Snider
KTW Seattle Wash		
KTYW Yakima Wash		

— KU —

KUIN Grants Pass Ore	R Hanson	E A Malone
KUJ Walla Walla Wash	H E Studebaker	M L MacLafferty
KUOA Siloam Springs Ark	S Whaley	K Maxwell
KUSD Vermillion S D	H Aarnes	S J Graf
KUTA Salt Lake City Utah	F C Carman	L O Wahlquist

— KV —

KVAK Atchison Kans	J Akers	B G Parker
KVAN Vancouver Wash	B E Stone	S W McReady
KVCV Redding Calif	R Bryan	R D Will
KVEC San Luis Obispo Calif	L Hacker	E Travis
KVFD Fort Dodge Ia	E Breen	D Sinclair
KVGB Great Bend Kans	C Morgan	L Legleiter
KVI Tacoma Wash	V Irwin	R Griese
KVIC Victoria Tex	J Fisher	R McCown
KVNU Logan Utah	R Bullen	C Secrist
KVOA Tucson Ariz	R B Williams	R Holsclaw
KVOD Denver Colo	W D Pyle	W D Pyle
KVOE Santa Ana Calif	E L Spencer	W S Wiggins
KVOL Lafayette La	G H Thomas	B H Bailey Jr
KVOO Tulsa Okla	W B Way	L W Stinson
KVOP Plainview Tex	W J Harpole	J Simms
KVOR Colorado Spgs Colo	E Shupe	H C Strang
KVOS Bellingham Wash	J F Adams	J C Haley
KVOX Moorhead Minn	M M Marget	H E Vose
KVRS Rock Springs Wyo	H L McCracken	A W Buchanan
KVSF Santa Fe N M		
KVSO Ardmore Okla	A Riesen	C M Milner
KVWC Vernon Tex		H F Ridgway

— KW —

KWAL Wallace Idaho	R G Binyon	A Haapanen
KWAT Watertown S D	F L Bramble	F Alwin
KWBU Corpus Christi Tex	H Hogan	N Cuesta
KWBW Hutchinson Kans	W Wyse	M H Clary
KWEW Hobbs N M		R Evans
KWFC Hot Springs Ark	W E Ware	E H Butler
KWFT Wichita Falls Tex	C E Clough	J Adams
KWG Stockton Calif	G Ross	
KWIL Albany Ore	C Wheeler	B Hansen
KWJB Globe Ariz	P Merrill	H Hartman
KWJJ Portland Ore		
KWK St Louis Mo	R Dady	N J Zehr
KWKH Shreveport La	F Ohl	W E Antony
KWKW Pasadena Calif	W J Beaton	P W Spargo
KWLC Decorah Ia	R Bergstrom	O Fittreim
KWLK Longview Wash	C O Chatterton	R H Mietzke
KWLM Willmar Minn	H W Linder	L Stenberg
KWNO Winona Minn	L L McCurnin	
KWOC Poplar Bluff Mo	P H Cunningham	D Lidenton
KWON Bartlesville Okla	J F Case	D DeGrafenreid
KWOS Jefferson City Mo	R L Rose	H White
KWRC Pendleton Ore	P E Walden	P E Walden
KWSC Pullman Wash	G Jones	R Baird
KWTO Springfield Mo.	R D Foster	F Bauer
KWYO Sheridan Wyo	J Carroll	B Crosthwait

— KX —

KXA Seattle Wash	F Wallace	J N Dubuque
KXEL Waterloo Ia	J DuMond	D Kassner
KXL Portland Ore	H S Jacobson	H Scholfield
KXO El Centro Calif	K Thornton	J Coin
		L Bellwood
KXOK St Louis Mo	C L Thomas	A Rekart
KXOX Sweetwater Tex	J H Hubbard	G W Dotson
KXRO Aberdeen Wash	F G Goddard	K Grinde
KXYZ Houston Tex	T F Smith	J R Chinski

— KY —

KYA San Francisco Calif	D Fedderson	P Schulz
KYCA Prescott Ariz		
KYOS Merced Calif		
KYSM Mankato Minn	J F Meagher	J Houts
KYUM Yuma Ariz	R C Smucker	L Wheeler
KYW Philadelphia Pa	L W Joy	I N Eney

— WA —

WAAB Worcester Mass		
WAAF Chicago Ill	B R Eidmann	C W Ulrich
WAAT Newark N J	I R Rosenhaus	F V Bremer
WABC New York N Y	A H Hayes	W Lodge
WABI Bangor Me	F B Simpson	W Dickson
WABY Albany N Y	H E Smith	J H Corey
WACO Waco Tex	R E Glasgow	L H Appleman
WADC Akron O	A T Simmons	L P Hennigan
WAGA Atlanta Ga	C A Smithgall	A L Jones
WAGE Syracuse N Y		C W Brannen
WAGF Dothan Ala	J C Smith	J T Hubbard
WAGM Presque Isle Me	H D Glidden	L E Hughes
WAIM Anderson S C	J D McCoy	W R Davidson
WAIR Winston-Salem N C	G D Walker	L C King
WAIT Chicago Ill	G T Dyer	E Jacker
WAJR Morgantown W Va	K Knight	R C Spence
WAKR Akron O	S B Berk	G Paul
WALA Mobile Ala	H K Martin	R Killough
WALB Albany Ga	A M Israel	D Layton
WALL Middleton N Y	T Allen	M Karig Jr
WAML Laurel Miss	H M Smith	G Dennis
WAOV Vincennes Ind	V H Lund	G M Nutty
WAPI Birmingham Ala	T Holt	N S Hurley
WAPO Chattanooga Tenn	R G Patterson	B B Barnes
WARM Scranton Pa	M F Memolo	A W Oschmann
WASK Lafayette Ind	J Spring	H C Garha
WATL Atlanta Ga	J A Davenport	R W Minton
WATN Watertown N Y	G H Righter	
WATR Waterbury Conn	H Thomas	R Jensen
WATW Ashland Wis	J W Huss	H Dahlbacka
WAVE Louisville Ky	N Lord	W Hudson
WAWZ Zarephath N J		N Wilson
WAYS Charlotte N C	W H Goan	P Absher
WAYX Waycross Ga	J J Tobola	J J Tobola
WAZL Hazelton Pa	V C Diehm	J F Mathiot

— WB —

WBAA W Lafayette Ind	J W Ditamore	D Crim
WBAB Atlantic City N J	M L Mendelsohn	E Godfrey
WBAL Baltimore Md	H C Burke	R E Brunner
WBAP Ft Worth Tex	G Cranston	R C Stinson
WBAX Wilkes-Barre Pa	J H Stenger Jr	J H Stenger Jr
WBBB Burlington N C	E Z Jones	B Tysor
WBBL Richmond Va	M A Sitton	R W Raabe
WBBM Chicago Ill	J L Van Volkenburg	J J Beloungy
WBBR Brooklyn N Y	M A Howlett	R H Leffler
WBBZ Ponca City Okla	B Kelley	L E Brown
WBCM Bay City Mich	H A Giesel	R H Carpenter
WBEN Buffalo N Y	A H Kirchhofer	R J Kingsley
WBHP Huntsville Ala	W H Pollard	J Garrison
WBIG Greensboro N C	E Ridge	E Allison
WBIR Knoxville Tenn	J P Hart	J R Horton
WBLJ Dalton Ga	W V Williams	W C Roberts
WBLK Clarksburg W Va	G C Blackwell	J Wright
WBML Macon Ga	C W Pittman	H S Goodrich
WBNS Columbus O	E T Wolfe	L H Nazger
WBNX New York N Y	W I Moore	A L Solbrig
WBNY Buffalo N Y	R L Albertson	T L Venes
WBOC Salisbury Md		P A Alfonsi
WBOW Terre Haute Ind	G Jackson	D Aldrich
WBRC Birmingham Ala	J Bell	G P Hamann
WBRE Wilkes Barre Pa	A C Baltimore	C Sakoski
WBRK Pittsfield Mass		
WBRW Welch W Va	J H Metz	J H Metz
WBRY Waterbury Conn	E J Frey	F B Hales
WBT Charlotte N C	A D Willard Jr	M J Minor
WBTA Batavia N Y	C R Switzendick	H Cochran
WBTH Williamson W Va	A Shein	R W Bullio
WBTM Danville Va	R S Guyer	H W Spencer
WBYN Brooklyn N Y	W Norin	P Testan
WBZ Boston Mass	C S Young	W H Hauser
WBZA Springfield Mass	C S Young	H E Randol

— WC —

WCAE Pittsburgh Pa	R C Daniel	J Schultz
WCAL Northfield Minn	M C Jensen	O Haldorsen
WCAM Camden N J	W H Markward	C E Onens

U. S. AM Stations, Cont.

WCAO Baltimore Md	L W Milbourne	M L Jones
WCAP Asbury Pk N J	M Scheck	R M Gordon
WCAR Pontiac Mich	H Y Levinson	W N Cook
WCAT Rapid City S D		
WCAU Philadelphia Pa	L Levy	G Lewis
WCAX Burlington Vt	C P Hasbrook	J C Quill
WCAZ Carthage Ill		
WCBI Columbus Miss	B McRaney	J V Jones
WCBM Baltimore Md	G H Roeder	A E Eckels
WCBS Springfield Ill	C Neeld	H L Dewing
WCBT Roanoke Rapids N C	S E Crew	C Meares
WCCO Minneapolis Minn	A E Joscelyn	H S McCartney
WCED DuBois Pa	J S Gray	V Stahl
WCFL Chicago Ill	H T Keegan	R B Pappin
WCHS Charleston W Va	H L Chernoff	O E Robinson
WCHV Charlottesville Va	C Barham	W Gray
WCKY Cincinnati O	L B Wilson	A D Gillette
WCLO Janesville Wis	S H Bliss	W Clay
WCLF Joliet Ill	R L Bowles	L DeCosta
WCMI Ashland Ky	L D Newman	C W Weaver
WCNC Elizabeth City N C	J E Aydlett	J J Behonis
WCOA Pensacola Fla		
WCOC Meridian Miss	D W Gavin	D W Gavin
WCOL Columbus O	J Kelly	L DeConnick
WCOP Boston Mass	A N Armstrong	R Hale
WCOS Columbia S C	W C Bochman	H L Clippard
WCOU Lewiston Me	O J Norman	J T Duty
WCOV Montgomery Ala	G W Covington	J C Hughes
WCPO Cincinnati O	M C Watters	
WCRS Greenwood S C	D Crosland	E C Niemann
WCRW Chicago Ill	J A White	C R White
WCSC Charleston S C	J M Rivers	W R Albee
WCSH Portland Me	W H Rines	G F Crandon

— WD —

WDAE Tampa Fla	L S Mitchell	W P Moore
WDAF Kansas City Mo	D Fitzer	J A Flaherty
WDAK Columbus Ga	L J Duncan	D Pulley
WDAN Danville Ill	E C Hewes	T G Magin
WDAS Philadelphia Pa	P J Stanton	F Unterberger
WDAY Fargo N Dak	J Dunn	S J Savold
WDBC Escanaba Mich		
WDBJ Roanoke Va	R P Jordan	J W Robertson
WDBO Orlando Fla	W G McBride	J E Yarbrough
WDEF Chattanooga Tenn	F S Lane	B C Baker
WDEL Wilmington Del	J G Walsh	J E Mathiot
WDEV Waterbury Vt	L E Squier	H Grout
WDGY Minneapolis Minn	G W Young	G W Young
WDLP Panama City Fla	B Hayford	E Scott
WDMJ Marquette Mich		
WDNC Durham N C	J F Jarmon	W S Hill
WDOD Chattanooga Tenn	E W Winger	J C Vessels
WDRC Hartford Conn	F M Doolittle	I Martino
WDSM Superior Wis	A C Robinson	J M Laskey
WDSU New Orleans La	F Weber	C Whitney
WDWS Champaign Ill	J A McDermott	J R Baum
WDZ Tuscola Ill	W C Schafer	T A Giles

— WE —

WEAF New York N Y	F Mullen	O B Hanson
WEAN Providence R I	J Lopez	H Tilley
WEAU Eau Claire Wis	W C Bridges	T O Jorgenson
WEBC Duluth Minn		W H Lounsberry
WEBQ Harrisburg Ill	I M Taylor	J R Tate
WEBR Buffalo N Y	C King	R Lamy
WEDC Chicago Ill	F J Kotnour	C Lewicki
WEED Rocky Mount N C	W A Wynne	W W Primm
WEEI Boston Mass	H E Fellows	W J Stiles
WEEU Reading Pa	J M Nassau	H Shearer
WEGO Concord N C	W M Nelson	W M Nelson
WEIM Fitchburg Mass	E Clement	T Kalin
WELI New Haven Conn	D H Long	F King
WELL Battle Creek Mich	D E Jayne	E J Stone
WELO Tupelo Miss		
WEMP Milwaukee Wis	C J Lanphier	R Jost
WENR Chicago Ill	R McLaughlin	E C Horstman
WENT Gloversville N Y		
WENY Elmira N Y	D Taylor	T A Greene
WEOA Evansville Ind	C Leich	E Schoeny
WERC Erie Pa	C E Denny	T Phillips
WEST Easton Pa	E C Anderson	J E Mathiot
WESX Marblehead Mass		
WEVD New York N Y	H Greenfield	C W Brown
WEW St Louis Mo	N Pagliara	G E Rueppel
WEXL Royal Oak Mich	E C Thompson	J Steadley

— WF —

WFAA Dallas Tex	M Campbell	R Collins
WFAS White Plains N Y	F A Seitz	F A Seitz
WFBC Greenville S C	B Whitmire	W C Etheridge
WFBG Altoona Pa	R F Thompson	G R Burgoon
WFBL Syracuse N Y	S Woodworth	A R Marcy
WFBM Indianapolis Ind	F O Sharp	H S Holland
WFBR Baltimore Md	H H Barroll	W Q Ranft
WFCI Pawtucket R I	W A Walker	G Johnson
WFDF Flint Mich	H M Loeb	F D Fallain
WFEA Manchester N H	C Paine	R Schow
WFHR Wisconsin Rapids	G T Frechette	G N Bowker
WFIG Sumter S C	T D Youngblood	N Shubert
WFIL Philadelphia Pa	R W Clipp	L E Littlejohn
WFIN Findlay O	F R Hover	E C Smith
WFLA Tampa Fla	W W Tison	J H Mitchell
WFMD Frederick Md	L Leonard	J Thiel
WFMJ Youngstown O	W F Maag	F A Dieringer
WFNC Fayetteville N C	W C Ewing	
WFOR Hattiesburg Miss	C J Wright	E Sanders
WFOY St Augustine Fla		
WFPG Atlantic City N J	E E Kohn	B K Thron
WFTC Kinston N C	J Weiland	D E Hardison
WFTL Ft Lauderdale Fla	S Smithgall	F R Clark
WFVA Fredericksburg Va	P Whitney	P Whitney
	N Winkler	

