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FM AND TELEVISION

DEC. 1944

FM FOR GREATER SAFETY & SPEED

Directory of R. R. Signal Engineers

★ ★ Edited by Milton B. Sleeper ★ ★

REG. U.S. PAT. OFF.

THE GIFT OF TELEVISION

Think of television as a gift long desired. It is — the answer to man's ageless yearning for eyes and ears to pierce the barrier of distance. It is man's oldest dream come true.

Through the screen of your postwar television receiver, the pleasures of tomorrow's peacetime world will come to you in overflowing measure. You'll see a rich, living tapestry woven from the glamor, the laughter and suspense of the theatre and the sports field. You'll enjoy a new kind of university for all the family...with magic carpet lessons...and world leaders as teachers. You'll thrill at a Twentieth-Century newspaper that mirrors events as they transpire; conferring on every man the honor of participating in things worthwhile, lifting him to new joy and new dignity in the history of the world.

But for the war, a DuMont Television-Radio Receiver might have been your most exciting gift this Christmas! We shall do our best, God willing, to bring to you and yours the gift of fine quality television before the next Christmas Season.

DUMONT *Precision Electronics and Television*

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

OFFICIAL U. S. NAVY PHOTOGRAPH
FROM FREDERICK LEWIS

EACH LST HAS TWO NATIONAL RECEIVERS

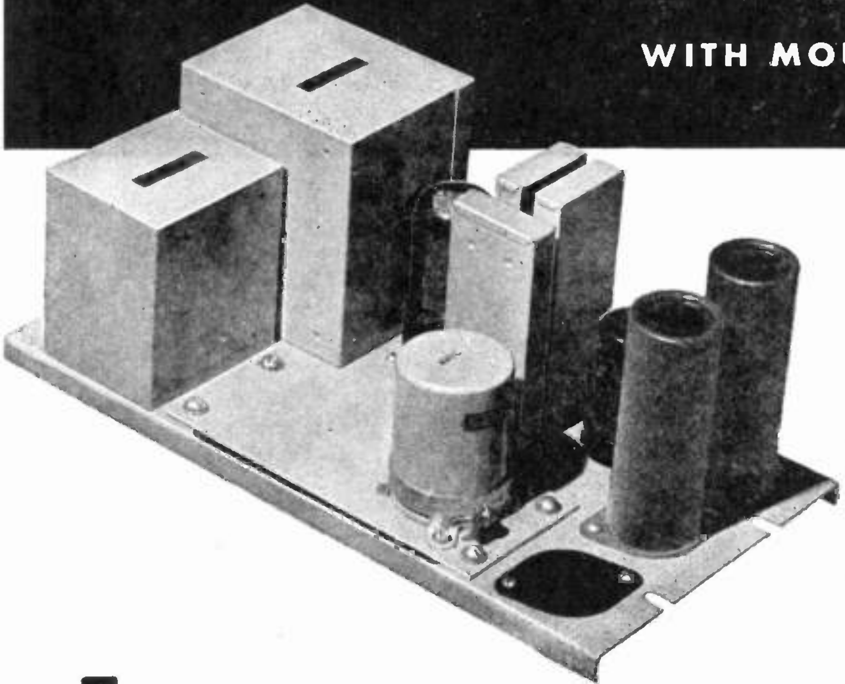
NATIONAL COMPANY

MALDEN, MASS., U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD

102 SERIES *Amplifiers*

WITH MOUNTING ACCESSORIES



TYPE 102-A—Two stage—Fixed gain 55 db. Input impedance 30, 250 or 600 ohms; output impedance 600 ohms. Frequency response 30-16,000 Cycles ± .5 db. Power output + 26 VU with less than 1% harmonic content. Requires external power supply 275 Volts DC 30 M.A., and 6.3 Volts AC .75 Amps. When a 102 Series Amplifier is used in conjunction with a 101 Series Amplifier, the latter is capable of supplying the necessary power.

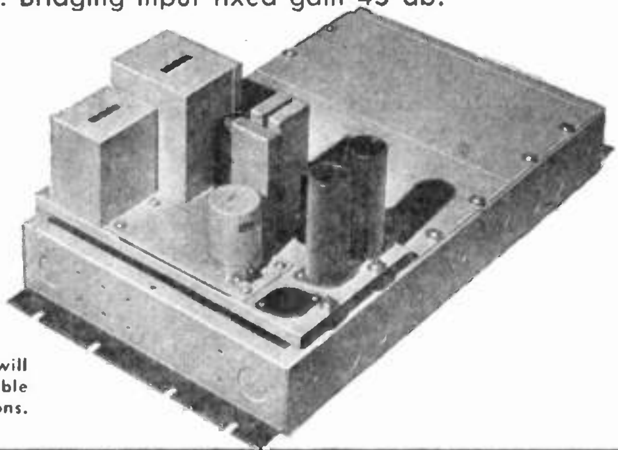
The 102 Series Amplifiers consist of four different amplifiers available simply by changing a small input panel on the master chassis. Except for the input panel, they all have the same transmission characteristics. Designed for the highest type audio service, they will meet frequency modulation requirements as to frequency response, power output vs. distortion and noise level.

TYPE 102-A as illustrated and described above.

TYPE 102-B—Three stage—Gain 95 db. Intended for high grade public address installations. Input stage electronic mixing.

TYPE 102-C—Three stage—Fixed gain 95 db.

TYPE 102-D—Two stage—Input impedance 600 ohms and bridging. Fixed gain 600 ohm input 61 db. Bridging input fixed gain 45 db.



The 3A Mounting Frame, requiring 10½ inches rack space, will accommodate up to THREE 102 Series Amplifiers and is suitable for wall mounting cabinet or rack and panel installations.

The Langevin Company
INCORPORATED

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FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 4 DECEMBER, 1944 NO. 12

CONTENTS

★ ★ ★ ★ ★ ★

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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, 240 Madison Avenue, New York City.

The publishers will be pleased to receive articles, particularly those well illustrated with photos and drawings, concerning radio-electronic developments. 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

EVER since 1914, radio manufacturers have been trying to develop radio communications equipment suited to the very special and exacting requirements of railway service. None of these efforts was successful until FM mobile units, similar to those used in police cars, were installed in Government arsenal yards. The highly satisfactory results renewed the interest of radio engineers in this great potential field. If railroad executives seem skeptical in their attitude toward this new effort, it is because they have seen so many failures. However, the application of FM to railroad use offers no insuperable problems, and we can expect this to be one of the next major fields of radio expansion.

WHAT'S NEW THIS MONTH

1. Change of Address
2. Rene Hemmes
3. TBA Conference

1. The New York offices of *FM* and Television have been moved from 240 Madison Avenue to larger quarters at 511 Fifth Avenue, New York 17. This address is at the corner of Fifth Avenue and 43rd Street. The new telephone is VAnderbilt 6–2483.

2. Rene Hemmes, whose name you will find on the contents page as Assistant Editor, has come to *FM* and Television after four years of teaching radio at Washington, where he has helped a great number of Army and Navy aspirants pass tests for radio ratings.

Originally from Great Barrington, Massachusetts, he is back home again, for our editorial department has been located there, on Radio Hill, for nearly a year.

In addition to being both a teacher and a student of radio, he has a wide background of practical experience, and he has held a first class operator's ticket since the days when, as a youngster, he sailed on fishing boats out of Boston — one of the roughest and toughest of all radio assignments.

His first undertaking for *FM* and Television is the preparation of text for the *FM Handbook*, a task for which he is eminently fitted. While the book is in preparation, certain of the chapters will be published in this Magazine. You will find in the *FM Handbook* a wealth of finely illustrated material that will be an outstanding contribution to radio engineering literature.

3. As predicted, the First Annual Conference of the Television Broadcasters Association was a tremendous success. The representation among advertising agencies was particularly large, but with smaller attendance from the radio manufacturers than might have been expected. However, the main ballroom of the Commodore Hotel, seating 1,000, was not adequate to accommodate all those who applied for tickets for the Monday night dinner where 28 television receivers, with 12-in. picture tubes, were set up to demonstrate reception from DuMont station WABD and NBC's station WNBT.

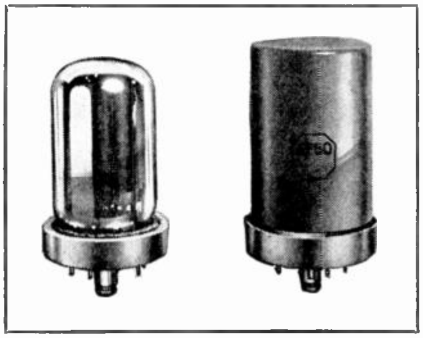
(CONTINUED ON PAGE 57)

SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

DECEMBER — *Published in the Interests of Better Sight and Sound* — 1944

Type EF-50 Pentode Found Useful at High Frequencies



Sylvania's Type EF-50 Amplifier Pentode, originally produced primarily for military purposes, has a number of unusual features that suggest many applications in postwar design.

The outstanding characteristic of the EF-50 is that it is designed to operate at 250 volts on both screen and plate, permitting operation at higher frequencies because of the resulting reduction in input loading.

Tube is provided with its own external shield, grounded through center lug, as well as internal shielding brought out on two terminals Since suppressor and cathode are brought out separately, 9 pins are needed.

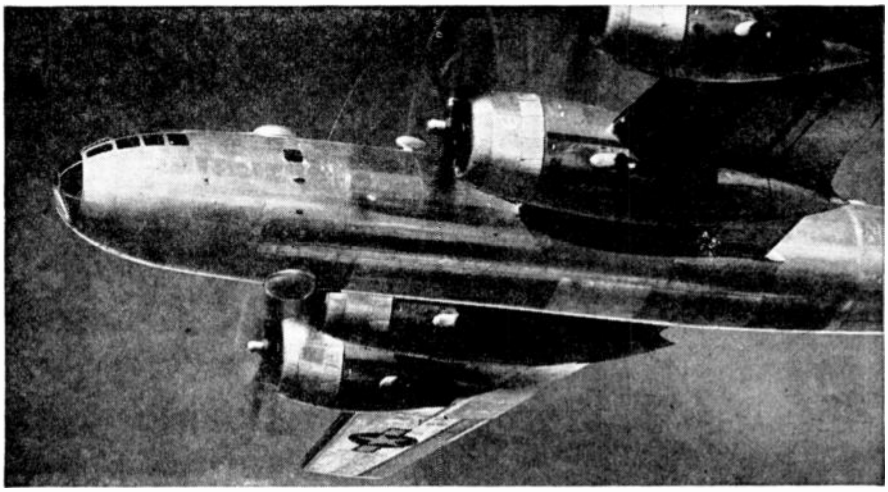
Full technical data on the EF-50 can be obtained from Sylvania.

"Next time you go bailing out, for heaven's sake grab a set with Sylvania Tubes!"

Sylvania Equipment Helps B-29s Report "Mission Accomplished"

Company's Tubes, Electronic Devices Extensively Used on Superfortresses

Radio communications equipment and electronic navigational aids have been developed to a new pitch of perfection aboard the giant Boeing Superfortresses, which have so convincingly demonstrated their ability to strike hard and effectively, deep within the enemy's territory, after flying from far-distant bases. The long operating range of the Superfortresses necessitates a complex electronic nerve system to assure close contact in flight, accuracy in reaching target, and safe return to base. Radio and electronic equipment — estimated to total approximately one ton for each Superfortress — includes the most modern navigational devices, in addition, of course, to the transmitters, receivers and other apparatus necessary for communication between crew members, between aircraft in flight, and between planes and their distant bases.



Exterior view shows the B-29 bristling with 50-calibre machine guns and 20 mm. cannon. The Superfortress is powered by four 2200-hp. engines, rolls on double-wheeled landing gear, carries electronic equipment such as is manufactured by Sylvania and others. (Boeing Photo)

Sylvania has made important contributions to the electronic equipment that helps make possible—and ultimately transmits—the terse, stirring message, "Mission Accomplished." Not only are many Sylvania tubes utilized in the various radio sets and control devices carried by the Superfortresses, but Sylvania is among the manufacturers supplying electronic equipment for the B-29s.

DID YOU KNOW…

That many industries use Sylvania Pirani tubes to measure pressures ranging from 1/10 to 1/10,000 mm?

★ ★ ★

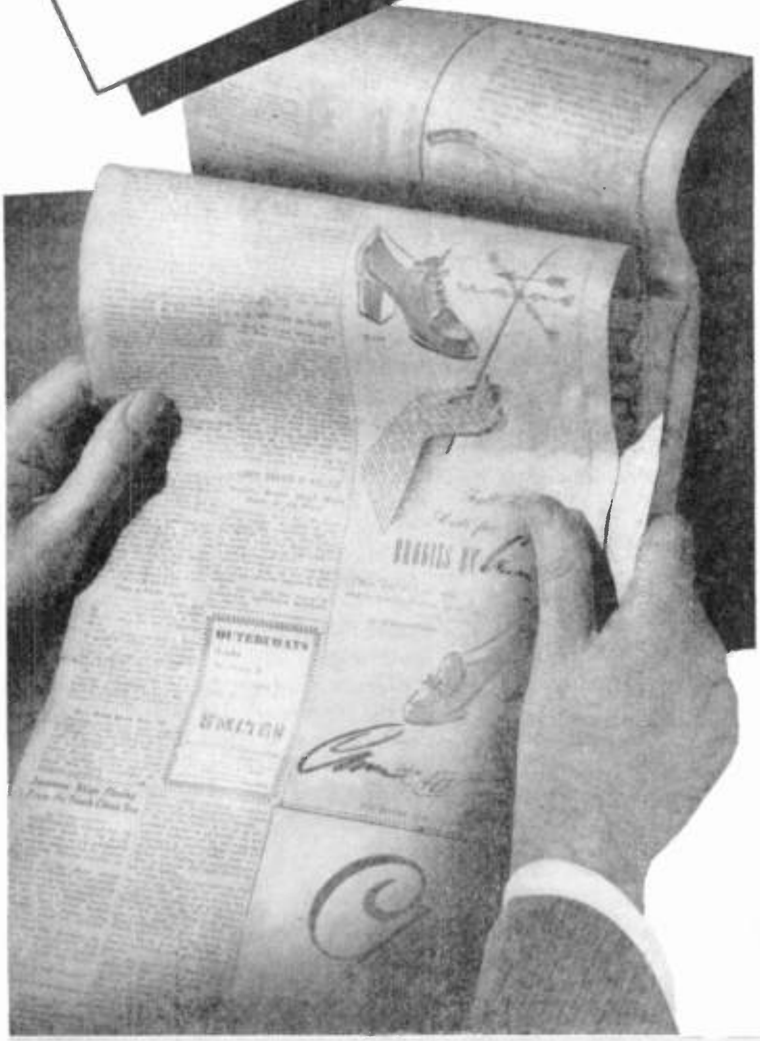
That newly defined life ratings for Sylvania Fluorescent lamps show that, in many applications, life expectancy is greater than previously indicated, when lamps are burned on long time-on cycles.?

SYLVANIA ELECTRIC PRODUCTS INC.
Radio Division · Emporium, Pa.

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

ADVERTISERS INDEX

WHO'S GOING TO PUBLISH THE FIRST FACSIMILE "NEWSPAPER" in your city?



Long before "Pearl Harbor," experimental radio newspapers, printed by Finch Facsimile, were beginning to appear in various parts of the country. To be exact, nineteen broadcasting companies took out Finch Facsimile licenses for this purpose. Among these were some of the most powerful stations, and some of the most powerful newspapers, in the country.

A central service bureau was set up, to prepare photostated copy almost like boiler plate and fly it daily to each associate broadcaster, in time to use the little used hours of early morning to broadcast (by amplitude modulation) what was called a complete newspaper, in time for breakfast.

Readers, upon arising, would find — rolling from their Facsimile Recorder — a continuous paper scroll of news, maps, photographs, cartoons, boxscores, market reports, cross-word puzzles — *and ads*. Some of these ads were to be national, secured and paid for by the central bureau; others were to be local copy pasted into the script by the broadcaster, in spaces provided in the photostats.

The F.C.C. then authorized multiplexing Frequency Modulation — sending audio and facsimile over the same wave bands simultaneously. This meant that Finch Facsimile could become a 24-hour service with license to sell time or space.

These developments make it more than probable that as soon as the Government gives the green light for non-essential production, highly developed self-sustaining facsimile newspapers or supplements will be started in many cities.

• • • • •

SPECIAL SERVICE FOR BROADCASTERS

Finch Telecommunications, Inc., holders of the essential patents for successful Facsimile operation, have established an Advisory Committee on Facsimile Publishing headed by Commissioner George Henry Payne, publicist, radio authority and author of The History of Journalism. Broadcasters wondering how to become publishers of the first successful Facsimile newspaper supplements in their cities are cordially invited to write us for further information.

FINCH TELECOMMUNICATIONS, INC.
PASSAIC, N. J.

Automatically synchronizing

finch facsimile

ENGINEERING SALES

RCA: Has appointed Radio & Appliance distributors, Inc. as distributor of RCA Victor products in the Chattanooga territory. This is a new concern, of which Mark H. Hays is president and Harry F. McCool is treasurer. Address is 410 Broad Street.

Motorola: Announces the appointment of Edward L. Pincus as district sales manager for the Middle Atlantic states, with Headquarters in Philadelphia. He was assistant sales manager for Elliott-Lewis, and later sales manager managed the eastern Pennsylvania territory for Trilling & Montague. Prior to joining Motorola, he was chief field expediter for Philco.

Lear: Nate Hast, 25-year veteran of radio sales, has joined Lear, Inc. as merchandising manager, in charge of styling and marketing their new line of civilian radio equipment. His headquarters will be at 230 East Ohio Street, Chicago.

Colonial: Former advertising agency head Terry P. Cunningham, who handled the Sylvania tube account, will be contact man between Colonial and their major home radio customer, Sears, Roebuck.

Bendix: Edward R. Hanslip, Jr., formerly southwestern district sales manager for Stromberg-Carlson, has joined Bendix as district manager. He will continue to make his headquarters in Kansas City.

Electronic Labs: Has appointed Walter E. Peck as sales manager. He has been a member of the engineering department for the last four years, serving in the capacity of both design and sales engineer. He was previously connected with Noblitt-Sparks.

Magnavox: Has appointed J. B. Sharpless as Milwaukee district manager. His territory includes Wisconsin, North Dakota, South Dakota, Minnesota, the northern peninsula of Michigan, and northern Illinois except Chicago. He will be located at 2218 North Summit Avenue, Milwaukee.

Made in Japan*

* Japanese components illustrated obtained from the Pacific war theatre for the UTC Research Laboratory

A recent UTC analysis of Japanese components substantiates the conclusive superiority of products of American design and construction . . . for example, on transformer components . . .

JAPANESE unit weighs **8 oz.**
. . . failed on 15 minute submersion test
. . . very narrow frequency range.

UTC hermetic ouncer weighs **1 oz.**
. . . takes full hermetic sealing tests
. . . has twice the frequency range.

MAY WE COOPERATE WITH YOU ON DESIGN SAVINGS FOR YOUR APPLICATION . . . WAR OR POSTWAR

UTC

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

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

HYTRON has made them all!

The march of Hytron receiving tube progress down through the years is fascinating. One looks back on tubes, tubes, and more tubes: battery, AC, AC/DC, diodes, triodes, pentodes, beam tetrodes, multiple purpose types, G's, MG's, BANTAM GT's — and now the miniatures. Price and size have been drastically cut; quality and performance, amazingly improved.

Hytron has made them all. Its long and varied experience is priceless in a complex industry where probably never will all the answers be known. In making radio tubes, painfully acquired practical experience must supplement the formulae of science.

With an eye to present and future, Hytron is concentrating its production of receiving tubes on preferred BANTAM GT types needed for war — for today's civilian replacements — and ultimately for post-war. Its wartime activities are teaching Hytron new techniques of miniature production. Many potentially popular Hytron miniatures are in development. Typical American dissatisfaction with anything but perfection continues; the parade of Hytron receiving tubes marches on.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

BUY ANOTHER WAR BOND

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, Taxis, 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 of 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!

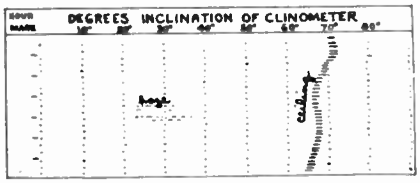
ALDEN

PRODUCTS COMPANY

117 North Main Street

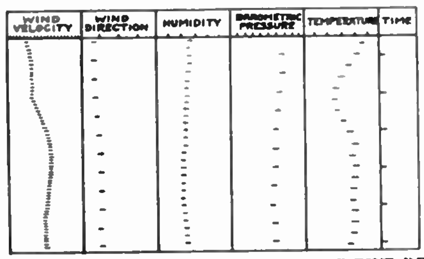
BROCKTON (64F1), MASSACHUSETTS

CATCHING THE CATHODE RAY SIGNALS IN A PERMANENT RECORD • Probably one of the greatest of all 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 a permanent record on paper of what can be seen instantaneously on the cathode ray tube screen.



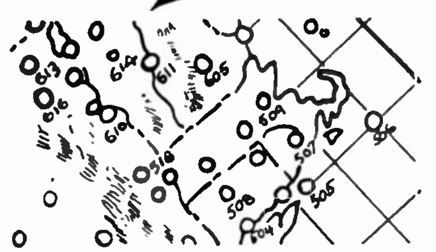
REFERENCE MARKS MAKE IT EASY TO INTERPRET RECORDING • This type of recording shows how standard or definite reference marks are recorded vertically for the accurate interpretation of received signals, whose intensity is indicated by shade and width of mark. Time intervals are impressed laterally.

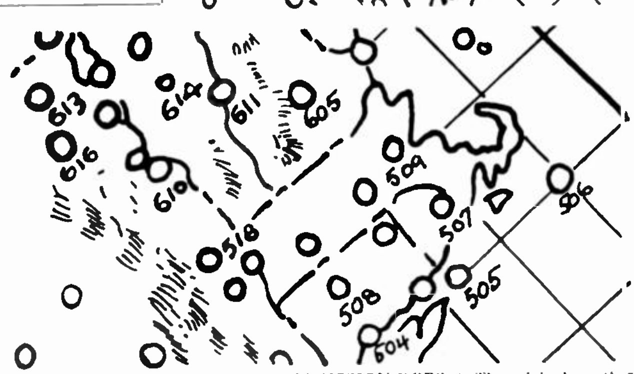
Alfax



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, recording rate of flow, pressure, velocity, temperature, humidity — is recorded day by day or hour by hour nearby or at a remote center.