— WG —

WGAA Cedartown Ga		
WGAC Augusta Ga	J B Fuqua	J Lyon
WGAL Lancaster Pa	W O Miller	J E Mathiot
WGAN Portland Me	C E Gatchell	R W Hodgkins
WGAR Cleveland O	J F Patt	R M Pierce
WGAU Athens Ga	M C Gorman	M C Gorman
WGBB Freeport N Y	H H Carman	H H Carman
WGBF Evansville Ind	C Leich	F Gehres
WGBG Greensboro N C	R M Lambeth	J H Warlick
WGBI Scranton Pa	G D Coleman	K R Cooke
WGBR Goldsboro N C	H G Bright	D B Trueblood
WGCM Gulfport Miss	H O Jones	D Murphy
WGES Chicago Ill	J A Dyer	E W Jacker
WGGA Gainesville Ga	H R Holt	E Sampatt
WGH Newport News Va	E E Bishop	W P Grether
WGIL Galesburg Ill	R B Laughner Jr	H C Day
WGKV Charleston W Va	J S Phillips	M Swillinger
WGL Ft Wayne Ind	F V Webb	H Beck
WGN Chicago Ill	F P Schreiber	G W Lang
WGNC Gastonia N C	P McSwain	W C Groves
WGNY Newburgh N Y	H W Cassill	M S Seimes
WGOV Valdosta Ga	Mrs E D Rivers	J W Stewart
WGPC Albany Ga	M U Kinnett	C M Kinnett
WGR Buffalo N Y	I R Lounsberry	K B Hoffman
WGRC Louisville Ky	C L Harris	P W Esten
WGRM Greenwood Miss		
WGST Atlanta Ga	F Gaither	
	J Fulton	B Akerman
WGTC Greenville N C	M J Laughinghouse	H Tribley
WGTM Wilson N C	A Wannamaker	W Wooten
WGY Schenectady N Y	K Hager	W J Purcell

— WH —

WHA Madison Wis	H B McCarty	J H Stiehl
WHAI Greenfield Mass	H W Nichols	L F Wheeler
WHAM Rochester N Y	J H Lee	K J Gardner
WHAS Louisville Ky	W L Coulson	D C Summerford
WHAT Philadelphia Pa		
WHAZ Troy N Y	W J Williams	W C Stoker
WHB Kansas City Mo	J T Schilling	H E Goldenberg
WHBB Selma Ala	J Smith	T F Kelly
WHBC Canton O	F Hinkle	K L Sliker
WHBF Rock Island Ill	L C Johnson	R J Sinnett
WHBI Newark N J		
WHBL Sheboygan Wis	G P Richards	H J Mayer
WHBQ Memphis Tenn	E A Alburty	S D Wooten
WHBU Anderson Ind	J R Atkinson	L F Podhaski
WHBY Appleton Wis	J L Gallagher	G E Merkl
WHCU Ithaca N Y	M R Hanna	T McLean
WHDF Calumet Mich	A W Payne	G L Burgan
WHDH Boston Mass	R G Matheson	R G Matheson
WHDL Olean N Y	T L Brown	T J Gill
WHEB Portsmouth N H	B Georges	P G Lindsay
WHEC Rochester N Y	G O Wilg	B C O'Brien
WHFC Cicero Ill		
WHIO Dayton O	R H Moody	E Adams
WHIS Bluefield W Va	H I Shott Jr	P T Flanagan
WHIT New Bern N C		G Neuville
WHIZ Zanesville O	A Haid	W Hunt
WHJB Greensburg Pa	G J Podeyn	L L Allen
WHK Cleveland O	K K Hackathorn	R H DeLany
WHKC Columbus O		
WHKK Akron O	R W Richmond	J S Hill
WHKY Hickory N C	E S Long	E S Long
WHLB Virginia Minn	O H Peterson	E Jokinen
WHLD Niagara Falls N Y	E C Hull	R J Wilson
WHLN Harlan Ky	R B Helms	J F Fox
WHLS Port Huron Mich	H L Stevens	L C Conant
WHMA Anniston Ala	J W Buttram	J Hudson
WHN New York N Y		
WHO Des Moines Ia	J O Maland	P A Loyet
WHOM Jersey City N J	C Lawrence	T Gempp
WHOP Hopkinsville Ky	F E Lackey	C W Stratton
WHOT S Bend Ind		
WHP Harrisburg Pa	A K Redmond	R S Duncan
WHTD Hartford Conn	R Kand	R B Holt
WHUB Cookeville Tenn	M L Medley	H Beasley
WHYN Holyoke Mass	P J Montague	T R Humphrey

— WI —

WIAC San Juan P R		
WIBA Madison Wis	E C Allen	N Hahan
WIBC Indianapolis Ind	C A McLaughlin	H E Adams
WIBG Philadelphia Pa	E D Clery	J H Henninger
WIBM Jackson Mich	W Clzek	C W Wirtanen
WIBU Poynette Wis	W Forrest	L Doese
WIBW Topeka Kans	B Ludy	K G Marquardt
WIBX Utica N Y	Mrs M P Bowen	J T Dowdell
WICA Ashtabula O	R B Rowley	G E Gautney
WICC Bridgeport Conn	J T Lopez	G P Keich
WIGM Medford Wis	I Meyer	R Bohnert
WIL St Louis Mo	C W Benson	C Stoup
WILL Urbana Ill	J F Wright	A J Ebel
WILM Wilmington Del		J E Mathiot
WINC Winchester Va		
WIND Gary Ind		V H Voss
WING Dayton O	J P Williams	S Beck
WINK Ft Myers Fla	R B Woodyard	H Ritchey
WINN Louisville Ky	H McTigue	E Robb
WINS New York N Y	W Schroeder	C Reynolds
WINX Washington D C	L J Heller	R E Cannon
WIOD Miami Fla	J M Legate	W Chiles
WIP Philadelphia Pa	B Gimbel Jr	J M Tisdale
WIRE Indianapolis Ind	R Schepp	E E Alden
WIS Columbia S C	G R Shafto	J P Davenport
WISE Asheville N C	H H Thoms	M Hollerith
WISH Indianapolis Ind	C B McConnell	S Gresham Jr
WISN Milwaukee Wis	G W Grignon	N J Richard
WISR Butler Pa	D H Rosenblum	P F Rex
WITH Baltimore Md	T G Tinsley	J S Duff
WIZE Springfield O	A Karns	V L Bushong

— WJ —

WJAC Johnstown Pa	J C Tully	N L Straub
WJAG Norfolk Neb	A Thomas	F Wiedenbach
WJAR Providence R I	J J Boyle	T C J Prior
WJAS Pittsburg Pa	H K Brennen	W W McCoy
WJAX Jacksonville Fla		
WJBC Bloomington Ill	G M McGregor	J Hamm
WJBK Detroit Mich	J Hopkins	E T McKenzie
WJBO Baton Rouge La	R Dabadie	D K Allan
WJBW New Orleans La	P K Ewing	C C Carlson
WJBY Gadsden Ala		
WJDX Jackson Miss	W P Harris	P G Root
WJEJ Hagerstown Md	G C Crilley	G McIntire
WJHL Johnson City Tenn	W Lancaster	O K Garland
WJHO Opelika Ala	F M Hyatt	F M Hyatt
WJHP Jacksonville Fla	T Chapeau	B Hayford
WJIM Lansing Mich	F Wagenwoord Jr	M Wirth
WJJD Chicago Ill	A F Harre	W F Meyers
WJLB Detroit Mich	H M Gray	E H Clark
WJLD Bessemer Ala	H Falter	C M Callicott
WJLS Beckley W Va	V N Cooper	A J Ginkel
WJMC Rice Lake Wis	W C Bridges	R P Kolsky
WJMS Ironwood Mich	J W Huss	A Dahlbacka
WJNO W Palm Beach Fla	G P Willis	O C Wright
WJOB Hammond Ind	O E Richardson	S Strasburg
WJPA Washington Pa	J M Croft	J M Troesch
WJPF Herrin Ill	C R Cook	M F Sawyer
WJPR Greenville Miss	E H McMurry	G W Wilson
WJR Detroit Mich	L Fitzpatrick	M R Mitchell
WJRD Tuscaloosa Ala	J R Doss	J W Arendale
WJTN Jamestown N Y	D S Wilkins	H Krotzert
WJW Cleveland O	W M O'Neil	G Roberts
WJZ New York N Y	J H McNeil	G Milne
WJZM Clarksville Tenn	W E Williams	W B Thurman

— WK —

WKAQ San Juan P R		
WKAR E Lansing Mich	R J Coleman	N E Grover
WKAT Miami Beach Fla	J I Prosser	A Smith
		T Magee
WKBB Dubuque Ia	J D DCarpenter	L T Carlson
WKBH LaCrosse Wis	H Dahl	A Leeman
WKBN Youngstown	W P Williamson	W P Williamson
WKBO Harrisburg Pa	C G Moss	J E Mathiot
WKBV Richmond Ind	G F Albright	L Duning
WKBW Buffalo N Y	I R Lounsberry	K B Hoffman
WKBZ Muskegon Mich	G F Ashbacker	G Krivitzky
WKEU Griffin Ga		
WKEY Covington Va	E M Key	
WKIP Poughkeepsie N Y	H W Cassill	J P Burke
WKLA Ludington Mich		
WKMO Kokomo Ind	J C Jeffrey	G Palmer
WKNE Keene N H	D Carpenter	E Batchelder
WKNY Kingston N Y	L Steketee	J M Troesch
WKOK Sunbury Pa	B A Beck	H Bower
WKPA New Kengsington Pa		
WKPT Kingsport Tenn	J Swicegood	G W Upchurch
WKRC Cincinnati O	H E Fast	G A Wilson
WKRO Cairo Ill		
WKST New Castle Pa	A W Graham	R Emch
WKWK Wheeling W Va	J B Reynolds	F Baker
WKY Oklahoma City Okla	G V Grubb	H J Lovell
WKZO Kalamazoo Mich	J E Fetzer	C E Lee

— WL —

WLAC Nashville Tenn	F C Sowell	F D Binns
WLAG La Grange Ga	E Mullinax	J M McKay
WLAK Lakeland Fla	S O Ward	W P Lee
WLAP Lexington Ky	J E Willis	S Helt
WLAV Grand Rapids Mich	H M Steed	R Plank
WLAW Lawrence Mass	I E Rogers	G A Hinckley
WLAY Muscle Shoals Ala	E J Sperry	G Sandlin
WLB Minneapolis Minn	E W Ziebarth	Berton Holmberg
WLBC Muncie Ind	D A Burton	M M Crain
WLBJ Bowling Green Ky	K D Given	J Hight
WLBL Stevens Point Wis	F R Calvert	W Ninneman
WLBZ Bangor Me	E E Guernsey	J Wilby
WLDS Jacksonville Ill	E J Korsmeyer	G Cassens
WLEU Erie Pa	V H Weir	C Baker
WLIB Brooklyn N Y	E I Godofsky	A Faske
WLLH Lowell Mass	R Donahue	R Newton
WLNH Laconia N H	M B Avery	L C Steady
WLOF Orlando Fla		
WLOG Logan W Va	J C McGowan	

U. S. AM Stations, Cont.

WLOK Lima O	R Elvin	R Gartner
WLOL Minneapolis Minn	E S Mittendorf	G Brautigam
WLPM Suffolk Va	F L Hart	
WLS Chicago Ill	G Snyder	T L Rowe
WLVA Lynchburg Va	P P Allen	J Orth
WLW Cincinnati O	J D Shouse	R J Rockwell

— WM —

WMAL Washington D C	K H Berkeley	D Hunter
WMAM Marinette Wis	J D Mackin	M R Lund
WMAN Mansfield O	J M O'Hara	W E Morrison
WMAQ Chicago Ill	H C Kopf	H C Luttgens
WMAS Springfield Mass	W Greenwood	E Hewinson
WMAZ Macon Ga	W E Cobb	G P Rankin
WMBD Peoria Ill	E L Bill	T A Gilies
WMBG Richmond Va	W M Havens	W H Wood
WMBH Joplin Mo	D J Poynor	R Meek
WMBI Chicago Ill	H C Crowell	A P Frye
WMBO Auburn N Y	F L Keesee	
WMBR Jacksonville Fla	F King G Marshall	E Vordermark
WMBS Uniontown Pa	J C Burwell	W Henzly
WMC Memphis Tenn	H W Slavick	E C Frase
WMCA New York N Y	C Stark	F Marx
WMEX Boston Mass		
WMFD Wilmington N C	R A Dunlea	E I Herring
WMFF Plattsburg N Y	G F Bissell	J Vrindten
WMFG Hibbing Minn		W H Lounsbury
WMFJ Daytona Beach Fla		
WMFR High Point N C	H M Lambeth	R P Boyd
WMGH Moultrie Ga	J Pidcock	J M Wilder
WMIN St Paul Minn	E Hoffman	W B Fritze
WMIS Natchez Miss		T W Patterson
WMJM Cordele Ga	J S Rivers	H Harrell
WMMN Fairmont W Va	S P Kettler	R D Hough
WMOB Mobile Ala	S B Quigley	T W Greenwood
WMOG Brunswick Ga	K E White	K E White
WMOH Hamilton O		
WMPC Lapeer Mich		
WMPS Memphis Tenn	H R Krelstein	J G Deaderick
WMRC Greenville S C	W E Bray	G D Tate
WMRF Lewiston Pa		
WMRN Marion O	R T Mason	F T Peters
WMRO Aurora Ill		V G Cofey
WMSL Decatur Ala	E Mobley	J V Roser
WMT Cedar Rapids Ia	W B Quarton	G Hixenbaugh
WMUR Manchester N H	H Carter	V H Chandler
WMVA Martinsville Va	J W Shultz	D W Muse

— WN —

WNAB Bridgeport Conn	L Thomas	V DeLaurentis
WNAC Boston Mass	J Shepard 3rd	I B Robinson
WNAD Norman Okla	J W Dunn	C L Farrar
WNAX Yankton S D	D E Inman	C M Todd
WNBF Binghamton N Y	C D Mastin	L H Gilbert
WNBH New Bedford Mass	H R Norman	E T Parker
WNBZ Saranac Lake N Y	J F Grimes	H B Williams
WNEL San Juan P R		
WNEW New York N Y	B Judis	M J Weiner
WNHC New Haven Conn		
WNLC New London Conn	G J Morey	G J Morey
WNOE New Orleans La	J E Gordon	A J Bourgeois
WNOX Knoxville Tenn	O L Smith	J Cole
WNYC New York N Y	M S Novik	J De Prospo

— WO —

WOAI San Antonio Tex	H A L Halff	F Sterling
WOC Davenport Ia	J B Lottridge	P A Arvidson
WOCB W Yarmouth Mass		
WOI Ames Ia	W I Griffith	L L Lewis
WOKO Albany N Y	H E Smith	O A Sardi
WOL Washington D C	M S Jones	H H Lyon
WOLF Syracuse N Y	T S Marshall	D F Foote
WOLS Florence S C	N L Royster	H L Hanks
WOMI Owensboro Ky	H O Potter	L R Goodaker
WOMT Manitowoc Wis	F M Kadow	W F Duben
WOOD Grand Rapids Mich	S W Barnett	F W Russell
WOPI Bristol Tenn	W A Wilson	R H Smith
WOR New York N Y	T C Streibert	J R Poppele
WORC Worcester Mass	M P Stanton	
WORD Spartanburg S C	F R Knutti	C J Burdette
WORK York Pa		J E Mathiot
WORL Boston Mass	G Lasker	J W Parker
WOSH Oshkosh Wis	B A Laird	N Williams
WOSU Columbus O	R C Higgy	C H Boehnker
WOV New York N Y	RN Weil	H Holt
WOW Omaha Neb	J J Gillin	W J Kotera
WOWO Ft Wayne Ind	P E Mills	B H Ratts

— WP —

WPAD Paducah Ky	P E Lackey	U C Morris
WPAR Parkersburg W Va	G H Clinton	C Knowles
WPAT Paterson N J	S J Flamm	E Lucas
WPAX Thomasville Ga	H Wimpy	J W Poole
WPAY Portsmouth O	P Wagner	M L Myers
WPDQ Jacksonville Fla	R R Feagin	J Donovon
WPEN Philadelphia Pa	A Simon	C Burtis
WPIC Sharon Pa	J Fahnline Jr	A C Heck
WPRA Mayaguez P R		
WPRO Providence R I	F R Ripley	J Ferri
WPRP Ponce P R		
WPTF Raleigh N C	R H Mason	H Hulick

— WQ —

WQAM Miami Fla	F W Borton	W E Davenport
WQAN Scranton Pa	E J Lynett	
WQBC Vicksburg Miss	O W Jones	C E Drake
WQXR New York N Y	E M Sanger	R D Valentine

— WR —

WRAK Williamsport Pa	G E Joy	L N Persio
WRAL Raleigh N C	F Fletcher	S Brown
WRAW Reading Pa	R A Gaul	H O Landis
WRBL Columbus Ga	W Herrin	A Timms
WRC Washington D C	C D Smith	D Cooper
WRDO Augusta Me	Q Crandall	H Dinsmore
WRDW Augusta Ga	W R Ringson	H Aderhold
WREC Memphis Tenn		
WREN Lawrence Kans	V Bratton	C Bilesner
WRGA Rome Ga	H Quarles	D Williams
WRHI Rock Hill S C		
WRJN Racine Wis	H R LePoidevin	F L Dechant
WRLC Toccoa Ga	V E Craig	E Church
WRLD West Point Ga		
WRNL Richmond Va	E S Whitlock	W R Selden
WROK Rockford Ill		
WROL Knoxville Tenn		J N Gilbert
WROX Clarksdale Miss	D M Segal	C Hicks
WRR Dallas Tex	C B Jordan	D J Tucker
WRRF Washington N C	W R Roberson Jr	G P Martin
WRRN Warren O	E J Pryor	C J Hurton
WRUF Gainesville Fla	G Powell	P Craig
WRVA Richmond Va	C T Lucy	D C Woods

— WS —

WSAI Cincinnati O	W A Callahan	W F Symons
WSAJ Grove City Pa	H W Harmon	D Smock
WSAM Saginaw Mich		V T Seaman
WSAN Allentown Pa	B B Musselman	R H Musselman
WSAP Portsmouth Va	T W Aydlett	E M Cronk
WSAR Fall River Mass	W T Welch	
WSAU Wausau Wis	B F Hovel	R R Richardt
WSAV Savannah Ga	H Daniel	M E Thompson
WSAY Rochester N Y	G P Brown	G P Brown
WSAZ Huntington W Va	M Rosene	L Kilpatrick
WSB Atlanta Ga	J M Outler	C F Daugherty
WSBA York Pa	L Vyner	W N Weaver
WSBC Chicago Ill		R O Miller
WSBT S Bend Ind		
WSFA Montgomery Ala	H E Pill	C Shelkofsky
WSGN Birmingham Ala	H P Johnston	G F Bishop
WSIX Nashville Tenn	J M Draughon	B E Porter
WSJS Winston-Salem N C	H Essex	P Hedrick
WSKB McComb Miss	G Blumenstock	R L Sanders
WSLB Ogdensburg N Y		
WSLI Jackson Miss	L M Sepaugh	C A Perkins
WSLS Roanoke Va	J H Moore	J P Briggs
WSM Nashville Tenn	H Stone	G Reynolds
WSMB New Orleans La	H Wheelahan	H G Nebe
WSNJ Bridgeton N J	P Alger	F Fekel
WSNY Schenectady N Y	G R Nelson	I P Beck
WSOC Charlotte N C	E J Gluck	L L Caudle
WSON Henderson Ky	H S Lackey	
WSOO Sault Ste Marie Mich	S R Pratt	E T Kaari
WSOY Decatur Ill	E E Lindsay	P A Wnorowski
WSPA Spartanburg S C	S J Brown	H R Beckholt
WSPB Sarasota Fla	J B Browning	J E Grant
WSPD Toledo O	E Y Flannigan	W Stringfellow
WSPR Springfield Mass	Q A Brackett	L A Reilly
WSRR Stamford Conn	H H Meyer	E L Markman
WSTP Salisbury N C	B P Beard	C Watson
WSTV Steubenville O	J Laux	J Troesch
WSUI Iowa City Ia	C H Menzer	C H Menzer
WSUN St Petersburg Fla	N E Brown	L J Link
WSVA Harrisonburg Va	F L Allman	D A Nichols
WSYB Rutland Vt	J H Weiss	N Ransom
WSYR Syracuse N Y	H C Wilder	A G Belle Isle

— WT —

WTAD Quincy Ill	W J Rothschild	U Whitman
WTAG Worcester Mass	E E Hill	E A Browning
WTAL Tallahassee Fla	T M Meyer	W A Snowden
WTAM Cleveland O	V H Pribble	S E Leonard
WTAQ Green Bay Wis	H R Evans	W J Stangel
WTAR Norfolk Va	C Arnoux	J L Grether
WTAW College Station Tex	S Mayer	H C Dillingham
WTAX Springfield Ill	J A Johnson	E C Swaringen
WTBO Cumberland Md	A S Becker	D Jefferies
WTCM Traverse City Mich	L Biederman	L Biederman
WTCN Minneapolis Minn	C T Hagman	M Fleming
WTEL Philadelphia Pa	H N Cocker	E D Hibbs
WTHT Hartford Conn	C G DeLaney	C S Masini
WTIC Hartford Conn	P W Morency	H D Taylor
WTJS Jackson Tenn	A A Stone	C Brummel
WTMA Charleston S C	R E Bradham	D M Bradham
WTMC Ocala Fla	T S Gilchrist	D R Richardson
WTMJ Milwaukee Wis	W J Damm	D W Gellerup
WTMV E St Louis Ill		
WTNJ Trenton N J	F J Wolff	E P Knowles
WTOC Savannah Ga	W T Knight	C M Gray
WTOL Toledo O	A Shawd	J Sheehan
WTOP Washington D C	C J Burkland	C M Hunt
WTRC Elkhart Ind	R R Baker	L W Zellmer
WTRY Troy N Y	W A Riple	W P Whitman
WTSP St Petersburg Fla	L L D Herron	W D Mangold
WTTM Trenton N J	P Alger	T P Kilmer

— WW —

WWDC Washington D C	G B Larson	R H Beville
WWJ Detroit Mich	H Bannister	H F Tank
WWL New Orleans La	W H Summerville	J D Bloom
WWNC Asheville N C	D S Ellas	C B Hoskins
WWNY Watertown N Y	T E Martin	M B Davis
WWPG Palm Beach Fla	D S Greenlief	P McGinty
WWRL New York N Y	W H Reuman	W H Reuman
WWSR St Albans Vt	W L Blake	T Boisvert
WWSW Pittsburgh Pa	F R Smith	R Harlow
WWVA Wheeling W Va	G W Smith	E L Keim

— WX —

WXYZ Detroit Mich	H A Campbell	C Kocher

Canadian FM Stations

VE9AK Toronto Ont	H Sedgwick	J Sharpe
VE9CM Montreal Que	R M Brophy	J Gettenby

Canadian AM Stations

— CB —

CBA Sackville N B		
CBF Montreal Que	O Renaud	E D Roberts
CBH Halifax N S		
CBJ Chicoutimi Que	V Fortin	J E Roberts
CBK Watrous Sask	J B Finlay	R L Punshon
CBL Toronto Ont		
CBM Montreal Que	O Renaud	E D Roberts
CBO Ottawa Ont	C P Wright	M W Gilbert
CBR Vancouver B C	I Dilworth	N R Olding
CBV Quebec Que	M Valiquette	C Frenette

— CF —

CFAB Windsor N S		
CFAC Calgary Alta	A M Cairns	E C Connor
CFAR Flin Flon Man	G B Quinney	R J Tate
CFBR Brockville Ont	J C Whitby	G W Anderson
CFCF Montreal Que	R M Brophy	J Gettenby
CFCH North Bay Ont		
CFCN Calgary Alta	H G Love	B Lamb
CFCO Chatham Ont	J Beardall	G Brooks
CFCY Charlottetown PEI	K S Rogers	R F Large
CFGP Grande Prairie Alta	C L Berry	G Sadler
CFJC Kamloops B C	I Clark	D Sharp
CFNB Fredericton N B	J S Neill	G B Cassidy
CFOS Owen Sound Ont	B Hawkins	B Vallins
CFPA Port Arthur Ont	R H Parker	R H Parker
CFPL London Ont	W J Blackburn	J Warder
CFPR Prince Rupert B C	C H Insulander	C H Insulander
CFQC Saskatoon Sask	A A Murphy	
CFRB Toronto Ont	H Sedgwick	J Sharpe
CFRC Kingston Ont		
CFRN Edmonton Alberta	G R A Rice	F Makepeace

— CH —

CHAB Moose Jaw Sask	H C Buchanan	A E Jacobson
CHAD Amos Que		
CHEX Peterborough Ont	H Cooke	A E Crump
CHGB St Anne de la Pocatiere Que	G T Desjardins	
CHGS Summerside PEI	R L Mollison	A McKie
CHLN Trois-Rivieres Que	L Trepanier	L Trepanier
CHLP Montreal Que	M Lefebvre	A Cloutier
CHLT Sherbrooke Que	A Gauthier	R Paquette
CHML Hamilton Ont		W Crawford
CHNC New Carslisle Que	Dr C H Howde	
CHNS Halifax N S	W C Barrett	A W Greig
CHOV Pembroke Ont		
CHPS Parry Sound Ont	G E Smith	L A Croutel
CHRC Quebec Que	J N Thivierge	A Nadeau
CHSJ St John N B	L C Rudoff	J G Bishop
CHUM Toronto Ont		
CHWK Chilliwack B C		

— CJ —

CJAT Trail B C	F C Aylen	F Fleming
CJBC Toronto Ont		
CJBR Rimouski Que	G A Lavoie	F C Coak
CJCA Edmonton Alta	G S Henry	G Shillabeer
CJCB Sydney N S	N Nathanson	A Vernon
CJCH Halifax N S		
CJCJ Calgary Alta		
CJCS Stratford Ont	S E Tapley	G Hildebrand
CJFX Antigonish N S	J C Nunn	G MacDougall
CJGX Yorkton Sask		A Mills
CJIC Sault Ste Marie Ont		
CJKL Kirkland Lake Ont		T G Watson
CJLS Yarmouth N S		
CJMH Medicine Hat Alta	J H Yuill	S R Sadler
CJOC Lethbridge Alta	N Botterill	J C Stewart
CJOR Vancouver B C	A H Chandler	
CJRL Kenora Ont	H Clark	P Whitebread
CJSO Sorel Que		
CJVI Victoria B C	M V Chestnut	J Sommers

— CK —

CKAC Montreal Que	P Lalonde	L Spencer
CKBI Prince Albert Sask	L Moffatt	T Van Ness
CKCH Hull Que	R Benoit	M Gebhardt
CKCK Regina Sask	H Crittenden	E A Strong
CKCO Ottawa Ont	G M Geldert	W McLellan
CKCR Kitchener Ont	W C Mitchell	T Hartman
CKCV Quebec Que	P LePage	M Belanger
CKCW Moncton N B	F A Lynds	A J White
CKEY Toronto Ont	J K Cooke	E O Swan
CKFI Ft Frances Ont		
CKGB Timmins Ont	H Freeman	E D Mott
CKLN Nelson B C	J Orr	R McKay
CKLW Windsor Ont	J E Campeau	W J Carter
CKMO Vancouver B C	D M Sheridan	R L Whiteside
CKNB Campbellton N B	C H Houde	L P Paquet
CKNW New W Minster B C		
CKNX Wingham Ont	W T Cruickshank	W T Cruickshank
CKOC Hamilto Ont	W T Cranston	L Horton
CKOV Kelowna B C	J W B Browne	J H B Browne
CKPA Port Alberni B C		
CKPC Brantford Ont	J D Buchanan	A Teague

U. S. AM Stations, Cont.

CKPR Port Arthur Ont — R H Parker
CKRC Winnipeg Man G Gaetz — A W Hooper
CKRM Regina Sask W A Speers — W McDonald
CKRN Royne Que
CKSF Cornwall Ont
CKSO Sudbury Ont D McGill — J McRae
CKTB St Catherines Ont — W H Allen
CKUA Edmonton Alta J B McRae — R Usher
CKVD Val D'or Que L Godin — G Pope
CKWS Kingston Ont J M Davidson — C McCurdy
CKWX Vancouver B C F H Elphicke — G Fairweather
CKX Brandon Man W F Seller — C E R Collins
CKY Winnipeg Man W H Backhouse — W A Duffield

— VO —

VONF St Johns Nfd W F Galgay

U. S. General Managers

— A —

Aarnes H KUSD
Aburty E A WHBQ
Adams J F KVOS
Adelman P KTBC
Akers J KSAN
Albright G F WKBV
Alexander J KODY
Alger P WSNJ WTTM
Allen E C WIBA
Allen E L KGIW
Allen P P WLVA
Allen T WALL
Allman F L WSVA
Amoo L R KSJB
Anderson E C WEST
Andrews L W KICD
Armstrong A N WCOP
Armstrong E H W2XMN
Arnoux C WTAR
Asch L L WBCA
Ashbacker G F WKBZ
Atkinson J R WHBU
Avery M B WLNH
Aydlett J E WCNC
Aydlett T W WSAP

— B —

Baker R R WTRC
Balch O H KSAL
Baltimore A C WBRE
Bannister H WWJ
Barham C WCHV
Barnett S W WOOD
Barrett H KRBC
Barroll H H WFBR
Barry J KBIX
Bartlett P R KFRE
Bates W H KTRB
Baudino J E KDKA KDKA-FM
Beard B P WSTP
Beard Mrs J P KBTM
Beaton W J KWKW
Becker A S WTBO
Beckner R M KIUP
Bell J C WBRC
Benson C W WIL
Bergstrom R KWLC
Bert S B WAKR
Berkeley K H WMAL
Bettinger H WRGB
Biederman L WTCM
Bill E L WMBD
Binyon R G KWAL
Bishop E E WGH
Bissell G F WMFF
Blackwell G C WBLK
Blake W L WWSR
Bliss S H WCLO
Blumenstock G WSKB
Bonebrake M H KOCY
Bochman W C WCOS
Borroff E R WENR
Borton F W WQAM
Bowen Mrs M P WIBX
Bowles R L WCLS
Boyle J J WJAR
Brackett Q A WSPR
Bradham R E WTMA
Bramble F L KWAT
Bramstedt A O KFAR
Brandt D
Bratton V WREN
Bray W E WMRC
Breen E KVFD
Brennen H K WJAS
Bridges W C WEAU WJMC
Bright A L KFPY
Bright H G WGBR
Brown F H KFRU
Brown F K KOMA
Brown G P WSAY
Brown J E WTZR
Brown J M KONO
Brown N E WSUN
Brown T L WHDL
Browning J B WSPB
Bryan R KVCV
Buford P KHBG
Bullen R KVNU KID
Burbach G M KSD
Burke H C WBAL
Burke J F KFVD
Burkland C J WTOP
Burns G L KNEL
Burton D A WLBC
Burwell J C WMBS
Buttram J W WHMA