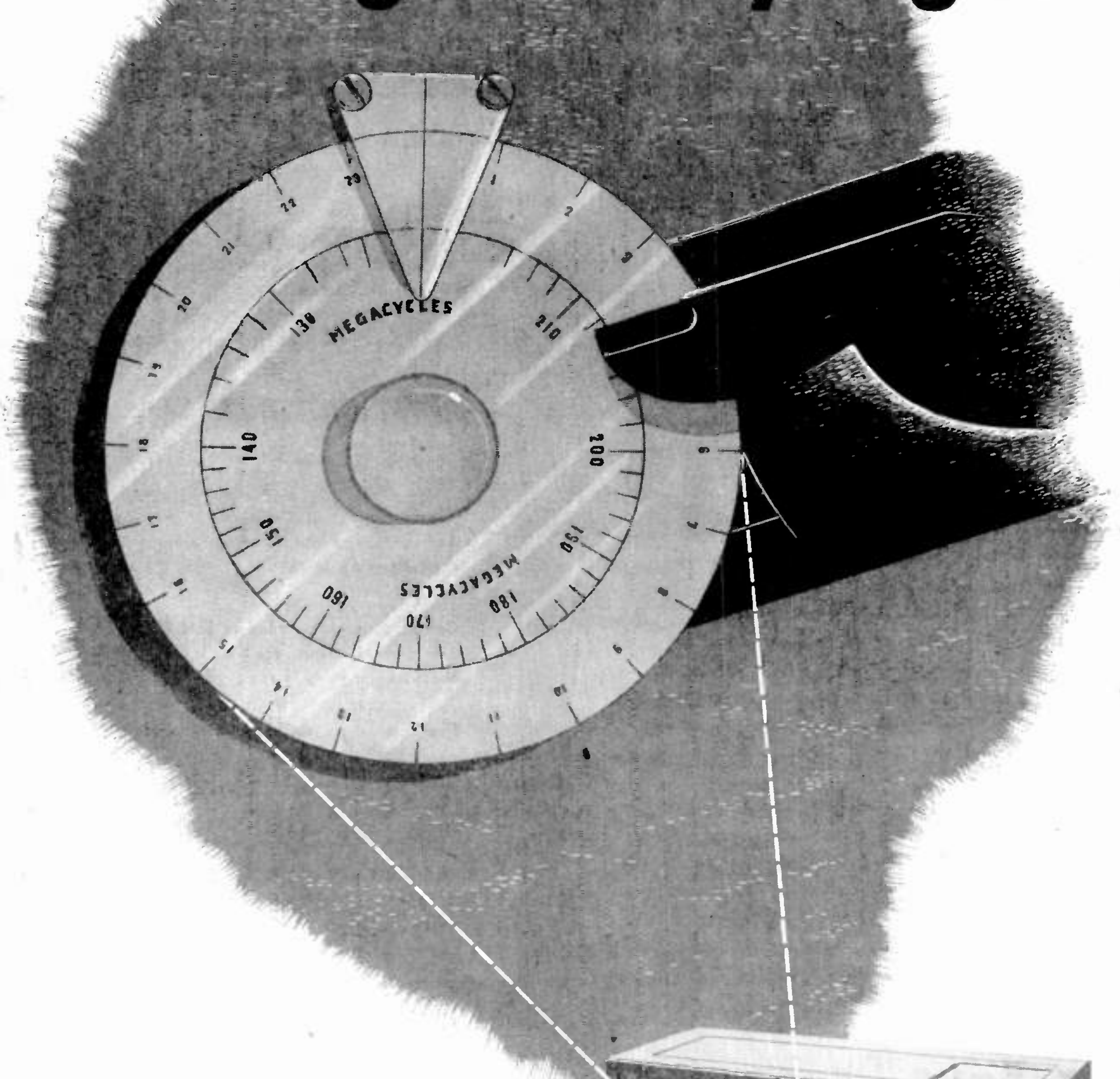
Alfax

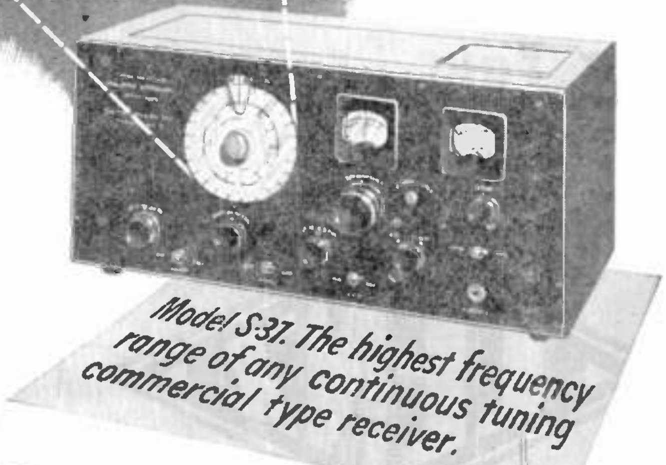




WHAT ENLARGEMENT IN TRANSMISSION DOES • The original weather map is transmitted as filled in, and enlarged one-and-a-half times during transmission. It shows the possibility of closely written information being received so it can be easily read, and on paper on which further drawing or writing can be added. In this instance, the forecaster can draw his own interpretation of the isobars. Again Alfax paper can be made translucent for printing or overlaying.

how high is very high?





★ Engineers at Hallicrafters are continually striving for new heights of perfection in high frequency development work. The Model S-37 is one example of the progress they have made. This is the first and only set of its kind—covering both AM and FM and operating in the range of 130 to 210 Mc. Two r.f. stages are used and in conjunction with an intermediate frequency of 18 Mc., assure an amazingly high ratio of image rejection. It is becoming a valuable instrument in the hands of all exploring the upper reaches of the high frequency ranges.

hallicrafters RADIO

Buy a War Bond Today!

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

A WEST COAST VIEW OF TELEVISION

Television's Problems as Seen by the Executive Vice President of an Independent Network

BY LEWIS ALLEN WEISS*

AMONG the various addresses delivered at the First Annual T.B.A. Conference, that by Lewis Allen Weiss was selected for publication because it brings out aspects of the television picture which have not been discussed by others.

Of particular interest is the reference to the position of the broadcaster who must risk a large capital investment in the hope that it will produce enough revenue to amortize the cost of television equipment before the progress of the art makes it obsolete and return some slight profit, at least. This is in contrast to the position of the receiving set manufacturer who risks only merchandise to the extent of one production release at a time, on which he can make an immediate profit.

Mr. Weiss speaks for the independent broadcaster who, though able to write off experiments with television against sales expense incurred in maintaining his competitive position, cannot draw upon such reserves as are available to the major networks, and must relate his pioneering in television to some reasonable expectancy of profit. At the same time, these are the broadcasters who will have to go into television before service will be available to the public on a national scale.

AT THE outset, I would like to pay tribute to those distinguished colleagues in the television broadcasting business who preceded me this morning. I was glad that the many guests at this Conference had the opportunity of hearing a realistic explanation, description, and analysis of those things that have to do with this art. You must have been struck, as I was, listening to those speakers this morning, by the wide contrast between their conservative statements and the processes still to be solved; the contrast between their expressions and the expressions of the animated and overly enthusiastic publicists who would lead you to believe that television is going to provide at least fifty million of the sixty million postwar jobs that we heard about over the air in November.

Some of the publicity I have heard about television is comparable to the story of the old darky preacher who, with all the fervor that only a darky puts into his prayers, was praying for rain to relieve the condition of the arid acres of his poor parishioners.

Either by coincidence or because of the efficacy of his prayers, it started to rain that night, and it rained continuously for two weeks. It not only irrigated the farms of his parishioners, but it washed them down the muddy river. At this point, the old darky preacher got down on his knees again and said, "Lawd, I knows I prayed for rain to help my poor flock, but what's going on now is plumb ridic'lous!"

As most of you know, I come from an area that is rather adept at superlatives, typical of which was at a meeting between two herring destroyers out there recently. Jake asked Sam: "How's business?" Sam replied: "It's colossal. In fact, it's super colossal, but it's improving!"

Now, television is not colossal, and it is not super colossal. Television is here. The producers of television are ready to deliver it to the public, and the public is ready to receive it.

We start with that premise, and any questions that I pose are not in any sense directed critically at any one but they reflect the things, the factors that the broadcaster who is entirely dependent on the product of his station for income should, if he is a sound business man, take into serious account.

In Lincoln's day — and I studied law in Illinois and have some of that background — you will recall that a young man aspiring to be President did not have to matriculate at Groton or Harvard, with all due respect to those two institutions. In Lincoln's day, if a young man wanted to become a lawyer, he went into a law office and, in addition to sweeping out and running errands, in his spare moments he did what they politely called "read the law" and after he had been doing that for a number of years, either to a point where his company became obnoxious to the other members of the firm or he himself decided he wanted to earn a living, one of the senior members of the law firm would approach one of the traveling circuit judges and recommend that this young man be admitted to the Bar on what they called "motion."

It was customary for the jurist confronted with a young applicant of that type to question him as to why he felt qualified to practice law. Well, this particular candidate in Lincoln's time very promptly answered that he was qualified because he had read and practically memorized every precedent-establishing case in the Illinois Library.

The judge looked at him and said: "Young man, do you realize you might wake up tomorrow morning and discover that the Supreme Court has reversed everything that you know?"

Now, if the Federal Communications Commission accepts the recommendations of Columbia, as given during the last Allocations Hearing, we may wake up one morning and discover that the FCC has reversed everything that we know about television broadcasting!

There are other factors that confront us, and to which the answers have not yet been provided.

Venture capital is not going to be encouraged until some amelioration of the tax program is developed, because there is no incentive to gamble any appreciable amount of money, of assuming risk, and having the opportunity of a very insignificant return if the risk proves successful.

Another factor that I think is worthy of consideration — and I say this without partisan bias — is that we are hoping that there will be a change in the trend of the past twelve years to substitute Government edict for the experienced judgment of business.

These are all factors that have to be given serious consideration in contemplating anything that is as long-range as the opportunities of providing a return such as characterizes this business of broadcasting television.