— C —

Cagle G L KFJZ
Callahan WA WSAI
Calvert F R WLBL
Campbell H A WXYZ
Campbell M WFAA
Cappellini E R KALB
Capps G KLBM
Carmaine J KFSG
Carman F C KUTA
Carman H H WGBB
Carpenter D WKNE
Carpenter J D WKBB
Carroll J KWYO
Carroll J D KMYC
Carter H WMUR
Case J F KWON
Cassill H W WGNY-WKIP
Chapeau T WJHP
Chapman Mrs D KPAB
Chatterton C O KWLK
Chernoff H L WCHS
Chilton A L KSKY
Church A B KMBC-FM KMBC
Chytil J KELA
Cizek W WIBM
Clark P S KFH
Clement E WEIM
Clery E D WLBG WIBG
Clinton G H WPAR
Clipp R W WFIL-FM WFIL
Clough C E KWFT
Clough L KLUF
Cobb W E WMAZ
Cocker H N WTEL
Coleman G D WGBI
Coleman R J WKAR
Collins K B KMJ
Conley J B KEX
Connor N KRKD
Conroy J J KBIZ
Cook C R WJPF
Cooley J B KLPM
Coombs C F KARM
Cooper V N WJLS
Corrigan B C KOWH
Cosby C G WINS
Coulson W L W9XEK WHAS
Covington G W WCOV
Craig V E WRLC
Crandall Q WRDO
Craney E B KGIR
Cranston G WBAP
Crawford Miss L KFGQ
Crew S E WCBT
Cribb W W KHMO
Crilley G C WJEJ
Croft J M WJPA
Crosland D WCRS
Crowell H C WDLM WMBI
Cuff S H WABD
Cunningham P H KWOC
Curtis J R KFRO

— D —

Dabadie J R WBRL-FM WJBO
Dady R KWK
Dahl H WKBH
Damm W J WTMJ WMJT WMFM
Daniel H WSAV
Daniel R C WCAE
Davenport J A WATL
Davis H W KMAC
Dean R J KOTA
Degner H A KOCA
DeLaney C G WTHT
Dellar L KSFO
Denny C E WERC
Diehm VC WAZL
Dillard E L KOZY
Dirks D KTRI
Ditamore J W WBAA
Dobyns M KGER
Donahue R WLLH
Doolittle F M WDRC-FM WDRC
Doss J R WJRD
Drake M KFOR
Draughn J M WSIX
DuMond J KXEL
DuMont A B W2XWV
Duncan L J WDAK
Dunlea R A WMFD
Dunn J WDAY
Dunn J W WNAD
Dyer G T WAIT
Dyer J A WGES

— E —

Eddy M KGFF
Eldmann B R WAAF
Elghmey F C KGLO
Ellas D S WWNC
Elvin R WLOK
Elwood J W KPO
England J A KFPW
Enoch R D KTOK
Esau J KTUL
Escoe A H KAND
Essex H WSJS WMIT
Evans H R WTAQ
Ewing P K WJBW
Ewing W C WFNC

— F —

Fahnline J WPIC
Fahy A A KABR
Fairbanks L A KFIZ
Falknor F B KMOX
Falter H WJLD
Fast H E WKRC
Fay W WHFM
Feagin R WPDQ
Fedderson D KYA
Fellows H E WEEI
Fern C J KOTH
Fetzer J E WKZO
Fisher B F KJR
Fisher J KVIC
Fitzer D WDAF
Fitzpatrick L WJR
Fitzsimonds F E KFYR
Flaherty E T KSCJ
Flamm S J WPAT
Fletcher F WRAL
Fletcher H H KSEI
Flinn W F KRJF
Forrest W C WIBU
Foster R D KWTO
Fox S S KDYL
Franklin E P KJBS
Frechette G T WFHR
Frey E J WBRY
Fry P KBON
Fultin J WGST
Fuqua J B WGAC

— G —

Gaither F WGST
Gallagher J L WHBY
Garland C KTFI
Garner J E KFPW
Gatchell C E WGAN
Gaul R A WRAW
Gavin D W WCOC
Georges B WHEB
Giesel H A WBCM
Gilchrist T S WTMC
Gillin J J WOW
Gilmore M E KBPS
Gimbel B WIP WIP-FM
Given K D WLBJ
Glasgow R E WACO
Gleeson W L KPRO KPOR KARO
Glidden H D WAGM
Gluck E J WSOC
Goan W H WAYS
Goddard F G KXRO
Godofsky E I WLIB
Gordon J E WNOE
Gordon K S KDTH
Gorman M C WGAU
Graham A W WKST
Gray G KOIL
Gray H M WJBL WLOU
Gray J S WCED
Greenfield H WEVD
Greenlief D S WWPG
Greenwood W WMAS
Griffith W I WOI
Grignon G W WISN
Grimes H KOME
Grimes J F WNBZ
Gross J O KFMB
Grossman H WOOC WOOW
Grove W C KFBC
Grubb G V WKY
Guernsey E E WLBZ
Guyer R S WBTM

— H —

Hackathorn K K WHK
Hacker L KVEC
Hager K WGY
Hagman C T WTCN
Hahn N H WIBA
Hald A WHIZ
Halff H A L WOAI
Hall L KPPC
Handley E KSRO
Hanna J KPDN
Hanna M R WHCU
Hanson R KUIN
Harmon H W WSAJ
Harpole W J KVOP
Harre A F WJJD
Harris C L WGRC
Harris W P WJDX
Hart F L WLPM
Hart J P WBIR
Harvey H C KNOW
Hasbrook C P WCAX
Hathaway D L KDEN
Havens W M WMBG
Hawkins J KIUN
Hayek E L KATE
Hayes A H WABC WABC-FM
Hayford B WDLP
Heath W KMMJ
Heller L J WINX
Helms R B WHLN
Hendrick L L KRRV
Henkin M KSOO
Herrin W WRLB
Herron L L D WTSP
Herrmann E H WWZR
Hewes E C WDAN
Higgins G KSO
Higgy R C WOSU
Hill E E WTAG WTAG-FM
Hilliard L L KGKY
Hinkie F WHBC
Hinlein M J KDRO
Hirsch O C KFVS
Hoffman E WMIN
Hoffman G C KGGM
Hoffman P KRNT
Hogan H KWBU
Hogue H M KTKN
Hohenstein H H KFUO
Hollinger F KDB
Hollingsworth R KGNC
Holt H R WGGA
Holt T WAPI
Hopkins J WJBK
Hovel B F WSAU
Hover F R WFIN
Howlett M A WBBR
Hubbard J H KXOX
Hubbard S E KSTP
Hughes B KEYS
Hull E C WHLD
Hunt R R KHUB
Hurt F E KFXD
Huss J W WJMS WATW
Hyatt F M WJHO

— I —

Ide F D KGB
Ingstad R E KOVC
Inman D E WNAX
Irwin V I KVI
Israel A M WALB

— J —

Jackson G WBOW
Jacobs L KBKR
Jacobson H S KXL
Jaren C L KGDE
Jarman J F WDNC
Jayne D E WELL
Jeffrey J C WKMO
Jennings G WBEZ
Jensen M C WCAL
Johnson A KOY
Johnson G W KTSA
Johnson L C WHBF
Johnson J A WTAX
Johnson K B WCOL
Johnson G C WDBO
Johnston H P WSGN
Jones E T KPLT
Jones E Z WBBB
Jones G KWSC
Jones H O WGCM
Jones M S WOL
Jones O W WQBC
Jones R KPQ
Jordan C B WRR
Jordon R P WDBJ
Joscelyn A E WCCO
Joy G E WRAK
Joy L W KYW-FM
Judge R KLRA
Judis B WNEW

— K —

Kadow F M WOMT
Kanna R WHTD
Karns A WIZE
Keegan H T WCFL
Keesee F L WMBO
Keich M KENO
Kellam K K KTHS
Kelley B WBBZ
Kelly J WCOL
Kettler S P WMMN
King C WEPR
King F WMBR
King L K KPAS
Kinnett M U WGPC
Kirchhofer A H WBEN
Kirchner T KGFJ
Kmety V WWZR
Knight N WAJR
Knight W T WTOC
Knuttl F R WORD
Kohn E E WFPG
Koph H C WMAQ
Korsmeyer E J WLDS
Kotnour F J WEDC
Krebsbach E E KGCY
Kreistein H R WMPS
Kroeck L F KTMS

— L —

Lackey F E WHOP
Lackey P E WPAD
Lackey H S WSON
Lahr M WKOK
Laird B A WOSH
Lambeth H M WMFR
Lambeth R N WGBG
Lancaster W H WJHL
Landis D KFYO
Landsberg K W6XYZ W6XLA
Lane F S WDEF
Lanford T B KRMD
Lang J WHOM
Lanphier C J WEMP
Larson G B WWDC
Lasker G WORL
Lasky P G KROW
Laughinghouse M J WGTC
Laughner R B WGIL
Laurie B KNET
Laux J WSTV
Lawrence C WHOM
Lawrence V KROD
Leavitt S KPAC
Lee J H WHAM
Legate J M WIOD
Leich C WEOA WMLL WGBF
LeMasurier D KILO KDAL
Leonard L WFMD
LePoidevin H R WRJN
Levenson W B WBOE
Levinson H Y WCAR
Levy L WCAU
Levinson H Y WCAR
Lewis R O KTAR
Linder A W KWLM
Lindsay E E WSOY
Lindsay L D KCRC
Lindsley R K KFBI
Little L KTUC
Locke C B KFDM
Loeb H M WFDF
Loggan F H KBND
Long D H WELI
Long E S WHKY
Lopez J WEAN
Lopez J T WICC
Lord N WAVE
Lottridge J B WOC
Lounsberry I R WGR WKBW
Lucy C T WRVA
Ludy B KCKN WIBW
Lund V H WAOV
Lynett E J WQAN

— M —

Maag W F WFMJ
Macandrew J F WYNE
Mackin J D WMAN
MacPherson J R KOA
Malzlish H KFWB
Maland J O WHO
Marget M M KVOX
Markham G E WGFM
Markward W H WCAM
Marshall G WMBR
Marshall T S WOLF
Martin H K WALA
Martin T E WWNY
Mason R H WPTF
Mason R T WMRN
Mastin C D WNBF-FM WNBF
Matheson R G WHDH
Mayborn F W KTEM
Mayer S WTAW
Mayes W KBWD
McBride W G WDBO
McBroom R G KFIO
McCarty H B WHA
McConnell C B WISH
McCormack J C KTBS
McCoy J D WAIM
McCrackenH L KVRS
McCurnin L L KWNO
McDaniel T KGBS
McDermott G B KBUR
McDermott J A WDWS
McDonald J M KRLH
McGowan J C WLOG
McGregor G M WJBC
McIntyre F C KID
McLaughlin C A WIBC
McLaughlin R WENR
McMurry E H WJPR
McNeil I A KGFX
McNeil J H WJZ
McRaney B WCBI
McSwain P WGNC
McTigue H WINN
Meagher J F KYSM
Medley M L WHUB
Memolo M F WARM
Mendelshon M L WBAB
Menzer C H WSUI
Merkle W W WPTZ
Merrill P KGLU
Metz J H WBRW
Meyer A G KMYR
Meyer H H WSRR
Meyer I WIGM
Michaels B KABC
Milbourne L W WCAO
Miller A KOAC
Miller R O WSBC
Miller W D KFJI
Miller W O WGAL
Mills P E WOWO WOWO-FM
Miner W WCBW
Mitchell L S WDAE
Mittendorf E S WLOL

U. S. General Managers, Cont.

Mobley E	WMSL
Montague P J	WHYN
Moody R H	WHIO
Moore J H	WSLS
Moore W I	WBNX
Morency P W	WTIC WTIC-FM
Morey G J	WNLC
Morgan C	KVGB
Morgan G B	KLO
Morgan J C	KLAW
Mosby A J	KGVO
Moss C G	WKBO
Mullen F	WEAF WEAF-FM
Mullinax E	WLAG
Mulrony M A	KGU
Murdock L	KSUB
Murdock M M	KFH
Murphy J A	KMO
Murphy J A	KIT
Musselman B B	WSAN
Myers C W	KOIN
Myers F O	KCMC
Myers T M	WTAL

— N —

Nafzger L H	WELD
Nassau J M	WEEU
Neath E A	KBRM
Neeld C W	WCBS
Nell J	KRIC
Nelson G R	WSNY
Nelson W M	WEGO
Newman L D	WCMI
Nichols H G	KFOX
Nichols H W	WHAI
Norin W	WBYN
Norman H R	WNBH
Normand O J	WCOU
Novik M S	WNYC-FM WNYC

— O —

O'Fallon G	KFEL
O'Halloran P	KPOW
O'Hara J M	WMAN
Ohl F	KWKH
Olsen T	KGY
O'Neil W M	WJW
Ormsby B W	KTBI
Orr B F	KTRH
Outler J M	WSB
Owen E	KBIZ

— P —

Pabst W D	KFRC
Pagliara N	WEW
Paine C	WFEA
Palmer T B	KGO
Pangborn A X	KGW
Parrish B J	KOTN
Parsons L E	KAST
Patt J F	WGAR
Patterson R G	WAPO
Payne A W	WHDF
Peffer E F	KGDM
Pengra M H	KRNR
Peters L W	KIEV
Peterson N C	KGNO
Peterson O H	WHLB
Pettey H L	WHNF
Phillips G	KIDO
Phillips J S	WGKV
Pidcock J F	WMGH
Pill H E	WSFA
Pittman C W	WBML
Pitts B	KFEQ
Podeyn G J	WHJB
Pollard W H	WBHP
Pollock R	KDON
Potter H O	WOMI
Powell G	WRUF
Powell H J	KGGF
Poynor D J	WMBH
Pratt S R	WSOO
Pribble V H	WTAM
Price F	KFKA
Priebe R E	KRSC
Prosser J I	WKAT
Pryor E J	WRRN
Pyatt A	KUIL
Pyle W D	KVOD

— Q —

Quarels H	WRGA
Quarton W B	WMT
Quigley S B	WMOB

— R —

Rapp J C	KMA
Redmond A K	WHP
Reichert M J	KGCU
Rembert G W	KRLD
Reuman W H	WWRL
Reynold G A	WSM-FM
Reynolds J B	WKWK
Reynolds R O	KMPC
Richards G P	WHBL
Richardson O E	WJOB
Richmond R W	WHKK
Ridge E	WBIG
Riesen A	KVSO
Righter G H	WATN
Rines W H	WCSH
Ringson W R	WRDW
Riple W A	WTRY
Ripley F R	WPRO
Rivers E D Mrs	WGOV
Rivers J S	WMJM
Rivers J M	WCSC
Roberson H P	KFDA
Roberson W R Jr	WRRF
Roberts I S	KGBS
Robinson A C	WDSM
Robischon F	KGHL
Roeder G H	WCBM
Rogers I E	WLAW
Rose R L	KWOS
Rosenblum D H	WISR
Rosene M	WSAZ
Rosenhaus I R	WAAT WAAW
Ross B	KSWO
Ross G	KWG
Rothschild W J	WTAD
Rowley R B	WICA
Royal J F	WNBT
Royster N L	WOLS
Rupard J N	KTSW
Ryan J M	WBTA
Ryan W B	KFI

— S —

Sanger E M	WQXR WQXQ
Schaefer C J	WGYN
Schafer W C	WDZ
Schepp R	WIRE
Schilling J T	WHB
Schilplin F	KFAM
Schreiber F P	WGN WGNB
Schroeder W	WINS
Schultz J W	WMVA
Schurz F D	WSBF
Scott C	KECA
Scott C P	KTKC
Segal D M	WROX
Seibert L O	KGKL KBST
Seitz F A	WFAS
Sepaugh L M	WSLI
Seston M	KROS
Shafto G R	WIS
Sharp F O	WFBM
Sharp I	KSL-FM
Sharp T E	KFSD
Shaw G	KLX
Shawd A	WTOL
Sheck M	WCAP
Shein A	WBTH
Shepard H V	KDNT
Shepard J III	WMTW WGTR WNAC
Shott H I Jr	WHIS
Shouse J D	WLW W8XFM
Shupe E	KVOR
Siebert L O	KGKL
Simmons A T	WADC
Simon A	WPEN
Simpson F B	WABI
Sims B	KEVR
Sipes L M	KELD
Sitton M A	WBBL
Slavick H W	WMC
Smith C D	WRC
Smith F R	WTNT
Smith G W	WWVA
Smith H E	WABY WOKO
Smith H M	WAML
Smith J C	WAGF WHBB
Smith O L	WNOX
Smith T F	KXYZ KEEW KRIS
Smithgall C A	WAGA
Smithgall C	WFTL
Smucker R C	KYUM
Smullin W B	KIEM
Snyder G	WLS
Sowell F C	WLAC
Spencer E L	KVOE
Sperry E J	WLAY
Spring J	WASK
Squier L E	WDEV
Stamps H W	KADA
Stanton M P	WORC
Stanton P J	WDAS
Stark C	WMCA
Steed H M	WLAV
Steketee L	WKNY
Stenger J H Jr	WBAX
Stevens H L	WHLS
Stoddard R L	KOH
Stone A A	WTJS
Stone B E	KOOS KVAN
Stone H	WSM
Stone L B	KIRO
Stone R B	WRGB
Streibert T C	WOR WBAM
Stubbs R F	KFNF
Studebaker H E	KUJ
Sudbury H	KLCN
Sulzer E G	WBKY
Summerville W J	WWL
Swicegood J	WKPT
Switendink C R	WBTA
Symons F	KFPY

— T —

Taft A	KOL
Taft W R	KRKO
Taylor A J	KRGV
Taylor D	WENY
Taylor I M	WEBQ
Terry H B	KLZ
Thomas A	WJAG
Thomas C L	KXOX
Thomas E A	KGFW
Thomas G H	KVOL
Thomas H	WATR
Thomas L	WNAB
Thompson E C	WEXL
Thompson L L	WABF
Thompson R F	WFBG
Thoms H H	WISE
Thornburgh D W	KNX
Thornton K	KXO
Thwaites E N	KFUN
Tinkham K O	KMTR
Tinsley T G	WITH
Tips K	KPRC
Tison W W	WFLA
Tobola J J	WAYX
Todd J	KANS
Tolboe C A	KOVO
Treloar D C	KCEZ
Trommlitz L W	KORE
Tully J C	WJAC
Twambly E H	WBEN

— U —

Ulmer J G	KGKB
Umberger H	KSAC
Upton E O	WBKB WGXBK WGXBT
Urban L	KORN

— V —

VanVolkenburg J L	WBBM-FM
Vinsonhaler S C	KGHI
Virgin W J	KMED
Vroman M A	KFXM
Vyner L	WSBA

— W —

Wade R E	KOAM
Wagenvoord F Jr	WJIM
Wagner P	WPAY
Wagstaff W E	KIDO
Walden P E	KWRC
Walker G D	WAIR
Walker W A	WFCI
Wallace F	KXA
Walsh J G	WDEL
Wannamaker A	WGTM
Ward G P	KTTS
Ward S O	WLAK
Wardell J G	KGBX
Ware W E	KWFC
Warner S W	KLS
Warren J C	KFFA
Watters M C	WCPO
Watts D L	KHAS
Way W B	KVOO
Weber F	WDSU
Webb F V	WGL

Fine instruments produced in volume with quality first . . . . to last.

Triplett

STANDARDS ARE SET BY TRIPLETT

ELECTRICAL INSTRUMENT CO.
BLUFFTON, OHIO

U. S. General Managers, Cont.

Weil R N	WOV
Weiland J	WFTC
Weir V H	WLEU
Weiss J H	WSYB
Weiss L A	KHJ W6XAO KHJ-FM
Welch W T	WSAR
West N	WCAU-FM WCAU
Westlund A	KRE
Whaley S	KUOA
Wheelahan H	WSMB
Wheeler E K	WENA
Wheeler C	KWIL
White A K	KPOF
White J A	WCRW
White K E	WMOG
White R B	WAWZ
Whitlock E S	WRNL
Whitmire B	WFBC
Whitmore W E	KGFL
Whitney N	WFVA
Whitney P	
Wick B	KDLR
Wiig G O	WHEC
Wike D A	KRLC
Wilder H C	WSYR
Wilkins D S	WJTN
Wilkins J P	KFBB
Willard A D Jr	WBT
Williams E	KFAB
Williams J P	WING
Willionis R B	KVOA
Williams W E	WJZM
Williams W J	WHAZ
Williams W V	WBLJ
Williamson W P	WKBN
Willis G P	WJNO
Willis J E	WLAP
Wilson D	KPLC
Wilson E E	KEEW
Wilson L B	WCKY
Wilson N	WAWZ
Wilson W A	WOPI
Wimpy H	WPAX
Wing G	KROC
Winger E W	WDOD
Wixon H	KHQ KGA
Wolf E T	WBNS
Wolf F J	WTNJ
Woodruff H W	WRBL
Woodworth S	WFBL
Woodyard R B	WINK
Wright C J	WFOR
Wright J F	WILL WIUC
Wyler K O	KTSM
Wynne W A	WEED
Wyse W	KWBW

— Y —

Yates D E	KRBA
Young C S	WBZ WBZ-FM WBZA
Young G W	WDGY
Youngblood T D	WFIG

— Z —

Ziebarth E Q	WLB
Zimmerman G E	KARK

U. S. Chief Engineers

— A —

Absher P	WAYS
Adams E L	WHIO
Adams J	KWFT
Adams H E	WIBC
Aderhold H J	WRDW
Akerman B	WGST
Albee W R	WCSC
Alden G	WIRE
Aldrich D	WBOW
Alexander	KORN
Allen D K	WJBO WBRL-FM
Allen L L	WHJB
Alfonsi P A	WBOC
Allison E	WBIG
Alwin F	KWAT
Amoo L R	KSJB
Anderson S W	KFRE
Andresen E H	WBEZ
Andrew G	KROS
Anhalt H	WGYN
Antic J L	KIUP
Antony W E	KWKH
Appleman L H	WACO
Arendale J W	WJRD
Arvidson P A	WOC
Atherstone T	KFEL
Auglin A W	KPLT

— B —

Bailey B H Jr	KVOL
Baird R	KWSC
Baker B C	WDEF
Baker C	WLEU
Baker C W	KLPM
Baker F	WKWK
Baldwin J M	KDYL
Barkman R N	KFNF
Barnes B B	WAPO
Barnett G	KBIX
Bartlett F E	KSO
Batchelder E F	WKNE
Bates W H	KTRB
Bauer F	KWTO
Baum J R	WDWS
Beasley H	WHUB
Beck H	WGL
Beck I P	WSNY
Beck R	KTRI
Beck S	WING
Beckholt H R	WSPA
Beehler E G	KGEK
Belle Isle A G	WSYR
Bellwood L	KXO
Beloungy J J	WBBM-FM
Benonis J J	WCNC
Beville R H	WWDC
Biederman L	WTCM
Billington W E	KSWO
Binns F D	WLAC
Bishop G F	WSGN
Blatterman H L	KFI
Bledsoe W S	KFYO
Bliesner C	WREN
Bloom J D	WWL
Boatwright G	KPAC
Boehnker C H	WOSU
Bohnert R	WIGM
Boisvert T	WWSR
Boland T	KOH
Bookwalter L S	KOIN
Bourgeois A J	WNOE
Bower H	WKOK
Bowker G N	WFHR
Bowman L H	KNX
Boyd R P	WMFR
Bradham D M	WTMA
Brandt D	KPOW
Brannen C W	WAGE
Brautigam G	WLOL
Bremer F V	WAAW WAAT
Briggs J P	WSLS
Brolly A H	WBKB
Brott F J	KJR
Brown C W	WEVD
Brown G P	WSAY
Brown J E	WTZR
Brown L E	WBBZ
Brown R	KOME
Brown S H	WRAL
Browning E A	WTAG WTAG-FM
Brummel C	WTJS
Brunner R E	WBAL
Buchanan A W	KVRS
Buckley W C	KDB
Bullio R W	WBTH
Bullock M W	KFAB
Burdette C J	WORD
Burgan G L	WHDF
Burgoon G R	WFBG
Burke J P	WKIP
Burrichter D E	KRNT
Burtis C W	WPEN WPEN-FM
Bush R S	KRIS
Bushong V L	WIZE
Butler E H	KWFC

— C —

Cain C M	KDTH
Callicott C M	WJLD
Cannon R E	WINX
Capps G	KLBM
Caraway J B	WMLL
Carlson C C	WJBW
Carlson L T	WKBB
Carman H H	WGBB
Carmean W R	KEEW
Carpenter R H	WBCM
Carroll J D	KMYC
Casey J B	KRBC
Cassens G	WLDS
Caudle L L	WSOC
Cecil J	KRLH
Chandler H J	KRNR
Chandler V H	WMUR
Chapin M F	KGVO
Chapman T R	KPAB
Chiles W R	WIOD
Chinski J R	KXYZ
Church E	WRLC
Clark E H	WLOV WJLB
Clark F R	WFTL
Clark F C	KROC
Clary M H	KWBW
Clay W	WCLO
Clipard H L	WCOS
Clough L	KLUF
Coburn O G	KGEZ
Cochran H D	WBTA
Cofey V G	WMRO
Coln J	KXO
Cole G	KTBI
Cole H G	WSBF
Cole J	WNOX
Coleman M D	KCRC
Collins R	WFAA
Collins W G	KGB
Conant L C	WHLS
Conner B	KLCN
Cook W N	WCAR
Cooke K R	WGBI
Cooper D H	WRC
Cooper K H	KFKA
Corey J H	WABY
Cox F V	KTFI
Cozzens W D'Orr	KLO
Craig P	WRUF
Crain M M	WLBC
Crandon G F	WCSH
Crim D	WBAA
Cronk E M	WSAP
Crosthwait B	KWYO
Cuesta N	KWBU
Curry W F	KTTS
Curtis J R	KFRO

— D —

Dadisman A C	KFH
Dahlbacka A	WJMS
Dalbacka H	WATW
Damm F H	KFEQ
Daugherty C F	WSB
Davenport J P	WIS
Davenport W E	WQAM
Davidson W R	WAIM
Davis H C	KTSW
Davis M B	WWNY
Day H C	WGIL
Deaderick J G	WMPS
Dechant F L	WRJN
DeConnick L	WCOL
DeCosta L L	WCLS
DeGrafenreid D	KWON
DeLany R H	WHK
DeLaurentis V	WNAB
Denechand R	KECA
Dennis G	WAML
DeProspo J	WNYC
Dettman R A	KDAL
Dewing H L	WCBS
Dickson W	WABI
Dieringer F A	WFMJ
Dillingham H C	WTAW
Dillon P	WMIT
Dinsmore H	WRDO
Ditamore J W	WBAA
Dodds L F	KGGM
Doese L	WIBU
Dolde A	KPRO
Donovan J	WPDQ
Dorothy R M	KARM
Dotson G W	KXOX
Douglas J E	KBTM
Dowdell J T	WIBX
Downey C E	KROW
Drake C E	WQBC
Duben W F	WOMT
Dubuque J N	KXA
Duff J	WITH
Duncan R S	WHP
Duning L	WKBV
Dunn E C	KEYS
Durham H	KOCY
Durham M M	KTKN
Dutton C	KJBS


CL
★ LAPEL ★
Crystal Microphone
THINK ★ American
when you begin to utilize the conversions of military perfected voice transmission and electronic circuits that will be prevalent in the immediate post war period. Check the advantage of American Microphone quality. It is discernable . . . . it always is.
A G
Crystal Microphone
Public Address
C 6
Crystal Microphone
Public Address
C 7
Crystal Microphone
Public Address
JOBBERS
Get your name on the list now, to receive important announcements American will make when the war time job is done.
R C
Home Recorder
Crystal Microphone
American MICROPHONE CO.
1915 So. Western Avenue, Los Angeles 7, California

U. S. Chief Engineers, Cont.

Duty C E	KDON
Duty J T	WCOU
Dye R H	KGFX

— E —

Easum C M	KTOK
Eaves B	KODY
Ebel A J	WIUC WILL
Ebert S J	WSUI
Eckels A E	WCBM
Eckerman J	KICD
Egerton W G	KTSA
Elttreim O	KWLC
Elliot I A	KRJF
Elytt	KEX
Emch R	WKST
Eney I N	KYW KYW-FM
Esten P W	WGRC
Etheredge W C	WFBC
Evans A E	KGO
Evans C R	KSL-FM
Evans C W	KGA KHQ
Evans R	KWEW
Ewing G	KFXM

— F —

Fallain F D	WFDF
Farrar C L	WNAD
Faske A	WLIB
Feikert G S	KOAC
Fekel F	WSNJ
Fernyhough W	KPHO
Ferri J	WPRO
Flaherty J A	WDAF
Flanagan P T	WHIS
Fleming M	WTCN
Fletcher H H	KSEI
Flynn R M	KRLD
Foote D F	WOLF
Fox J F	WHLN
Frase E C	WMC
Fredericks J	KPAS
Freeman G A	KRSC
Freitag W O	KRKD
Frisk C C	KFMB
Fritze W B	WMIN
Frye A P	WDLM WMBI
Fuelling P	WHNF
Fulton J	WGST

— G —

Gallino J F	KBUR
Garba H C	WASK
Gardner K J	WHAM
Gardner K J	WHFM
Garland O K	WJHL
Garrison J	WBHP
Gartner R	WLOK
Gass W	KFVD
Gautney G E	WICA
Gavin D W	WCOC
Gehres F	WGBF
Gellerup D W	WTMJ
Gempp T	WHOM
Gemoets E L	KTSM
Gilbert J N	WROL
Gilbert L H	WNBF-FM WNBF
Gilles T A	WMBD
Giles T	WDZ
Gill T J	WHDL
Gillette A D	WCKY
Ginkel A J	WJLS
Gleeson W L	KARO KPOR KPRO
Godfrey E	WBAB
Goldenberg H E	WHB
Goldmark P	WCBW
Goodaker L R	WOMI
Goodrich H S	WBML
Gordon R M	WCAP
Gorman M C	WGAU
Graf S J	KUSD
Grant J E	WSPB
Gray C M	WTOC
Gray W	WCHV
Greaves G	KPO
Greene T A	WENY
Greene B	KGDM
Greenwood T L	WMOB
Grenier T B	WABF
Gresham S Jr	WISH
Grether J L	WTAR
Grether W P	WGH
Griese R	KVI
Griffiths A E	KOTA
Grinde K	KXRO
Grout H	WDEV
Grover N E	WKAR
Grove W C	KFBC
Groves W C	WGNC
Gunderson L	KHCU
Gundy P	KGHF
Gustafson L	KIEV
Guthrie W	KBND