The manufacturers of television receivers and transmitters have a somewhat different viewpoint because their opportunities of recovering are different than our own. I would like to borrow a phrase

(CONTINUED ON PAGE 44)

* Executive vice president, Don Lee Broadcasting System, Hollywood, Calif.; and vice president, Television Broadcasters Association, Inc. An address delivered at the T.B.A. Conference luncheon Dec. 11, 1944, Hotel Commodore, New York City. This text is from the transcript furnished by Accurate Reporting Co., 154 Nassau St., N. Y. C. Certain obvious typographical errors in the transcript have been corrected. (EDITOR)

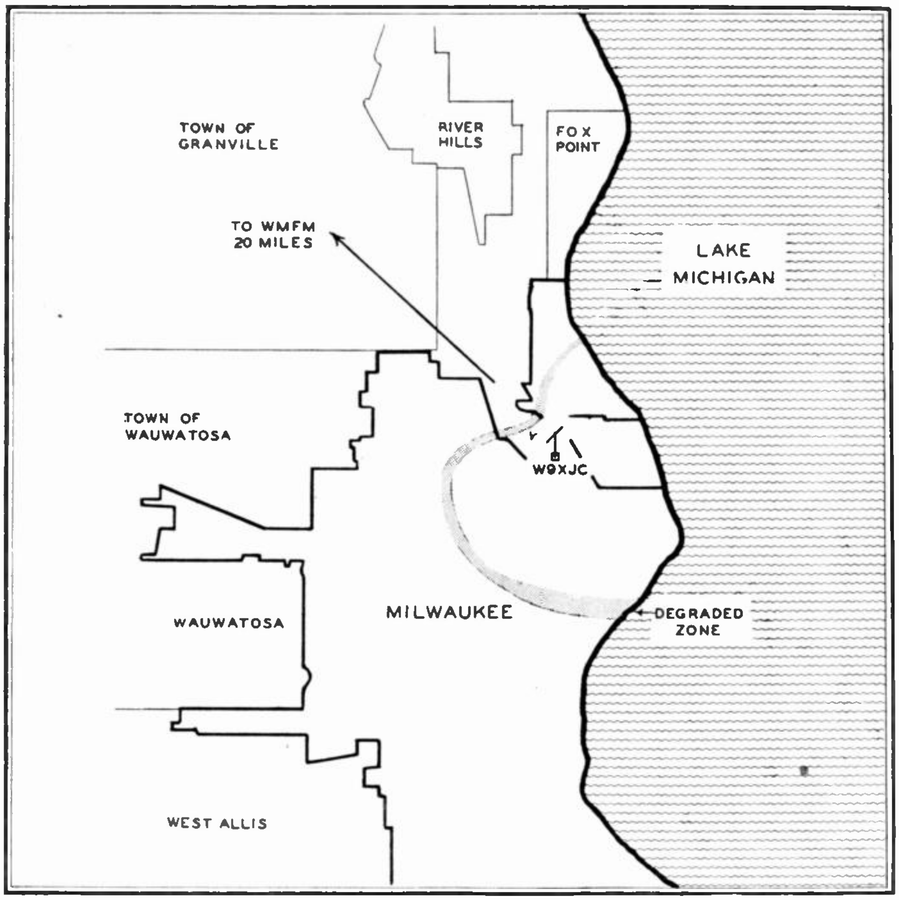


FIG. 4. THE NARROW ZONE OF DEGRADED SERVICE, DUE TO CO-CHANNEL OPERATION, IS SHOWN ON THIS MAP OF THE MILWAUKEE AREA

CO-CHANNEL SYNCHRONOUS FM SATELLITE

By Exciting a Satellite from the Main Station, the Need for a Second Frequency Is Eliminated

BY PHIL B. LAESER*

THE outer limits of the service area of a broadcast station are defined by the field intensities necessary for good rural service. For FM broadcasting, this is taken as the 50-microvolt contour. Inside the area defined by this contour there may exist localities and small areas which, because of the existence of shadows, the presence of higher noise levels, or other reasons will not receive good service.

Obstructions such as hills, cliffs, or buildings, when present in the transmission path, introduce attenuation, creating shadow effects. The area encompassed in a shadow will receive only a fraction of the theoretical signal intensity, which may be anywhere from 10 to 100%, depending on the degree of shielding. Such areas may be compared to holes in a piece of Swiss cheese. It is not unusual to find these holes in the patterns of existing stations, and such conditions present serious problems to the broadcaster, especially if a shadow falls inside the 1,000-microvolt or primary service area. A practical method of serving these areas is by the use of boosters or satellite stations.

There are three possible types of booster or satellites, as follows:

1. The operation of a separate low-power transmitter carrying the same program on a different channel from that of the main station.

2. The operation of a low-power transmitter carrying the same program on the same channel as the main station, but without synchronization.

3. The operation of a separate low-power station on the same channel as the master station, with both the carrier frequency and the program synchronized.

The general characteristics of these three types of booster or satellite are as follows:

The operation of an independent low-power transmitter on a frequency other than that assigned to the main station requires the use of two channels. One disadvantage to this method is the loss of frequency identification by using dual channels. It also reduces the maximum number of channels available for primary broadcast services.

The use of an independent low-power transmitter, operating on the same frequency with only sufficient power to fill out the service pattern, is called non-synchronous carrier operation because the carrier of each station is generated independently and the two stations are related only insofar as simultaneous transmission of the program is concerned.

* FM and Television Engineering Supervisor, *The Milwaukee Journal* Radio Stations WMFM, WMTJ, Milwaukee, Wis.

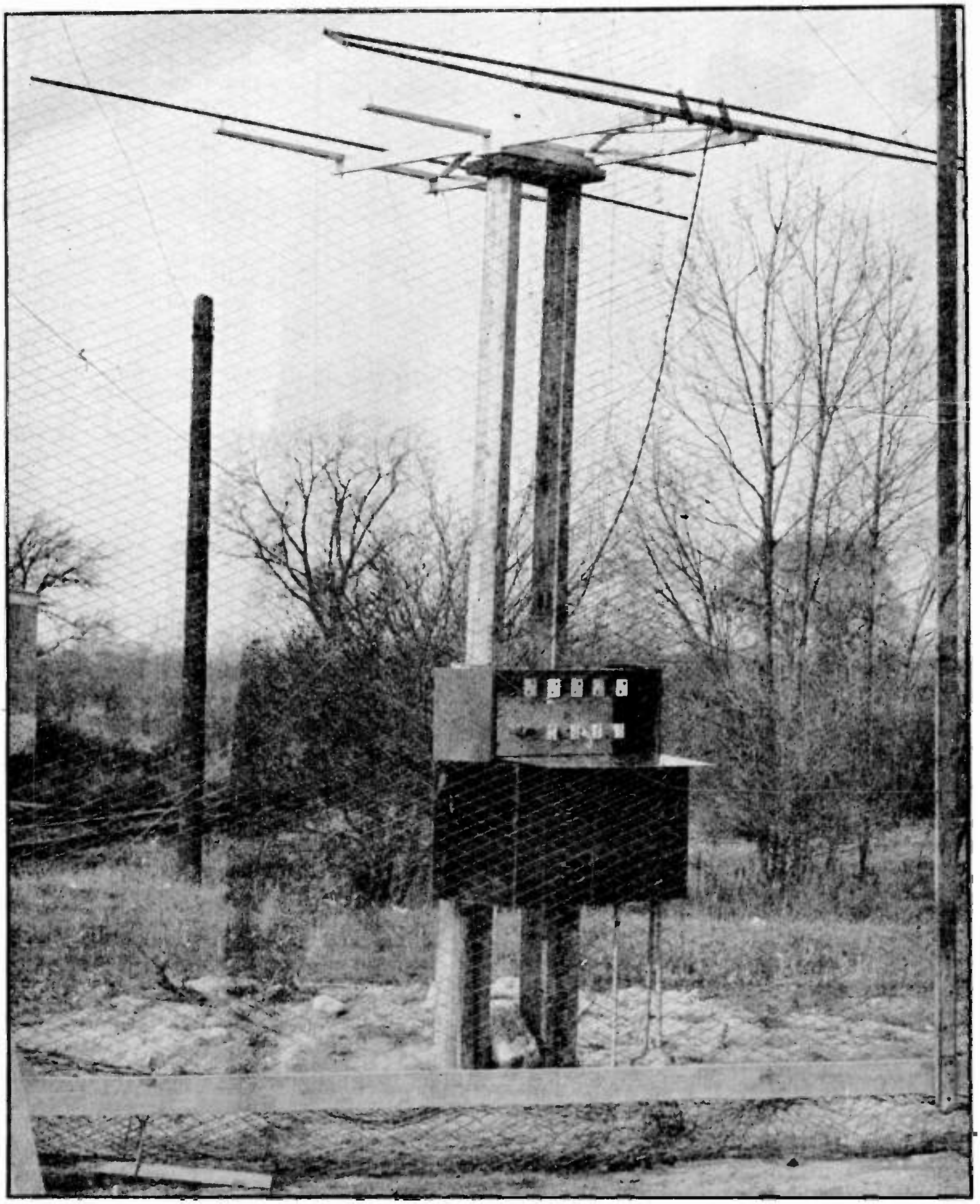


FIG. 1. THIS PICKUP RECEIVER IS 430 FT. FROM THE TRANSMITTER. FIRST CONVERTER IS IN UPPER COMPARTMENT. BELOW ARE POWER SUPPLY, TELEPHONE, AND COAXIAL LINES

With this type of booster, a mush area is created at points where the signals approach equal intensity. Objectionable interference is especially noticeable during program pauses and at times of zero modulation. The interference takes on the form of a beat note, the frequency being the difference between the two carriers. Unless this type of booster is placed so that this zone falls in an area of relatively few potential listeners, no particular service advantages can be ascribed to its use.

Third is the type of booster that depends on the main station for both its carrier and modulation. This should be defined as complete synchronous operation, and seems to offer several advantages over the other types. Using this system, it is not necessary to convert to audio frequencies and remodulate another transmitter.

Under a developmental license from the FCC, *The Milwaukee Journal* has been carrying on a program to determine the feasibility of operating a satellite FM station at the WMFM studio site in Milwaukee, Wisconsin, using a directional receiving antenna near by to pick up the signals from the WMFM main transmitter on 45.5 mc. at Richfield, some 20 miles distant, and repeating this carrier and modulation faithfully in all respects. Our main objective was to determine if