— H —

Haapanen A	KWAL
Haas C H	KFSG
Hahn N	WIBA
Haigh R H	KFRU
Haldorsen O	WCAL
Hale R C	WCOP
Hales F B	WBRY
Haley J C	KVOS
Hamann G P	WBRC
Hamm J	WJBC
Hanson B	KWIL
Hanson O B	WEAF WNBT WEAF-FM
Hanks H L	WOLS
Hardison D E	WFTC
Harlow J R	WTNT
Harlow R	WWSW
Harrell H	WMJM
Harris C F	KMAC
Hartman H	KGLU KWJB
Hartwig L	KRGV
Harvey J B	KMOX
Hatfield J B	KIRO
Hathaway D L	KDEN
Haughaout J H	KTAR
Hauser W H	WBZ WBZ-FM
Haverkamp H O	WYNE
Hayford B	WJHP
Hearin A W	KELD
Heck A C	WPIC
Hedrick P	WSJS
Hellums E R	KAND
Helt S	WLAP
Hennigan L P	WADC
Henninger J H	WIBG WLBG
Henzly W	WMBS
Herrin W	WRBL
Herring E I	WMFD
Hewinson E	WMAS
Hibbs E D	WTEL
Hickman R	KGNO
Hicks C	WROX
Hiebert A G	KFAR
Hight J A	WLBJ
Hilker B R	KSTP
Hill J	WHKK
Hill W	WDNC
Hinckley G A	WLAW
Hiner T	KTRH
Hirsch O C	KFVS
Hixenbaugh G	WMT
Hoag D S	WBCA
Hodgkins R W	WGAN
Hoffman K B	WGR WKBW
Holbert V B P	KSAC
Holland H S	WFBM
Hollerith M	WISE
Holmberg B	WLB
Holselaw R	KVOA
Holt H	WOV
Holt R B	WHTD
Horstman E C	WENR
Horton J R	WBIR
Hoskins C B	WWNC
Host R	WEMP
Hough R	WMMN
Houts J	KYSM
Howard R V	KSFO
Hubbard J T	WAGF
Hudson J	WHMA
Hudson W	WAVE
Hughes B	KRIC
Hughes J C	WCOV
Hughes L E	WAGM
Hulick H	WPTF
Humphrey T R	WHYN
Hunt C M	WTOP
Hunt D T	KABR
Hunt L	KFJI
Hunt W	WHIZ
Hunter D	WMAL
Hurley N S	WAPI
Hurt E	KFXD
Hurton C J	WRRN
Hyatt F M	WJHO

— I —

Ing G	KONO
Irby J C Jr	KRMD

— J —

Jacker E	WAIT
Jacker E W	WGES
Jaffe H	KIUN
James G	KMYR
Jaren C L	KGDE
Jeffereies D	WTBO
Jensen R	WATR
John T	KRRV
Johnson A P	KBIZ
Johnson G	WFCI
Johnson G S	KOB
Johntz J A	KIDO
Jokinen E	WHLB
Jones A L	WAGA
Jones A M	KBST
Jones F	KGKL
Jones J V	WCBI
Jones M L	WCAO
Jones R	KVOS
Jorgenson T O	WEAU

— K —

Kaart E T	WSOO
Kalin T	WEIM
Karig M Jr	WALL
Kassner D E	KXEL
Keich G	WICC
Keim E L	WWVA
Keich M	KENO
Kelly T F	WHBB
Kennedy F M	KHJ-FM KHJ-LA
Kenney T C	KDKA-FM
Kenville G	KHUB
Kilchli J	KGHL
Killough R	WALA
Kilmer T P	WTTM
Kilpatrick L	WSAZ
Kimzey T	KFJZ
King F	WELI
King L	WAIR
Kingsley R J	WBEN
Kinnett C M	WGPC
Klichli J	KGHL
Knowles E P	WTNJ
Knowles C	WPAR
Kocher C	WXYZ
Kolesar J D	KMO
Kolsky R P	WJMC
Kotera W J	WOW
Krivitzky G	WKBZ
Krotzert H	WJTN

— L —

Laeser P B	WMJT WMFM
Lamy R	WEBR
Landis H O	WRAW
Landsberg K	W6XYZ W6XLA
Lang G W	WGNB WGN
Langford G E	KFPY
Laskey J M	WDSM
Laurie B	KNET
Lawson L	KATE
Layne C N	KID
Layton D	WALB
Lee C E	WKZO
Lee W P	WLAK
Leeman A	WKBH
Leffler R H	WBBR
Legleiter L	KVGB
Leonard S E	WTAM
Levy G	WCAU
Lewicki C	WEDC
Lewis G	WCAU-FM WCAU
Lewis J	KGFW
Lewis J E	KNOW
Lewis L L	WOI KFGQ
Lewis R	KGIW
Lidenton D	KWOC
Lind P C	KOL
Lindsay P G	WHEB
Link L J	WSUN
Lippencott E	KELA
Littlejohn L E	WFIL-FM WFIL
Livingston C	KTUC
Lodge W	WABC WABC-FM
Long E S	WHKY
Lounsberry W H	WEBC WDUL
Lovell H J	WKY

PEOPLE'S RADIO FOUNDATION

(CONTINUED FROM PAGE 33)

writers, could develop children's programs designed to inspire and to educate rather than to rasp the nerves of youngsters, could provide the people with public health information, instead of phony patent medicine blurbs.

Such stations could be used directly by labor in at least three ways:

1) As organizing mediums. An FM station can tell a trade union's story to prospective members just as effectively as commercial radio now booms the virtues of Wheaties, General Electric, du Pont and the National Association of Manufacturers. The code of the National Association of Broadcasters prohibits sale of time for solicitation of membership, but there is nothing in the law nor in FCC regulations which imposes such a restriction.

2) In times of labor-employer disputes, FM can ensure labor a chance to get its story to the public. Commercial radio is monopolized by employer interests and inevitably favors their side.

3) On all major issues — cost of living, full employment, reconversion, international affairs — labor can use FM to make its views known and its position appreciated. The NAB code today forbids the sale of time for such union programs but, again, no governmental regulations restrict it.

The FM group which was initiated in New York for the purpose of establishing a station in that city gradually broadened in its composition. At the time it submitted its articles of incorporation for approval, its sponsors included:

Leon Barzin, Radio — Musical Director of Station WQXR
Joseph Brodsky, Attorney
Charles Chaplin, Actor
Joseph Curran, President, National Maritime Union, CIO
Howard Fast, Author
Bernard Fein, Radio Engineer
Frederick V. Field, Council for Pan American Democracy
Leo Gallagher, Attorney
William Gropper, Artist
Mrs. Ida E. Guggenheimer, Civic Leader
Leverett Gleason, Editor, *Reader's Scope*
A. A. Heller, Educator
Langston Hughes, Author
Albert E. Kahn, Author; President of Jewish People's Fraternal Order, IWO
Rockwell Kent, Artist; General President of International Workers Order
Corliss Lamont, Author, Educator
Dr. Robert L. Leslie, Editor-Publicist
Ray Lev, Concert Pianist
John T. McManus, President, New York Newspaper Guild, CIO
Samuel Novick, President, Electronics Corporation of America
Arthur Osman, President, Local 65, Wholesale Warehouse Workers Union, CIO
Earl Robinson, Composer
Joseph P. Selly, President, American Communications Association, CIO
Arthur Szyk, Artist
Margaret Webster, Actress and Producer
Dr. Max Yergan, Civic Leader, Executive Secretary, Council on African Affairs

Meanwhile, contacts had been established by the PRF with individuals or groups

(CONTINUED ON PAGE 65)

U. S. Chief Engineers, Cont.

Loyet P A	WHO
Lucas E	WPAT
Lubcke H R	W6XAO
Ludwick C	KHBG
Lund M R	WMAM
Luttgens H C	WMAQ
Lyon H H	WOL
Lyon J	WGAC

— M —

MacLafferty M L	KUJ
MacLafferty M L	KRLC
Maddox C H	KTBS
Magee T	WKAT
Magin T G	WDAN
Malone E A	KUIN
Mangold W D	WTSP
Marcy A R	WFBL
Markman E L	WSRR
Marks F	WMCA
Marquardt K G	WIBW
Martin A F	WIZE
Martin G P	WRRF
Martino I A	WDRC WDRC-FM
Marx F L	WMCA
Masini C S	WTHT
Mason A	KOCA
Mason C	KFI
Matheson R G	WHDH
Mathiot J E	WKBO WGAL WEST WDEL WAZL
Mathis C	KCMC
Maxwell K	KUOA
Mayer H J	WHBL
McArdle J J	KFRC
McCartney H S	WCCO
McCauley H	KSRO
McCown R	KVIC
McCoy W W	WJAS
McCready S W	KVAN
McDowell L W	KFOX
McGinty P	WWPG
McIntire G	WJEJ
McKay J M	WLAG
McKenzie E T	WGBK
McKernan P	KRE
McLean T	WHCU
McNaughton H B	WQJR
Meares C W	WCBT
Meek R	WMBH
Menzer C H	WSUI
Metz J H	WBRW
Merkl G E	WHBY
Meyers W F	WJJD
Meyers W S	KFIZ
Mietzke R H	KWLK
Milburn E P	KHSL
Miller S	KORE
Milne G O	WJZ
Ming M M	KSKY
Minor M J	WBT
Minton B	WATL
Mitchell J H	WFLA
Mitchell J M	WFLA
Mitchell M R	WJR
Moler A R	KMBC KMBC-FM
Moore W P	WDAE
Morey G J	WNCL
Morgan O L	KMLB
Moritz R	KDLR
Morris U C	WPAD
Morrison H	KGKY
Morrison W E	WMAN
Morse F W	KLS
Moses E C	KPLC
Mulrony M A	KGU
Murphy H B	KIT
Murphy D	WGCM
Muse D W	WMVA
Musselman R H	WSAN
Myers H	KFWB
Myers M L	WPAY
Myhre W L	KFBB

— N —

Natzger L H	WBNS WELD
Nazak J	WMFF
Neal N A	WBOE
Nebe H G	WSMB
Nelson I	KFYR
Nelson W M	WEGO
Neuville G	WHIT
Newton R	WLLH
Nielson K	KLAW
Niemann E C	WCRS
Nichols D A	WSVA
Nickolay A	KTMS
Ninneman W	WLBL
Nutty G M	WAOV

— O —

Oakley R	KGER
O'Brien B C	WHEC
Obuchon H	KGFJ
Olson A E	KIEM
O'Malley A J	WQAN
Onens C E	WCAM
Orth J	WLVA
Osborn P H	W2XMN
Oschmann A W	WARM
Owen R H	KOA

— P —

Palmer G E	WKMO
Pappin R B	WCFL
Parker B G	KVAK
Parker E T	WNBH
Parker J W	WORL
Parker S	WNBH
Parrish B J	KOTN
Parsons V	KPPC
Pash W	KDRO KIUL
Patremio	WABD
Patterson N J	KSAN
Patterson T W	WMIS
Patton A D	KNEL
Paul G	WAKR
Peak E	KFJB
Perkins C A	WSLI
Perry G	KRBA
Persio L N	WRAK
Peters F T	WMRN
Petrich A	KILO
Phillips T	WERC
Pierce R M	WGAR
Plank R	WLAV
Podhaski L F	WHBU
Poole J W	WPAX
Poppele J R	WOR WBAM
Porter B E	WSIX
Primm W W	WEED
Prior T C J	WJAR
Provis J	KGIR KBRM
Pulley D	WDAK
Purcell W J	WGY WGFM
Pyle K W	KFBI
Pyle W D	KVOD

— Q —

Quill J C	WCAX

— R —

Raabe R W	WBBL
Randol H E	WBZA WBZA-FM
Ranft W Q	WFBR
Rankin G P	WMAZ
Ransom N	WSYB
Rasmussen P	KOVO
Ratts B H	WOWO WOWO-FM
Rees D H	KMED
Reilly L A	WSPR
Rekart A F	KXOK
Reuman W H	WWRL
Rex P	WISR
Reynolds C	WINS
Reynolds G	WSM-FM WSM
Ricciotti S	KGFF
Richardt R R	WSAU
Richard N J	WISN
Richardson D R	WTMC
Riesen A	KVSO
Righter G H	WATN
Ridgway H F	KVWC
Ritchey H	WINK
Roark C A	KGY
Robb E	WINN
Roberts G	WJW
Roberts W C	WBLJ
Robertson J W	WDBJ
Robinson I B	WMTW WGTR WNAC
Robinson K H	KTRH
Robinson O E	WCHS
Rockwell R J	W8XFM WLW
Roman E W	WFIG
Root P G	WJDX
Roser J V	WMSL
Rowe T L	WLS
Rueppel G E	WEW
Runkle E G	KCMO
Russell F W	WOOD
Ryan J M	WBTA

— S —

Sakoski C	WBRE
Sampatt E	WGGA
Sanders E	WFOR
Sanders L M	KFDM
Sanders R L	WSKB
Sandlin G	WLAY
Sardi O A	WOKO
Savold S J	WDAY
Sawyer M F	WJPF
Sawyer R	KGLO
Schenke R M	KHMO
Schissler P H	KPOF
Schoeny E	WEOA
Schofield H	KXL
Schow R	WFEA
Schroeder R J	KMA
Schultz J	WCAE
Schultz A	KEVR
Schultz A F	KFUN
Schulz P	KYA
Scott E	WDLP
Seaman V T	WSAM
Seay L	KTBC
Secrist C	KVNU
Selmes M	WGNY
Seltz F A	WFAS
Selden W R	WRNL
Sexton J	KALB
Shade H	KOOS
Shatto L	KERN
Shaw P	KTEM
Shearer H	WEEU
Sheehan J	WTOL
Shelkofsky C	WSFA
Shepard H V	KDNT
Sheppard J B	KGKB
Shubert N	WFIG
Sigman L	KMPC
Simms J	KVOP
Sinclair D G	KVFD
Singleton H	KGW
Sinnett R J	WHBF
Sjostrom C J	KOVC
Sliker K L	WHBC
Smith A	WKAT
Smith A H	KSCJ
Smith E C	WFIN
Smith H	KPAB
Smith R H	WOPI
Smith R L	WRGB
Smith R S	KLX
Smock D	WSAJ
Snider R	KTUL
Snowden W A	WTAL
Solbrig A L	WBNX
Spargo P W	KWKW
Spence R C	WAJR
Spencer H W	WBTM
Spencer S	KGBS
Stafford L S	KOAM
Stahl V	WCED
Staley M	KSOO
Stangel W J	WTAQ
Steadley J	WEXL
Steady L G	WLNH
Stenberg L S	KWLM
Stenger J H Jr	WBAX
Sterling F	WOAI
Stewart A W	KBWD
Stewart J W	WGOV
Stiehl J H	WHA
Stiles W J	WEEI
Stinson L W	KVOO
Stinson R C	WBAP
Stoker W C	WHAZ
Stone E J	WELL
Stoup C	WIL
Strang H C	KVOR
Strasburg S	WJOB
Stratton C W	WHOP
Straub N L	WJAC
Sultt C L	KTHS
Summerford D C	W9XEK WHAS
Summerville W H	WWL
Sutton R B	KPQ
Swanson D	KMMJ
Swaringen E C	WTAX
Swenson S J	W2XWV
Swillinger M	WGKV
Symons W F	WSAI

PEOPLE'S RADIO FOUNDATION

(CONTINUED FROM PAGE 63)

in Detroit, Mich.; Buffalo and Albany, N. Y.; Washington, D. C.; Manhattan Beach and Los Angeles, Calif.; Seattle, Wash.; Lancaster and Philadelphia, Pa.; Chicago, Ill.; North Canton and Cleveland, Ohio; Newark, N. J.; and Butte, Mont.

FM Community Stations ★ The experience which had grown out of these various efforts began to shape themselves in the idea of FM community stations.

The reasons for this were simple and quite natural. From the standpoint of financial considerations, estimating the cost and operation of an FM station in the first year at about $50,000, the financing of such stations could be effected only through a community of interests. The reasons for this are:

1) It is a sound assumption that the average FM station will not be able to produce profits in the first year of its operation, and probably not until it is well into its second year. (Present FM experiences are not normal.)