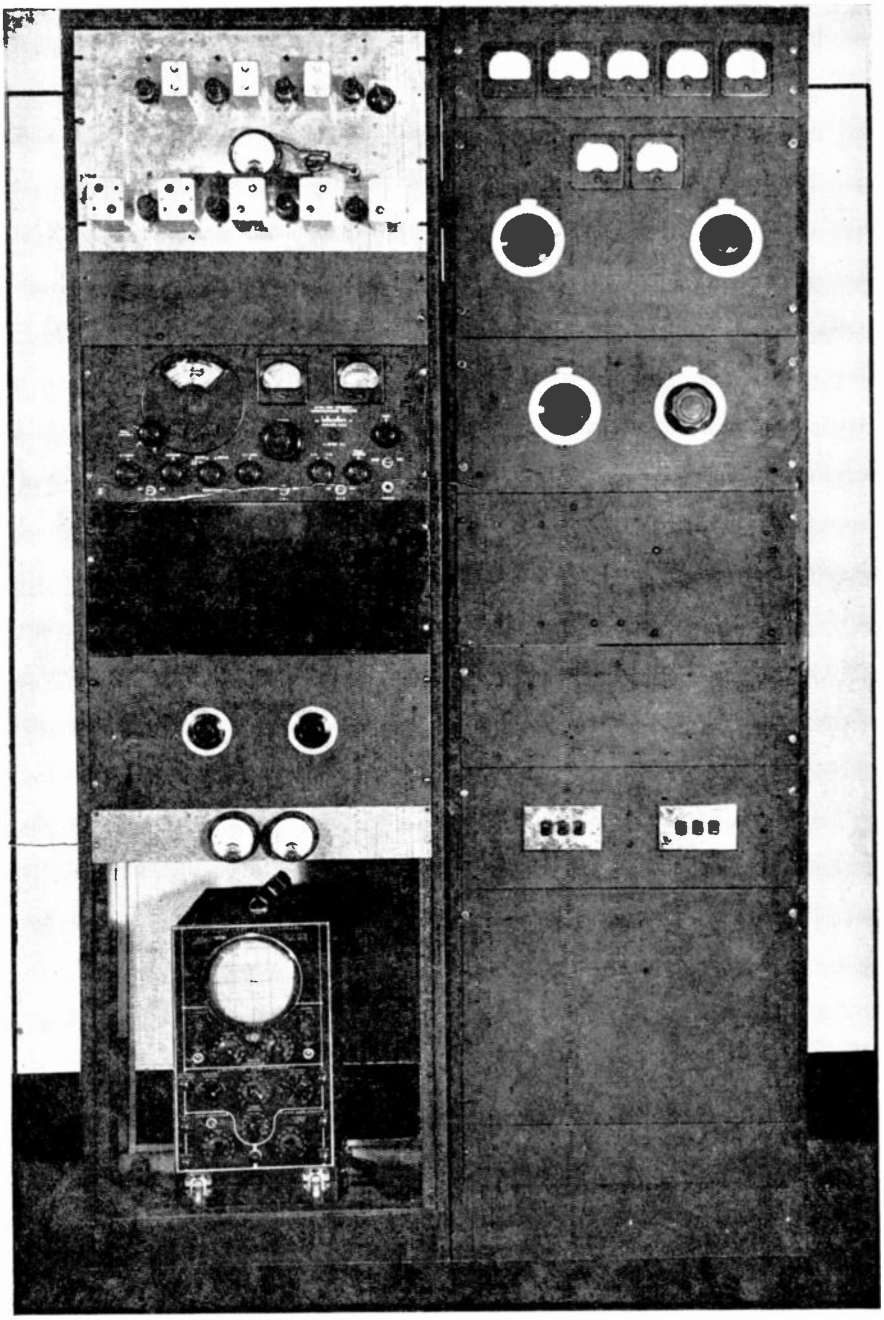


FIG. 2. AT LEFT ARE SECOND CONVERTER & SUPERVISORY RECEIVER. RIGHT, 100-WATT AMPLIFIER, IPA STAGE, AND POWER SUPPLIES BELOW

such operation was technically possible and if it could be made into a workable system with a minimum zone of degraded service, or area of objectional interaction effects between booster and main station signals.

It was our intention to find the minimum separation that would be required between the receiving antenna and the satellite transmitting antenna. Our program also included the testing of the booster station operating without frequency synchronization and described here as the second type. This meant that the programs were to be carried simultaneously by wire lines directly to the WMFM transmitter and also to the satellite.

Since this project employed a new method[1] of co-channel synchronous operation, a description of the installation and operation of such a system and the results that have been obtained will be of interest to other broadcast engineers:

The equipment used to accomplish synchronous operation can best be described by dividing it into two units, the remote pickup point, Fig. 1, and the transmitter proper, Fig. 2. The complete arrangement is shown in the block diagram, Fig. 3. A pickup point was selected 430 ft. from the proposed location of the satellite transmitter for the reception of the incoming signals from the WMFM transmitter on 45.5 mc. Here a directional antenna was used in conjunction with equipment which converted the incoming FM carrier and its modulation to a lower radio frequency.

The beat frequency of this converter was chosen to give an intermediate frequency of 5.5. mc., and was generated by a medium low crystal-controlled oscillator, followed by two multiplier stages. In actual practice, this oscillator was located at the satellite transmitter site, and its control voltage was transferred by a co-axial line to the two multiplier stages in the receiver associated with the shielded receiving antenna.

Following the first converter, several amplifier stages raise the IF voltage to a value sufficient to pass into the second co-axial line, terminating in a limiting amplifier at the transmitter location. By burying these lines 10 ins. to 1 ft. beneath the surface, along with the power and telephone circuits, we made sure that a minimum of feedback would occur. The setup of the entire 100-watt synchronous satellite station is outlined in Fig. 3.

At the transmitter end, the 5.5-mc. IF carrier is heterodyned back to 45.5 mc. by using the identical control voltage and frequency injected in the first converter. The output of the second converter is fed to a broad band amplifier operating on the carrier frequency, and is followed by two power amplifier stages, the last of which is capable of 100 watts output. A Variac is used in the primary of the rectifier transformer to control power output from zero to maximum.

At the present time, antennas at both pick-up and transmitting positions have patterns that closely resemble cardioids back-to-back, and combined give a rejection ratio better than 1,000 times. The initial antennas consisted of horizontal dipoles at both remote pickup and the transmitter, with a copper baffle screen directly back of each.

The field intensity from the main transmitter is in the order of 3.5 millivolts. It should be remembered that there is no need to operate a satellite in such a high field and consequently a reduction of the field voltage was brought about. This was done by lowering the power input to the WMFM transmitter until approximately 500 to 600 microvolts were obtained during periods of testing. The work was carried out in an area of heavily concentrated population and which, no doubt, contains many FM listeners. Therefore, it was necessary to do the work of testing before normal operating hours. The normal operating hours of WMFM are from 12:00 noon to 12:00 midnight.

Some difficulty was experienced during

[1] Patent applications have been filed on this system.

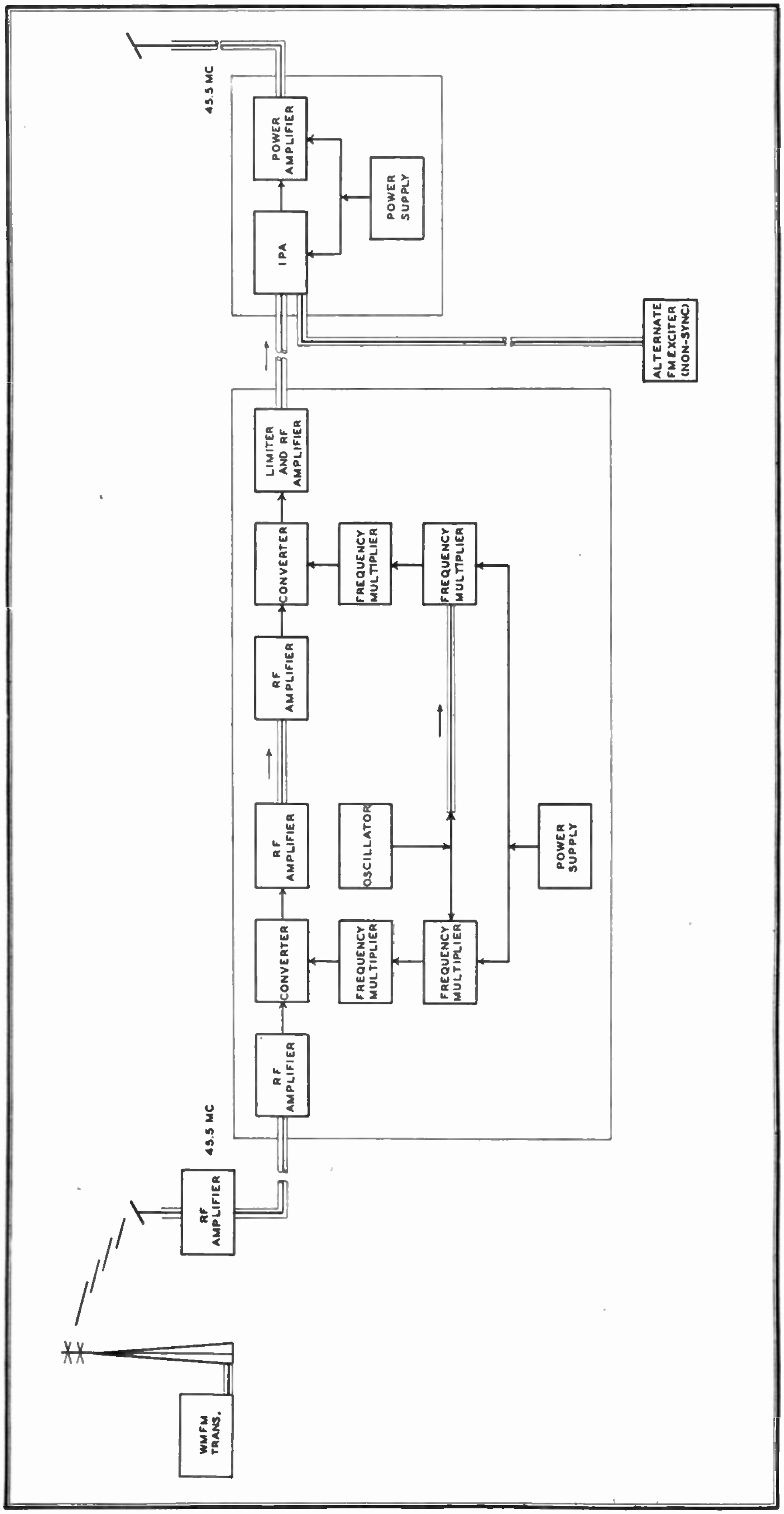


FIG. 3. BLOCK DIAGRAM OF THE 100-WATT SYNCHRONOUS SATELLITE W9XJG. NOTE THAT A NON-SYNCHRONOUS MODULATOR CAN BE SWITCHED IN FOR PURPOSES OF COMPARISON AND TO CHECK ZONE OF DEGRADED SERVICE

the early tests in determining just where the zone of degraded service might be, because in most cases we passed directly through it without detecting any noticeable change in program quality. The carrier of the satellite was cut every 15 seconds for identification. Therefore we could estimate the zone by watching a carrier meter on the receiver, but this did not prove accurate enough.

The zone was very accurately placed sometime later by using the non-synchronous setup referred to before as type No. 2. This was accomplished by modulating each transmitter with a separate audible tone in order to be able to differentiate between the two carriers. Tones of 1,200 cycles on the main transmitter and 250 cycles on the non-synchronous satellite were used. Driving away from the booster, only the 250-cycle tone was heard, but as the two signal intensities approached equality, the 1,200-cycle tone became audible. In this area standing waves from each station resulted in the tones jumping in and out, depending on which carrier gained control. After passing through this zone, only the 1,200-cycle tone was heard. By taking slightly different routes, the contour of equal intensity of the satellite and the main transmitter was obtained. This is shown on the map in Fig. 4. During all the tests, uniform power and identical antenna systems were used at the transmitter.

After this area had been examined, the booster was changed back to complete synchronous operation and the field car returned to this zone. Since the satellite depended on the main transmitter now for its carrier and modulation, only the 1,200-cycle tone could be heard.

The following are some observations on the operation of this co-channel synchronous system: There exist local points where the two carriers are nearly equal and out of phase. There is, however, a complete absence of any audio frequency beat. Some audible distortion was heard which might be traced to the difference in time over the individual paths of the carriers. By driving as slowly as 2 miles per hour, several sharply defined spots were found where the carriers cancelled out and distortion was high. It seemed that the zone or band where these spots occurred had now shrunk to a fraction of its width compared to non-synchronous operation. As far as could be determined, this degraded zone extended over a distance of several blocks. This cross-over point of the signals was found to be about $4\frac{1}{2}$ miles from the booster. These facts were determined by using a mobile FM receiver, cruising back and forth where the interference was anticipated and, to be positive, somewhat beyond.