2) The absence of an FM network, for the time being, makes FM stations less attractive for national advertisers who are looking for coast-to-coast or far-regional coverage. Therefore, FM — at the start — will depend largely upon local advertisers who cannot afford high rates.

3) The large number of available FM channels, as compared with AM, will tend to hold down commercial rates if those channels are utilized.

These reasons are even more pertinent when we consider that practically all FM stations will experience a transitional period of audience-building during which their advertising rates will be necessarily low.

The fact that a large number of publishers, radio interests, and AM broadcasters are planning and preparing to operate FM stations does not lead to the conclusion that FM will immediately develop into a lucrative commercial set-up. Publishers' expenditures can easily be written off as advertising and publicity investment. AM stations and networks are naturally finding places in the FM band as a matter of protecting their future positions. Whether they will attempt to commercialize their FM stations on the same scale that they have done in AM broadcasting is an open question. Before that can happen, a number of basic policies will have to be decided by the FCC, such as the use of FM stations for AM programs.

There is still another aspect which must be considered. Some individuals and groups are entering FM broadcasting on the hypothesis that the evolution of FM will parallel the evolution of AM

(CONTINUED ON PAGE 67)

U. S. Chief Engineers, Cont.

— T —

Talbott E P	KROD
Tank H F	WWJ
Tate G D	WMRC
Tate J R	WEBQ
Taylor H D	WTIC WTIC-FM
Teitsel W M	KCRC
Testan P	WBYN
Thiel J	WFMD
Thomas J R	KPDN KFDA
Thomas M W	KQMA
Thompson M E	WSAV
Thron B K	WFPG
Thurman W B	WJZM
Tilley H H	WEAN
Timms A	WRBL
Tisdale J M	WIP WIP-FM
Titus J	KAST
Tobola J J	WAYX
Todd C M	WNAX
Toomey F A	KGCX
Torrey W	KGNC
Towne R C	KRKO
Tracy K F	KLRA
Travis E	KVEC
Tribley H	WGTC
Troesch J	WKNY WJPA WSTV
Trueblood D B	WGBR
Tucker D J	WRR
Tysor B	WBBB

— U —

Ulrich C W	WAAF
Unterberger F	WDAS
Upchurch G W	WKPT
Urie H	KSUB
Utter R	WWZR

— V —

Valentine R D	WQXR WQXQ
Vance N E	KSAL
VanDusen V O	KGHI
VanHorn J M	KFPW
Venes T L	WBNY
Vessels J C	WDOD
Vordermark E B	WMBR
Vose H E	KVOX
Voss V H	WIND
Vrindten J	WMFF

— W —

Wada J	KOTH
Wahlquist L O	KUTA
Walden P E	KWRC
Walker H	KADA
Wallace W N	KMJ
Warlick J H	WGBG
Warren J C	KFFA
Watson C	WSTP
Watters M C	WCPO
Waymire D	KFIO
Weagant C	KBPS
Weaver C W	WCMI
Weaver W N	WSBA
Wehrman H	KLZ
Weimer O E	KOWH
Weiner M J	WNEW
Welch W T	WSAR
Wesser C H	WENA
Wheeler H	KPRC
Wheeler L	KYUM
Wheeler L F	WHAI
White C R	WCRW
White D	KGBX
White H	KWOS
White K E	WMOG
Whitman U	WTAD
Whitman W P	WTRY
Whitney C	WDSU
Whitney P	WFVA
Wibby J	WLBZ
Wiedenbach F	WJAG
Wiggins W S	KVOE
Wilder J M	WMGH
Will R D	KVCV
Williams D	WRGA
Williams H B	WNBZ
Williams M	KCKN
Williams N	WOSH
Williams S	KBKR
Williamson B	KTKC
Williamson W P	WKBN
Wilson G A	WKRC
Wilson G W	WJPR
Wilson N	WAWZ
Wilson P	KMTR
Wilson R	WHLD
Winkler C	KFOR KOIL
Winn D L	KARK
Wirtanen C W	WIBM
Wirth M	WJIM
Witschen R B	KFAM
Wina R	KBON
Wnorowski P A	WSOY
Wolf P	KABC
Woodward M W	KOZY
Wood W H	WMBG
Woods D C	WRVA
Wooten S D	WHBQ
Wooten W	WGTM
Wright J	WBLK
Wright O C	WJNO

— Y —

Yarbrough J E	WDBO
Yarger C R	KSD
Young G W	WDGY

— Z —

Zehr N J	KWK
Zeigler P	KOY
Zellmer L W	WTRC

Canadian General Managres

Aylen F C	CJAT
Backhouse W H	CKY
Barrett W C	CHNS
Beardall J	CFCO
Benoit R	CKCH
Berry C L	CFGP
Blackburn W J	CFPL
Borrett W C	CHNS
Botterill N	CJOC
Brophy R M	VE9CM CFCF
Browne J W B	CKOV
Buchanan H C	CHAB
Buchanan J D	CKPC
Cairns A M	CFAC
Campeau J E	CKLW
Chestnut M V	CJVI
Clark H	CJRL
Clark I	CFJC
Cooke H	CHEX
Cooke J K	CKEY
Cranston W T	CKOC
Crittendon H A	CKCK
Cruickshank W T	CKNX
Davidson J M	CKWS
Desjardins G T	CHGB
Dilworth I	CBR
Elphicke F H	CKWX
Finlay J B	CBK
Fortin V	CBJ
Freeman H	CKGB
Frigon A	CBC Network
Gaetz G	CKRC
Galgay W F	VONF
Gardner W R	CKMO
Gauthier A	CHLT
Geldert G M	CKCO
Godin L	CKVD
Hawkins W N	CFOS
Henry G	CJCA
Houde C H	CHNC CKNB
Insulander C H	CFPR
Jean E	CHLN
LaLonde P	CKAC
Lavoie G A	CJBR
Lefebvre M	CHLP
LePage P	CKCV
Love H G	CFCN
Lynds F A	CKCW
McGill D	CKSO
McRae J B	CKUA
Mitchell W C	CKCR
Moffat L	CKBI
Mollison R L	CHGS
Murphy A A	CFQC
Nathanson N	CJCB
Neill J S	CFNB
Nunn J C	CJFX
Orr J	CKLN
Parker R H	CFPA
Quinney G B	CFAR
Renaud O	CBM CBF
Rice G R A	CFRN
Rogers K S	CFCY
Rudoff L C	CHSJ
Sedgwick H	VE9AK CFRB
Seller W F	CKX
Sheridan D M	CKMO
Smith G E	CHPS
Speers W A	CKRM
Tapley S E	CJCS
Thivierge J N	CHRC
Trepanier L	CHLN
Valiquette M	CBV
Whitby J C	CFBR
Wright C P	CBO
Yuill J H	CJMH

Canadian Chief Engineers

Allen W H	CKTB
Andrews G W	CFBR
Belanger M	CKCV
Bishop J G	CHSJ
Brooks G	CFCO
Browne J H B	CKOV
Carter W J	CKLW
Cassidy G B	CFNB
Chandler A H	CJOR
Cloutier A	CHLP
Collins E R	CKX
Connor E C	CFAC
Crawford W	CHML
Croutel L A	CHPS
Cruickshank W T	CKNX
Crump A E	CHEX
Doak F C	CJBR
Duffield W A	CKY
Fairweather G	CKWX
Fleming F	CJAT
Frenette C	CBV
Gebhardt M	CKCH
Gettenby J	VE9CM CFCF
Gilbert M W	CBO
Grieg A W	CHNS
Hartman T	CKCR
Hildebrand G	CJCS
Hooper A W	CKRC
Horton L	CKOC
Insulander C H	CFPR
Jacobson A E	CHAB
Lamb B	CFCN
Large R F	CFCY
MacDougall G	CJFX
Makepeace F	CFRN
McCurdy G M	CKWS
McDonald W	CKRM
McKay R	CKLN
McKie A	CHGS
McLellan W	CKCO
McRae J	CKSO
Mills A	CJGX
Mott E D	CKGB
Nadeau A	CHRC
Olding N R	CBR
Olive G	CBC Network
Paquette R	CKNB CHLT
Parker R H	CFPA CKPR
Peters G	CKVD
Pope G	CKUD
Punshon R L	CBK
Roberts E D	CBF CBM
Roberts J E	CBJ
Sadler G	CFGP
Sadler S R	CJMH
Sharp D	CFJC
Sharpe J	VE9AK CFRB
Shillabeer G	CJCA
Sommers J	CJVI
Spencer L	CKAC
Stewart J C	CJOC
Strong E A	CKCK
Swan E O	CKEY
Tate R J	CFAR
Teague A	CKPC
Trepanier L	CHLN
Usher R	CKUA
Vallins B	CFOS
Van Ness T	CKBI
Vernon A	CJCB
Warder J C	CFPL
Watson R G	CJKL
White A J	CKCW
Whitebread P	CJRL
Whiteside R L	CKMO

PEOPLE'S RADIO FOUNDATION

(CONTINUED FROM PAGE 65)

broadcasting. From this standpoint, they believe that they can go into FM on a *minimum basis* — minimum expenditure for equipment and studio, minimum operation and programming — and coast along until FM becomes "big time." Then, they believe, they can sell out at a big profit, or adopt a maximum scale of operation and programming along with the rest.

The development of AM broadcasting did proceed along such lines to some degree. But there have been many AM stations which did not turn out to be money-makers. Even if this were not so, it is not inevitable that the commercial development of FM would or must parallel AM experience.

FM broadcasting is likely to develop along lines which may provide surprises — and even shocks — to the commercial-minded. Once the radio audience discovers that it can listen to high quality musical transcriptions and interesting programs of entertainment and education without 60–90% commercial sponsorship, that audience is likely to prefer such programs.

But over and above this aspect is the possibility that FM program techniques may re-discover values which AM commercial broadcasting has long discarded or ignored. Among these values are those which may be defined as *community interest.* Community interest may be based upon language, or common culture; it may have a *folk genre.* Community interest may spring from civic enterprises, or the industrial character of a particular region. Community interest may combine several, all, or even additional elements.

The significance of this point may be best illustrated in the function of community newspapers as compared with the big circulation newspapers. The smallest villages and towns have their own daily or weekly newspapers. Those papers are supported and read and wield influence because they express the *community life* in its own terms.

FM radio, by virtue of its numerous channels and non-interference between stations — as well as its other superior qualities — is very likely to be discovered as the medium to express and serve such community interest and life insofar as radio is concerned.

Once this happens, all existing program concepts and values will have to be reinterpreted and revaluated.

We need not speculate in this development. It is mentioned here, along with all the other factors, to indicate that, at least in its initial stages, FM broadcasting will probably not serve as a medium for big-money national commercial programming. There will be no large scale investments in FM until the investors are sure of self-sustaining operation to start with.

(CONCLUDED ON PAGE 68)

PEOPLE'S RADIO FOUNDATION

(CONTINUED FROM PAGE 67)

and a guarantee of fair profits within a reasonably short time.

How, then, is FM broadcasting to be financed? As Major Armstrong has stated, "economic conditions . . . now limit the number of stations."

The formula which presents the solution to this problem is simple enough: FM stations will be financed by individuals and groups who are drawn together in a particular area on the basis of a community of interests in the establishment of such a station.

As a corollary of this formula, such a community group will regard commercial time-sales for profits as a subsidiary objective.

The experience of the group in the People's Radio Foundation, as well as those in the CIO, have lead directly into the discovery and adoption of this formula and its corollary.

It was the original plan of the PRF to set itself up as a non-profit membership corporation. Any profits to be made by its FM station through the commercial sale of time were to be re-invested in equipment and program improvement. Under the laws of New York State, a membership corporation owning a potentially profitable property, such as an FM station, is unfeasible. Therefore, the PRF became a stock corporation. Nevertheless, it will allot a minimum ratio of time for commercial programs because its main objective is to serve a community of interests rather than establish a profit-making business.

This is the concept which guides similar groups in other cities from Los Angeles to Buffalo, who are following the PRF plan.

Even the powerful CIO is heading in the direction of community FM stations. The policy of the national offices of the CIO, as indicated by Sidney Hillman and others, is not to own and operate FM stations. Various unions of the CIO, however, such as the UAW, previously mentioned, propose to establish their own stations. But even the UAW, along with several other big CIO unions such as the National Maritime Union and United Electrical, Radio and Machine Workers Union, etc. — are keenly interested in the PRF community plan.

How this PRF community plan works out in practice is illustrated by developments in Los Angeles. There, four or five individuals and groups were proceeding independently in probing FM possibilities. Responding to Konecky's articles published in a western newspaper, they wrote independently to the PRF in New York. The PRF then helped to bring them together and now they are working as a single organization in a concerted effort to establish a community station in Los Angeles.

A remarkable aspect of this situation is the fact that a "community of interests" is not necessarily geographic. For instance, individuals in Los Angeles are extending financial aid to the establishment of an FM station by the PRF in New York.

In this case, the community of interests lies in the desire of individuals and groups in every part of the country to establish FM stations *anywhere* which will provide labor with a radio voice. It is believed that the speedy establishment of such a successful FM station in New York will stimulate the establishment of similar stations elsewhere. Therefore, supporters of labor in every part of the country enthusiastically support the effort to put a New York community FM station on the air.

The preference for community stations, as I have indicated, even extends to big and powerful unions which have sufficient funds in their own treasuries to finance their own stations. The reason for this is quite practical. Labor unions do not desire to operate a radio station just to talk to their own members. Naturally, they want to establish themselves before as broad an audience as can be obtained. The best and quickest way of effecting such a broad audience is through community stations.

The application of this policy is reflected in the charter membership of the People's Radio Foundation of New York which includes the heads of such strong unions as the National Maritime Union, (CIO) New York Newspaper Guild, (CIO) Local 65, Wholesale & Warehouse Workers Union, (CIO) and American Communications Association (CIO). Thus, we will witness two opposite developments headed in the same direction; union-owned stations becoming community stations and community stations supported by labor unions.

NEXT MONTH'S ISSUE

Two articles of special interest, originally scheduled for this issue of *FM* AND TELEVISION, were put over to the April issue for lack of space. These were Part 2 of our Editor's series on new ideas for home radio installations, and the conclusion of James D. McLean's series on television station WRGB, at Schenectady.

Also scheduled for publication next month is the text of briefs filed at the FCC's Oral Argument on proposed frequency allocations by DuMont Laboratories and CBS, presenting both sides of the question as to the FCC's meaning of "temporary" as applied to the lower television frequencies. This is a matter to which the entire radio industry should give the most careful consideration, because of its effect on television development in the immediate postwar period.

If you want the job done right—

A group of Hytron engineers decided in 1938 that to get those ideal tubes for "ham" radio — they must build them themselves. Combining years of experience in tube manufacture with exact knowledge of the tube characteristics desired, they went to work.

First they concentrated their efforts. Low and medium power types were most needed by the majority of hams. Hytron was equipped to make them. Gradually the engineers translated ideals into a comprehensive line—v-h-f triodes and pentodes, low and medium mu triodes, instant-heating r.f. beam tetrodes, and sub-miniatures.

Hams themselves, the engineers knew their brain children would be given the works. They built the tubes rugged; rated them conservatively. And did the amateur go for them! The v-h-f types — HY75, HY114B, HY615 — soon became accepted standards. Today's WERS operators use them almost exclusively.