(CONCLUDED ON PAGE 75)

PLANS FOR RAILROAD RADIO COMMUNICATIONS

A Progress Report, and Summary of Recommendations Formulated by the RTPB Committee on Railroad Radio Services—Part 1

BY RENÉ HEMMES

RADIO engineers have long recognized the potential advantages of communication with and between moving trains. Various efforts have been made during the past 30 years to develop suitable equipment, but mechanical and electrical failures were above the limits of dependability required of railroad equipment. It was not until the advent of FM, and the perfection of 2-way mobile police equipment that radio reached the point of delivering service acceptable to the railroads.[1]

Early Efforts ★ The first tests of railroad radio communications were conducted by the Delaware, Lackawanna & Western from 1914 to 1919. The conclusion was reached that results were unsatisfactory, and the project was abandoned. The work was carried forward in the 1920's by the Baltimore & Ohio; Chesapeake & Ohio; Great Northern; Indiana Harbor Belt; Nashville, Chattanooga & St. Louis; New York Central; New York, New Haven & Hartford; Pennsylvania; and the Virginia Railroads. Equipment of many different manufacturers was used for communication between engine and caboose and locomotives and signal towers. These tests only proved that available equipment was inadequate.

Further developments in the radio art encouraged a continuation of this work. Among the roads which experimented with radio in the 1930's were Central of New Jersey; New York, New Haven & Hartford; Pennsylvania; Chicago & North Western; Grand Trunk Western; Lehigh Valley; New York Central; and Southern Pacific. Again, although much technical data was obtained, the results were negative.

It should be noted that the equipment was supplied and the tests were carried out by radio manufacturers and at their expense, in almost every case. The railroads generally provided the facilities only.

The principal faults which precluded the adoption of various AM installations tried out over that 26-year period were due to antenna limitations imposed by the narrow clearance of bridges, tunnels, and other structures such as signal towers, to ambient noise conditions, electrical interference, or to mechanical vibration, impact and shock. Most serious were antenna problems and electrical interference.

Both of these were overcome, however, by the advent of FM communication on high frequencies, and several experimental FM installations were made in Government arsenals which proved so successful that they have continued in service.

Concurrently, experiments were resumed by radio manufacturers in conjunction with several of the railroads, notably the Atchison, Topeka & Santa Fe; Baltimore & Ohio; Chicago, Burlington & Quincy; Chicago, Rock Island & Pacific; Denver & Rio Grande Western; New York Central; New York, New Haven & Hartford; Reading; and Seaboard Air Line.

1944 ★ The mounting demands of wartime freight and passenger movements, combined with lack of manufacturing facilities to produce new rolling stock, required the railroads to keep more and more trains moving at higher and higher speed. Under pressure of accelerated schedules, the weaknesses of established railroad communications methods have been emphasized. Further, such accidents as the wreck of the Pennsylvania's Congressional Limited on September 6, 1943, and the Atlantic Coast Line's two Tamiami Champions on December 16, 1943 gave rise to the serious consideration of adapting to railroad use the Army's 2-way FM tank equipment which has proved able to withstand the gruelling punishment of battle conditions.

On February 11 and 12, 1944 a hearing was held by the U. S. Senate Kilgore Committee to consider the use of radio for railroad communication and signaling. Testimony at this hearing covered the use of 2-way radio telephone service as an adjunct to the block signals on lines so equipped, and also on lines which have no block signals, of which there are some 100,000 miles in the U. S. A. This represents over 25% of the total mileage.

Following this hearing, Senator Burton K. Wheeler, Chairman of the Senate Committee on Interstate Commerce, wrote Chairman Fly on February 19, 1944, to ask "whether or not the Federal Communications Commission has made a study as to the feasibility and desirability of using short wave radio communications systems on the railroads, and whether or not radio frequencies are now available for that purpose or will be available in the postwar period." Referring to the "alarming number of major accidents on the railroads of the Country," Senator Wheeler said: "It has been suggested to me, however, that some of them might have been prevented if the railroads had been equipped with more efficient signaling devices."

In reply, on March 9, 1944, Chairman Fly gave a very complete analysis of railroad radio applications, concurred in, no doubt, by the able engineering staff of the FCC. Concerning the use of radio for *signaling* purposes, he said that, according to Interstate Commerce Commission, "lack of an adequate block system was responsible for 28 of the 84 railroad accidents which it investigated during the fiscal year of 1943; indeed, lack of an adequate block system was found to be by far the most common cause of the accidents investigated.

"The reason why some 50,000 miles of passenger road remain unblocked is, of course, expense. The manual form of block operation requires additional employees along the road, and hence increases the cost of railroad operation. The automatic mode of block operation requires very considerable initial investment in signaling equipment. There is reason to believe that a radio-controlled block system, similar in some respects to the train communication system now in operation on one branch of the Pennsylvania Railroad, could make possible the increased safety which results from blocking with a much smaller personnel than is required by the manual block system and a much smaller initial investment in equipment than is required by the automatic block system."

Then, after a discussion of the various uses of radio for railroad *communications* purposes, he summarized the principal advantages of the 2-way radio telephone, saying:

"First, the (semaphore or light) signal can give only a few indications; its vo-

[1] See "FM Aids Battle of Transportation" by W. S. Halstead, Parts 1 and 2, *FM* RADIO-ELECTRONICS, July and August, 1943.

cabulary is limited to three or four conventional signs. Radio, in contrast, has an unlimited vocabulary; it can say not merely STOP, CAUTION, or PROCEED, but can deliver instantaneously such complex messages as 'Proceed with the utmost caution, the train ahead of you has just reported by radio a rough track on a curve beyond the next signal,' or 'Stop right away; the station you just passed has reported that you have a hot box in your seventh car.'

"A second inherent advantage of radio over traditional modes of signaling is that it affords two-way communication. When an order is given, it can be acknowledged immediately by the engineer who is to put it into operation or, better yet, read back by him to make sure that he has received it accurately and understood it. Except in limited circumstances, a signal cannot similarly report back that it has been viewed and understood.

"A third advantage of radio is its flexibility. Thus it is possible, through various modifications of a system already in successful experimental operation, to provide within a single system direct two-way communication between a railroad dispatching center on the one hand and either the front end or the rear end of any train in the system on the other; between the front end of any train and its own rear end; between any two locomotives; between any two rear-end cars; or between the rear end car of any train and the locomotive of any other. Study or investigation leading to the wider adoption of such communications systems might well exert a favorable effect on our annual railroad accident toll.

"One objection most frequently raised to the use of radio by railroads is that the equipment is too delicate and unreliable for use in connection with heavy railroad modes of operation. The successful use of radio in tanks advancing to battle in military operations, and in maintaining the safety of both civilian and military aviation operations throughout the world suggests that this objection is rebuttable. A second frequent objection is that the *safe failure principle*, by which a failure of the safety equipment is prevented from itself causing an accident, cannot be applied to radio communications. The fact that radio communication is two-way is itself in a very considerable degree an effectuation of the *safe failure principle;* and other applications of this principle to radio can be readily developed with a little ingenuity."

At the request of Senator Wheeler, FCC Commissioners, Jett (Chairman), Walker, and Case held hearings at Washington on September 13, 14, 15, 16, and 18, 1944, to give some forty representatives of the Association of American Railroads and of various individual roads, radio manufacturers, Government witnesses, and safety experts an opportunity to express their ideas on radio railroad services.

At the same time, the Railroads Radio Communications Services Committee 7 of RTPB Panel 13 was at work on its recommendations for submission at the FCC Allocations Hearing.

These recommendations are of great importance to railroad signal engineers and executives because they indicate the various applications planned for this field as soon as wartime restrictions are lifted. It should be noted that these applications are not merely what the railroad radio engineers would *like* to do, but what they know *can be done*, based on comparable military use during the war, and on experimental railroad installations put into service within the last year.

True, equipment designed specifically for railroad use has not been put into production by radio manufacturers. In some cases, a few special railroad equipments have been manufactured; in others, military models have been used with the understanding that they will be redesigned later. The important fact is that radio engineers and railroad men are working together now, so that the manufacturers will have the necessary understanding of railroad requirements, and the railroad communications and signal engineers will see for themselves just what services the new developments can perform for the roads.

HOWEVER archaic it may seem, orders are still handed up to engineers by tying a piece of paper with a loop of string held on a forked stick. The engineer puts his arm through the loop, and pulls it off the fork. It is necessary, of course, to slow down the train, but not to come to a full stop.

Crude as this method is, it is widely used today, even by the largest roads. Contrast this with the instantaneous, 2-way communications with trains moving at full speed afforded by the FM radio telephone.

Railroad men may still feel satisfied to use operating methods that were the best available back in the Civil War days, but they must come to understand that their string-and-stick means of communications, and other such antiquated practices, seem ridiculous to their passengers to whom the use of radio has become a part of their daily living!

Market for Railroad Radio ★ The use of radio by the roads will, in no application, replace any present communications or signal systems. On the contrary, it will represent a source of employment for many ex-servicemen who have become expert in the operation and maintenance of military communications equipment.

As a new market for radio equipment, this is one of the largest created by wartime progress of the art. According to the Association of American Railroads, there were in service during 1943 a total of 45,210 locomotives, 38,485 passenger cars, and 1,780,000 freight cars, operating on 229,174 miles of railroad with 399,627 miles of track. Railroads paid taxes in 1943 totalling $1,870,880,000.

The total property investment of Class One[2] roads amounted to $25,838,000,000 or an investment of $113,000 per mile. This group, in 1943, carried 730,407,500,000 ton-miles of freight, and 891,790,000 revenue passengers representing 87,974,200,000 passenger-miles. They paid 1,376,000 employees $3,564,330,000 in wages.

In contrast to the situation after the last war, the roads will meet the new peace with strong reserves for replacement and improvement of equipment and facilities. There will, unquestionably, be considerable resistance on the part of railroad officials to the use of radio communications. Railroad officials and the unions are probably the most hidebound industry group we have in this Country.

Further opposition can be expected from the manufacturers of railway signaling equipment, for they have complete patent control of this business and, through longstanding connections with the railroad officials, they can exert great influence in discouraging the introduction of radio communications. This they will most certainly do, for they have no patent control over radio equipment, and they are not organized to meet open competition from radio manufacturers.

Fortunately, there is a brighter side to this picture. Radio is a familiar service to every man, woman, and child who

(CONTINUED ON PAGE 74)

[2] Class One roads are those with annual operating income of $1,000,000 or more; Class Two, of $100,000 or more; Class Three, of less than $100,000.

SPOT NEWS NOTES

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

CIO-UAW FM: Six FM applications have been filed by United Auto Workers. Proposed stations in Los Angeles, Detroit, Flint, Cleveland, Newark, and New York will concentrate on "the arts, literature, economics, political and social sciences". The history and current problems of the labor movement will be featured, with "unparalleled freedom of speech and opportunity for discussion". Since UAW is a part of the CIO, does this mean that, if the applications are granted, no other affiliated with CIO can operate broadcast stations?