Performance in the proving ground of amateur radio was the proof of the pudding. You will find Hytron transmitting and special purpose tubes in war and civilian jobs of all kinds. Like the BANTAM GT and BANTAM JR., they are popular because they are built right for the job.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

BUY ANOTHER WAR BOND

ENGINEERING SALES

(CONTINUED FROM PAGE 8)

central New York and parts of Vermont and Massachusetts, is offering dealers an after-V-day plan which includes franchise protection, profit safeguards, advertising and promotion help, sales training, service suggestions, and the use of its spacious display room.

Philco: Has appointed T. A. O'Loughlin & Company, Industrial Building, Newark, N. J. as distributor for northern New Jersey and Staten Island. Head of the Company is Thomas O'Loughlin, connected with Philco sales since 1929, and recently put on the inactive list as a Captain of the Marines.

Tom Joyce: Resigned as general manager of RCA Victor's radio, phonograph, and television department. Because of his record of success in that capacity, and his promotion work on television, his future plans, to be announced after April 1st, are awaited with much interest.

Bendix: New appointments bring to a total of 25 the distributors for Bendix home radios. Latest additions are Graybar Electric for the San Francisco area including Utah; General Utilities Distributors, Inc., of Milwaukee, for Wisconsin and the upper Michigan peninsula; Republic Distributing Company, of Providence, for Rhode Island and three adjoining Massachusetts counties; D. K. Baxter Company, of Sioux City, for northwest Iowa, northern Nebraska, and all South Dakota except the 15 northeastern counties; Graybar Electric for Alabama, western Florida, and eastern Tennessee; and Lehr Distributors, 16 W. 61st Street, New York, for the greater New York territory.

Stromberg-Carlson: Has appointed the newly-established Better Home Products, Inc., as distributor for the Nashville, Tenn. area; Tri-State Supply Company for the Chattanooga area; and the Schiffer Distributing Company for the Atlanta area. These sections include some of the richest markets in the new South.

Motorola: Will distribute its line of radio receivers in lower Texas through Oakes Battery and Electric Company, 423 Texas Street, El Paso.

Admiral: Announces the appointment of Wallace C. Johnson, formerly midwest regional manager, as manager of field activities for the entire United States on all Admiral products.

Westinghouse: Has appointed Robert E. Burrows, formerly supervisor of advertising and sales promotion for the G.E. receiver division, as manager of general radio sales. He will make his headquarters in New York City.

FM ORAL ARGUMENT

(CONTINUED FROM PAGE 23)

co-channel long-distance interference than there would be to FM in the same frequency band on account of the larger number of stations.

Mr. Denny: Even assuming that the interference to FM and television might be exactly the same, indications are that television should get that lower band because we know that wherever FM is put in this Allocation, it is going to stay permanently. We don't know that to be true of television.

Dr. Wheeler's remarks are not convincing. If, eventually, there are 2,000 FM stations operating on the 90 channels proposed by the FCC, there will be only 22 Stations per channel. However, the T.B.A. proposal for the distribution of television stations in the United States, submitted by William A. Roberts, at the Oral Argument, calls for 445 stations on 12 channels, or 37 per channel. Dr. Wheeler, however, had in mind a total of about 100 television stations when he referred to the stations-per-channel ratio as favoring television.

3. If, then, the long-distance, co-channel interference below 84 mc. proves to be as serious as Dr. Wheeler and Mr. Norton predict, the FCC cannot feel that the 6 bands from 44 to 50 and 54 to 84 mc. will be of great value to television.

Does this indicate that the Commissioners have other, as yet undisclosed plans for the ultimate use of those frequencies? This would account for their proposal to move FM out of its present location in the spectrum to a place that the FCC has referred to repeatedly as the permanent FM band. It would also explain Commissioner Jett's statement about assigning television to the lower frequencies: "Therefore, the service that's temporary in character should take the interference; not the one that will be with the public throughout the entire future."

The services to eventually replace television might be emergency or railroad communications. However, that is pure conjecture at this time. So far, the FCC has given no hint of such a plan except in their proposal that these services may share time with television.

4. There is another possible explanation for the proposal to move FM. It is no secret that some radio manufacturers are already avoiding new contract undertakings in order to be free and clear for quick reconversion to civilian production. Since our military leaders took over control of WPB and the general civilian economy, they have made every effort to stop peacetime planning. Certainly they know that many manufacturers, particularly the larger ones, had their civilian equipment designs so far along as to be ready for a quick shift from war to peacetime production.

A very effective way to discourage such

planning and to wipe out the usefulness of what has been done would be to make a drastic change in operating frequencies. There is no public information to indicate that the War Department brought pressure to bear that might have influenced the FCC, but if that was the case, it would be in keeping with other efforts to tighten control of radio engineering effort until such time as it is no longer needed for the war effort.

It is not likely that the industry will have any explanation beyond the statements quoted here. And the to-move-or-not-to-move discussion of FM frequencies has gone on so long that the final decision from the FCC will be welcome, whatever it is. At least, the Commissioners have committed themselves to giving FM a permanent place in the spectrum with adequate room for future growth.

PROPOSED FM FREQUENCIES

(CONTINUED FROM PAGE 32)

cussion of Exhibit 380 has, however, indicated that the high-power stations ought to be placed at the upper end of the band instead of at the lower end as they are now operated. Whether or not the full advantage indicated by Fig. 3 with respect to the duration of Sporadic E interference will be realized fully, or some lesser value as indicated in Dr. Beverage's supplemental statement, remains to be seen.

Conclusion ★ It seems to me that the logical order of allocation in the 44- to 108-mc. band is:

Amateurs at the lower end;
FM in the center; and
Television in the upper end.

With FM starting at some point within its present band and expanding upward into a prospective 30 mc., it seems to me that, from a propagation standpoint alone, a more satisfactory service can be established than is promised for the upper end of the band. This can be done without encountering the risks inherent in moving bodily into another part of the spectrum about which information is admittedly incomplete.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

personal importance to our men as they fight their way farther and farther from home, and so Petrillo's activities have a magnified significance to them.

Certain it is that Little Caesar's arrogant disdain of the democratic principles for which our men are fighting is considered prime news by the Japs who write the scripts for Tokyo Rose. What they don't understand is that such news simply heightens the American's determination to speed the end of the war so they can straighten out some situations at home

(CONTINUED ON PAGE 82)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 81)

that developed while they were away. At the top of the list of what's been worrying them is a little man named Petrillo, who knows that several million men named Joe are coming back from doing things that our Washington administration only talks about. And that is reason enough for Mr. Petrillo to have a headache.

2. It is very difficult to get first-hand reports of events in which police FM equipment plays an important part. We are, therefore, greatly indebted to Chief Deputy Perry C. Bennett, of the Sheriff's Office, Belvidere, Boone County, for the following:

Last Christmas Eve, Sunday December 24th, 1944, about 8:00 P.M., everything at the Sheriff's Office was quiet and Sheriff Fred Smith and his wife were just leaving the place for a short visit with some relatives. I was sitting at the radio desk thinking that, in another hour, I'd be going home to my wife and three-year-old daughter, helping the wife put up the Xmas tree and place the presents around the tree so when the little girl got up the next morning, she would find Santa had been there.

The radio was quiet compared to other evenings, and everything was smooth except for one call inquiring about a drunken husband who had failed to come home with his pay check. All at once the telephone rang. It was the long-distance operator from Caledonia. She had an emergency call from Mike Richardson, operator at the Chicago and Northwestern's Caledonia depot. Mike shouted into the phone: "Get all the help you can, nurses, ambulances, doctors. The Viking left the rails about a mile east of Poplar Grove village!"

The word "Viking" meant one thing — the fast Twin City train from Minneapolis to Chicago, filled with holiday passengers, was in the ditch.

I notified Sheriff Smith and his wife to return to the office immediately and then put out a general alarm by radio to Rockford, District No. 2, State Police at Elgin, Winnebago County Sheriff, District No. 1, State Police at Sterling, and Beloit, Wisconsin State Police. The Sheriff and I left for the scene of the accident. Mrs. Smith took over the answering of the two telephones and operating the radio system. Within a half hour after this office was notified of the accident, there were 11 ambulances on the scene. Rockford sent over three squads and five ambulances, Beloit sent down six physicians to our two hospitals, Winnebago County sent over three squads, State Police at Elgin sent all of their men including Captain Hamlin and Lt. Fitzgerald, while District 1 at Sterling sent over a State Police Squad from Rockford. Many other ambu-

(CONCLUDED ON PAGE 83)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 82)

lances and officers kept arriving all the rest of the night in response to that alarm.

Arriving at the scene, we found that the train was a mile from any road, and the fields were filled with snow. The train was sitting on the tracks with engine and eleven cars. There were two coaches on the tracks, but the trucks under the coaches were all crumpled up underneath. Two coaches were lying on their sides way out in the field, where they had been thrown. Later we learned that the 12th and 13th coach had hit a broken rail and had been tossed out in the field, while the 14th and 15th coaches of the 15-coach train had stayed on the rails. The 12th coach had been empty except for a trainman. The last two coaches had soldiers from Truax Field at Madison, Wisconsin. They were invaluable in giving first aid and carrying the injured. We used the train for shuttling the injured back and forth to the ambulances waiting at the crossing ahead.

Within an hour and a half, all of the injured had been removed to the hospitals and were being given medical attention. There were 27 seriously injured and one dead. Another died later.

The Sheriff's squad car, standing at the crossing near the scene was the only means of communication. It was used numerous times to notify the hospitals when an ambulance load was coming in, and in obtaining more cots and other things needed at the scene. It was a God-send that we had a modern two-way radio system.

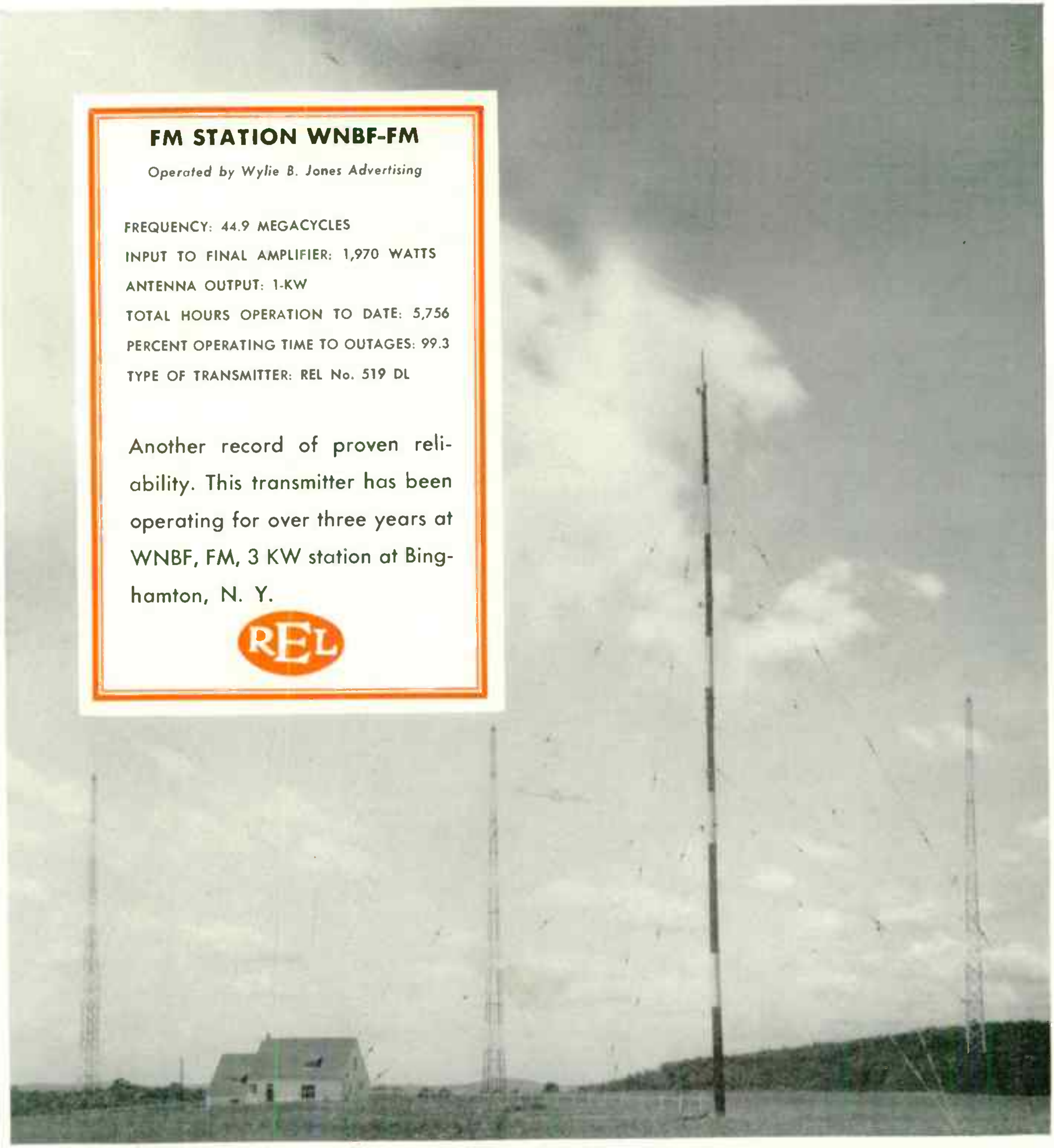
Many doctors who responded to the alarm said that if it hadn't been for the prompt removal of the injured to the hospitals for immediate medical attention, the death toll would have been higher.

In appreciation of the prompt removal of injured and in the well organized communications system at the scene the Northwestern donated to this office a substantial sum for the maintenance of our radio system.

I would hate to have to go through that same experience again without a 2-way radio system in operation. We would be handicapped seriously without it in a time like that. One onlooker among the people from this County who were standing around and watching the use of the two-way radio in the Sheriff's car, said: "And to think that some Board members were against the radio! They ought to be here and see how it works, and what it means to those injured and dying people over there in the overturned coaches!" An experience at a railway wreck like this would clinch any argument over county or municipal radio.

That's the way our 2-way radio system performed, the night the Viking was wrecked.


NEVER ALONE
Many thousands of Hammarlund
"Super-Pro" radio receivers
assist the Army Airways Communications System
in providing flight information
for Allied planes
in the skies everywhere . . .
Below we see a battery of
"Super-Pros" in action
Somewhere in the Pacific.
THE SIGN OF QUALITY
ESTABLISHED 1910
THE HAMMARLUND MFG. CO., INC., 460 W. 34TH ST., N.Y.C.
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT



FM STATION WNBF-FM

Operated by Wylie B. Jones Advertising

FREQUENCY: 44.9 MEGACYCLES

INPUT TO FINAL AMPLIFIER: 1,970 WATTS

ANTENNA OUTPUT: 1-KW

TOTAL HOURS OPERATION TO DATE: 5,756

PERCENT OPERATING TIME TO OUTAGES: 99.3

TYPE OF TRANSMITTER: REL No. 519 DL

Another record of proven reliability. This transmitter has been operating for over three years at WNBF, FM, 3 KW station at Binghamton, N. Y.

REL

Those broadcasters with experience in FM know the reliability performance that can be expected with the Armstrong Crystal-Controlled Phase Shift method of frequency modulation employed in REL transmitters of all power ratings. FM installations are our specialty—not our side-line. This accounts largely for our past successes. This specialization, together with the deeply-grounded knowledge and unusual experience of our staff of engineers will continue to lead the way for even greater success in FM expansion.

RADIO ENGINEERING LABS., INC.

Long Island City, N.Y.

RUMFORD PRESS
CONCORD, N. H.