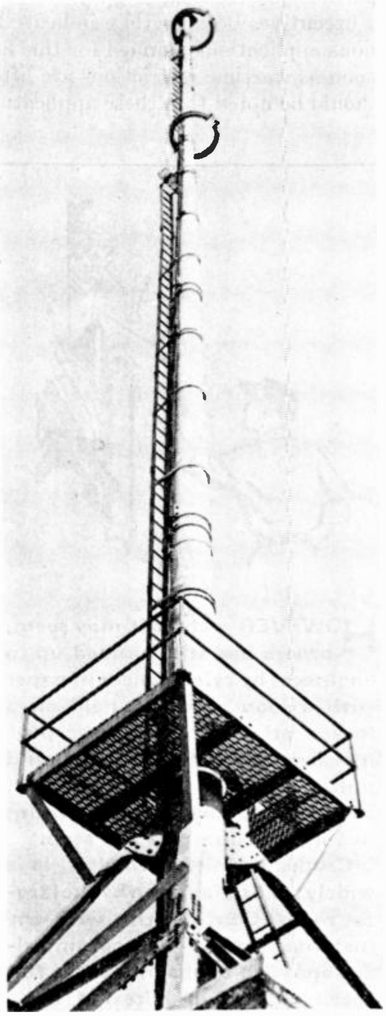
Television Transmitters: Will be produced by Western Electric and distributed by Graybar, according to F. R. Lack, vice president in charge of the W. E. radio division. An active program of television development will be undertaken as soon as war conditions permit.

I.R.E. Winter Meeting: Is scheduled for January 24–27 at Hotel Commodore, New York. Papers cover a very broad range, including tubes, quartz crystals, measurements, antennas, communications, and industrial electronics, but no papers on FM or television are listed in the program.

A. M. Wiggins: Formerly of RCA Princeton laboratories and a specialist on microphones and acoustic devices, has been appointed chief research engineer for Electro-Voice Corporation, South Bend, Indiana.

CBS Changes: Dr. Peter C. Goldmark, chief engineer, is now director of engineering and development. William B. Lodge, general engineering supervisor, has been appointed director of general engineering. Henry Grossman continues as director of technical operations under James M. Seward, director of operations.

WABC-FM: Located at Fifth Avenue and 42nd Street, New York, the CBS FM transmitter is now on the air with a G.E. 2-bay circular antenna. The 100-ft. tower is on a 700-ft. building. Provisions have been made for adding two more bays. At our editorial headquarters, Great Barrington, Mass., signals are now heard from WABC-FM, but they fade in and out slowly at about the same level as WEAF-FM on the Empire State Building. The distance is just 100 miles.



CIRCULAR ANTENNA RECENTLY COMPLETED FOR WABC-FM, N.Y.C.

Tube Plant Purchase: Although confirmation has not been received at this time of writing, it is expected that General Electric will purchase the Kenrad radio tube plant at Owensboro, Ky., and their four branch factories. The Kenrad electric lamp business is not included in these negotiations.

WPB: Has run down the curtain on its reconversion thinking. In fact, this subject is off the current agenda. Present attitude is: If you have any man hours available to work on plans for civilian production, don't ask us what to do or tell us you are doing it. This is not a quotation, for WPB has neither the time nor the inclination to talk about anything but military matters.

Plant Expansion: Garod Radio Corporation has added about 30,000 sq. ft. to its plant at 70 Washington Street, Brooklyn. This will be used for production and an experimental and development laboratory.

T.B.A. Officers: President of Television Broadcasters Association for 1945 is J. R. Poppele, secretary and chief engineer of WOR, New York. He succeeds Allen B. DuMont. Vice president is Robert L. Gibson, assistant to the vice president in charge of publicity and advertising at General Electric. Will Baltin was reëlected secretary-treasurer, and O. B. Hanson, vice president and chief engineer of NBC, was elected assistant secretary-treasurer.

Walter Schwalm: Heads a new division at Zenith Radio devoted to ultra high frequency developments. A specialist in this field, he has been with Zenith for the past six years.

2nd Annual FMBI Conference: Will probably be held at Chicago, where facilities for a totally new kind of conference program are available. Date will be announced soon after the FCC reaches its decision on postwar FM frequencies.

Louis Pieri: Manager of Eitel-McCullough's Salt Lake City tube plant has been made production manager of the home factory at San Bruno, Calif. He is succeeded by Hewitt V. Wilson.

New Address: FM AND TELEVISION will move from its present location at 240 Madison Avenue on January 1st, to larger offices at 511 Fifth Avenue. This is at the corner of 43rd Street. The new telephone number is Vanderbilt 6-2483.

Garrard Mountjoy: Has joined Lear, Incorporated, to direct research and development at the Company's laboratories at 1860 Broadway, New York City. He was previously head of the licensee consulting section of the RCA License Laboratory.

Standard Symbols: The American Standards Association has completed its work on coördinating symbols for telephone, telegraph, and radio circuit diagrams. These are shown in pamphlet Z32.5-1944, available from the American Standards Association, 39 West 39th Street, New York City, at 30¢ per copy. Every radio engineer and draughtsman should provide himself with a copy of this most useful pamphlet.

DR. PETER GOLDMARK: FOR WORK ON MOTION PICTURE PICK-UP AND ON COLOR TELEVISION

DR. VLADIMIR ZWORYKIN: FOR DEVELOPMENT OF THE ICONOSCOPE TUBE

LLOYD ESPENSCHIED: FOR ADAPTING COAXIAL CABLE TO WIDE-BAND TELEVISION TRANSMISSION

PHILO T. FARNSWORTH: FOR WORK ON SCANNING AND ELECTRON MULTIPLIER. RECEIVED BY B. R. CUMMINGS

DR. ALLEN B. DUMONT: FOR DEVELOPMENT WORK ON THE CATHODE RAY TUBE

F. J. BINGLEY: FOR WORK ON FLAT-FACED TUBES AND ON TELEVISION LINKS FOR OUTDOOR PICKUP

NEWS PICTURE

AT the First Annual T.B.A. Conference, the six engineers pictured above received awards "for technical pioneering in television." Also, awards for general contributions to television were made to General David Sarnoff, Dr. W. R. G. Baker, David B. Smith, and Dr. Alfred N. Goldsmith. Program awards went to WABD, WCBW, and W6XYZ, and to the first network stations WNBT, WRGB, and WPTZ.

The engineering awards were given to those who have contributed to bringing television up to its present state of development as represented by transmitting and receiving equipment now in use. Work on military applications cannot, of course, be recognized at this time.

DO YOU PLAN TO BUILD AN FM STATION?

With the Aid of the Data Presented Here, You Can Estimate Required Capital, Potential Revenue, and Possible Profits—Part 1

BY KEITH KELSEY*

FM has enjoyed wide publicity through news articles, postwar advertising by manufacturers, and technical articles of a theoretical nature. This publicity has stimulated but not answered questions such as "FM sounds good, but is it a good investment?", "Can I stimulate the sale of my product as well with FM as with AM?", and "FM seems to be in its development stage. Should I, therefore, wait until after the war before taking steps?"

The prospective investor, whether he is a newspaper publisher, a department store owner, a manufacturer, or a man seeking employment for his capital, is not primarily interested in the detailed technical aspects of FM nor in glowing generalized statements. Rather he is more interested in knowing how much money will be required to build a transmitting station, how many listeners can be reached, what risks are involved, what is the competitive picture, what are the growth trends, what is the potential revenue and probable operating cost, and what is the procedure involved in establishing an FM station.

Summarized in this analysis are answers to these and other similar questions. However, these answers all involve judgment, both collective and individual, in which the investor might not concur even though considering the same basic data. Therefore, following the summary, brief technical and financial data are given to enable each one interested to form his own conclusions. Furthermore, a method is outlined for making preliminary economic analyses of specific locations and for further investigation of any situation which the preliminary analysis indicates to be attractive.

Summary ★ The findings of this analysis can be summarized as follows:

1. FM has definite and important technical advantages over AM.

2. FM will gradually supplant AM with the possible exception of high-powered AM stations on clear channels.

3. Just before the war, FM started a rapid growth similar to that enjoyed by AM in the latter's infancy.

4. The investment cost, net time sales, operating expenses, and listener coverage are not greatly different as between AM and FM stations under similar conditions. Any differences in these factors are more likely to be in favor of FM.

5. The investment cost and operating expenses of television transmitters and receivers are much higher than for FM.

6. A new 1,000-watt FM station will cost about $42,000 to construct, not including preliminary engineering, and assuming that the site can be leased.

7. The 1,000-watt FM station will have a range of 25 to 100 miles or more depending upon the elevation of the antenna above the area served.

8. The 1,000-watt FM station will cost approximately $60,000 a year to operate, depending upon the extent of service rendered to its listeners.

9. The 1,000-watt FM station, suitably located, will have a potential net time sales of $100,000 per annum and should earn before Federal Income Taxes about 40% on net sales and 30% on total capital requirements.

10. In 1942, the average clear channel major network AM station earned before Federal Income Taxes, 33% of net time sales and 77% on investment cost. The corresponding figures for regional stations were 27% and 47% and, for local stations, 10% and 19%.

11. The FCC has been favorably disposed toward FM.

12. If its present policies continue, the FCC is likely to favor local ownership and early filing where more than one application is filed for the same location.

13. If the investor decides to own and operate an FM station, action should not be deferred; a suitable site should be located and tied up; and application filed with FCC; and equipment ordered for postwar delivery.

14. Alternative procedures are to buy a currently operated FM station, or an AM station having an FM license.

Frequency and Amplitude Modulation ★ Sound and radio are both vibratory phenomena. Sound vibrations are transmitted by compression waves in air, while radio waves are electromagnetic radiations. The average human ear can hear sounds of from 16 to 16,000 vibrations per second or cycles per second, which are termed audio frequencies. Radio waves are propagated in the range of about 20,000 to 300,000,000 cycles per second or more. For convenience in radio work, the units kilocycle (kc) or 1,000 cycles and megacycle (mc) or 1,000,000 cycles are used. The electric utility power in the home provides 60-cycle current. AM broadcasting is in the 550- to 1,600-kc. band. FM broadcasting has been assigned the band [1] from 42 to 50 mc., or 42,000 to 50,000 kc.

It is common knowledge that sound waves are attenuated, i.e. lose strength, rapidly and have very limited ranges. On the other hand, radio waves reach hundreds and sometimes thousands of miles. This greater range is utilized for the transmission of intelligence by employing the radio wave as carrier. At the radio transmitter, the low frequency sound or voice wave is superimposed on the high frequency radio wave, which process is termed modulation. At the radio receiving station, the incoming radio frequency signal is demodulated by electrical circuits where the audio frequency electrical vibrations are carried to the driving magnet of a loudspeaker. Thus the diaphragm of the speaker is caused to set up waves, audible to the ear, which duplicate the sound waves impressed upon the carrier at the transmitter.

Modulation of a radio carrier wave by audio frequencies may be done by varying the *amplitude*, or power, of the carrier in proportion to the amplitude of the audio wave; or the *frequency* of a constant-power carrier may be varied at a rate determined by the frequency of the audio signals, and to an extent determined by the amplitude of the audio signals. The former is termed amplitude modulation or AM. The latter is frequency modulation or FM.

Whereas the average human ear can detect sounds from about 16 to 16,000 cycles per second, frequencies from 400 to 2,500 cycles are sufficient for good speech intelligibility and 50 to 6,000 cycles for fairly good musical fidelity. Few instruments reach 5,000 cycles on fundamental tones, but overtones which

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[1] This will be modified when the new FCC frequency allocations are announced, but any resultant modification of the FM broadcasting band will not alter the conclusions presented in this paper.

distinguish different instruments playing the same note and produce richness of tone quality, reach well toward the limit of perception. This is the reason why it is sometimes difficult to distinguish between instruments on some radio programs, and why many sound effects lack realism. Special phonograph records reach 7,500 cycles, while experimental records have been made up to 15,000 cycles.

To modulate the carrier wave of a radio transmitter by either FM or AM requires a certain width of channel, or modulating frequency range, for each transmitter station. This is because side-band frequencies are caused by modulation. In AM there are two side bands, one being the carrier frequency plus the modulating frequency, and the other the carrier frequency minus the modulating frequency. Therefore, modulation by a 5,000-cycle audio frequency requires a total band width of 10,000 cycles; and if higher fidelity transmission were attempted on AM, serious interference would result under present station frequency allocations.

In FM, the modulation of the carrier wave produces an infinite number of side bands, only the first pair of which has appreciable amplitude. If signal-to-noise ratio were not important, the band width could be twice the maximum audio frequency or 32,000 cycles. However, to improve the signal-to-noise ratio, about 5 times this value is used, or a band of 150,000 cycles, or 150 kc., wide. The FCC is providing FM channels 200 kc. wide which are ample not only for high fidelity at high signal-to-noise ratios, but also to permit simultaneous transmission of facsimile. Under this provision, the whole FM band from 42 to 50 mc. would accommodate 40 stations in each locality, but a further restriction prohibiting the use of adjacent channels cuts this figure to 20. If the FM band is broadened to 43 to 58 mc., the number of stations in each locality could be increased to 75.

Impulses of static and man-made interference are amplitude variations, to which AM receivers are designed to respond. When these unwanted waves are impressed upon an FM receiver, however, they are blocked off by the limiter circuit which permits response only to constant-amplitude frequency variations. This results in practically static-free FM reception.

Radio Wave Propagation ★ Radio wave propagation in space is composed of the ground wave, which follows the surface of the earth, and the sky wave, which is free of the earth. The ground wave is attenuated rapidly, so that it is not usually detectable beyond 100 to 200 miles from the transmitter. The upper atmosphere of the earth is ionized, i.e. contains free electrons. This region is called the Heaviside layer and has a definite action on the propagation of sky waves. This action is similar to reflection and refraction. The height of the Heaviside layer varies from season to season and day to night, and its effect is different on waves of different frequencies.

As a result of this action in the range of frequencies used in AM broadcasting, the sky wave is reflected to earth at a distance from the transmitter where it may combine with the ground wave and cause varying degrees of distorting and fading within the service area. Reflected waves also cause interference within the service areas of distant stations on the same frequency. However, the Heaviside layer has little effect on sky waves at the high frequencies employed for FM broadcasting, as they pass through it to the outer regions. FM transmission is, therefore, much more reliable, and changes little from hour to hour or day to day.

THIS article is published in response to many inquiries received from AM broadcasts and from organizations and individuals considering the construction of FM stations.

The text has been planned to answer, as far as possible, all the questions raised by executives whose interests lie in the practical business aspects rather than in engineering details. Therefore, while this article is not of direct interest to engineers, it may well be used by engineering consultants for the information of their clients.

Part 1 covers the general considerations which must be weighed in planning an FM station. Part 2, to appear in the January issue, offers data from which the cost of an FM station can be estimated with reasonable accuracy. Figures are also given on the cost, operating expense, and revenue of AM stations of various power ratings.

Over a period of years, the interests of radio listeners have become confined to local stations with the result that long-distance reception has no commercial value. The saleable commodity of a broadcast station is, rather, dependable coverage of a given area. The coverage area of an AM station is less at night than during the day. An FM station of the same power will afford consistent day-and-night coverage as great or greater than the daytime coverage of the AM station. This will be determined by the height and type of antenna used at the FM transmitter.

The limit of FM transmission is theoretically equal to the horizon distance but, practically, the reliable range may be 3 to 4 times the horizon distance. The horizon distance in miles is given by the equation $d = 1.23\sqrt{h}$, where h is the height of the transmitter antenna in feet. With respect to a fixed receiver, doubling the height of the transmitter or receiver antenna doubles the signal strength at the receiver, whereas doubling the radiated power in the transmitter increases the field strength by 40%. From the foregoing it is apparent that increasing the power of an FM transmitter will improve reception at a station within range but will not greatly increase the range of the station. A transmitting antenna of more complex design than the simplest form will also increase the field strength at the receiver.

The ability of an FM receiver to discriminate against interfering signals is such that the signal from the desired station need be only twice as strong as that from an unwanted station, as against a required ratio of 100 times for AM. Therefore, the AM signal must be 50 times as strong as an equivalent FM signal at a given location. In terms of power, this means it takes approximately 2,500 times as much power at an AM station to deliver clear reception to a given receiving point as it would for an FM station operating at the same place. Therefore, where interference is the limiting factor for reception, a 200-watt FM station is equivalent to a 500,000-watt AM broadcast station.

A typical comparison of a 250-watt AM station on 1,400 kc. with a 250-watt FM station, both with 330 ft. antenna, shows that the AM station has a daytime service range of 13 miles and a night range of 5 miles, whereas the FM station has a range of 29 miles both day and night. The smaller range of the AM station at night may appear contrary to theory, as it would seem that the range should be greater at night. This would be the case if it were the only station operating, but due to the fact that many stations operate simultaneously on 1,400 kc., the increased propagation at night causes interference between stations on the same frequency, which cuts the service range drastically below the free transmission range.

The FCC regulations require that the field strength be 1,000 microvolts-per-meter in an FM station's urban area, and 50 microvolts in its rural area. Field strength calculations for a particular site can be made fairly accurately in advance, but FCC requires field tests after construction as part of the proof of performance. If the field strength is not sufficient, FCC may order changes in the transmitter.

The calculated 50 microvolt-per-meter range of FM stations of different power ratings are plotted in Fig. 1 for typical antenna heights and average ground conductivity.

The primary service area of an AM broadcast station is defined by FCC as the area in which the ground wave is not subject to interference or fading. A field strength of 500 microvolts-per-meter is sufficient to give reliable reception and with respect to receiver performance is roughly equivalent to 50 microvolts-per-meter FM. The 500 microvolt-per-meter ranges of AM stations of different power ratings are plotted in Fig. 1 for average ground conductivity. This curve shows that the ground wave range for AM stations is about the same for FM stations of the same power.

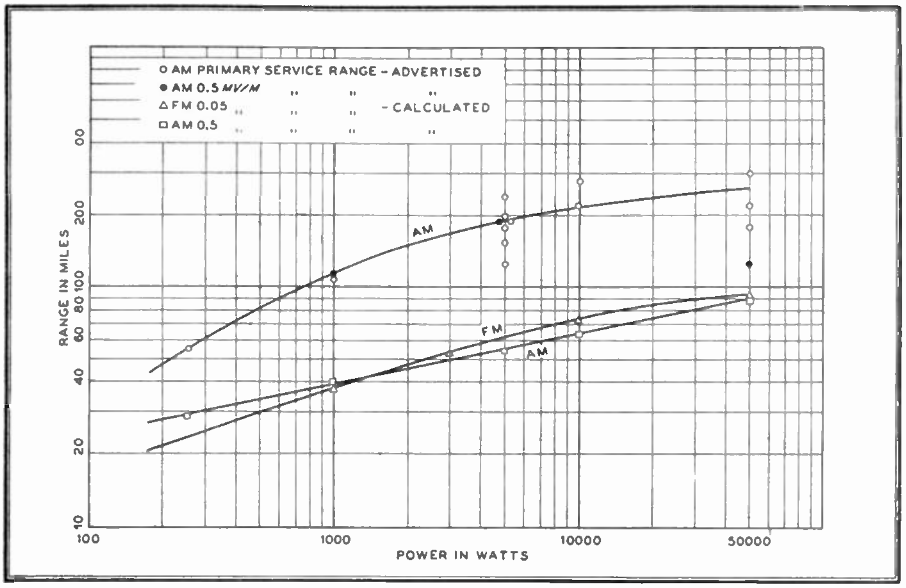


FIG. 1. TRANSMITTING RANGE OF AM AND FM BROADCASTING STATIONS

The third curve in Fig. 1 is the plotted claims of advertisements of AM stations. This curve shows a much greater range than similar FM stations and is probably due in some cases to a better ground conductivity than assumed for the FM curve and in other cases to the service area being predicated upon audience letters rather than FCC definition. In the latter method the limit of the primary service area is taken to be where the letters per 1,000 radio homes drops to 50% of the ratio for the county in which the station is located.

From the equipment standpoint, transmitter tubes employed in FM circuits operate at their maximum ratings, whereas in AM circuits they must operate on the average at less than their maximum ratings in order to prevent overloading when the carrier wave is fully modulated. The antenna for an AM transmitter is more elaborate and expensive than that for an FM station of the same power, and covers a greater land area.

Physically, an outside FM receiving antenna is smaller than the AM antenna, but should be as high as possible. An ordinary antenna used for picking up the AM broadcasting band can be used to pick up FM signals. However, a half-wave dipole receiving antenna, costing from $3 to $12, is relatively simple and much more effective for both FM and AM. Manufacturers predict combination AM-FM receivers at price ranges approximating those prior to the war. Postwar FM receivers of excellent performance are promised by manufacturers to retail as low as $60. It is interesting to note, however, that the most popular prewar models were FM-AM phonograph combinations in the price range from $175 to $350. The inference drawn from this is that listeners felt that the quality of FM reception on the better models justified the larger investment.

Federal Communications Commission ★ The FCC of the Department of Commerce has jurisdiction over all civilian radio including commercial broadcast service. In order to build and operate a broadcasting station, a construction permit and a license must be obtained. The license for the station is granted for one year and must be renewed annually. A license is revokable and does not guarantee the licensee the perpetual use of the assigned frequency. The construction permit and license are issued only when it is demonstrated to the Commission that the size, coverage, and type of service of the station will be in the best interest of the public. Although the attitude of the Commission toward FM has been favorable, and there is little prospect in the near future for legislation amending the Communications Act, there may be some political hazard present.

The FCC has announced that, in the future, the Commission will issue conditional grants for new stations involving critical materials, where it is shown that such grants would serve an outstanding public need or national interest. At the same time it was announced that WPB would consider each application for the release of the needed critical materials upon its merits.

In considering applications for the same market area and with other factors being equal, FCC is likely to favor local ownership over "foreign" ownership and the earlier applicant over those filing later. However, local ownership will probably be given more weight than the early ap-

TABLE 1—GROWTH OF BROADCAST INDUSTRY

Year	Number of Stations	Gross Billings $ Million	Net Time Sales $ Million	Receivers in Use Million
1922	30			
1923	556			
1924	530			
1925	571			
1926	528			
1927	733	4.8		
1928	677	14.1		
1929	618	26.8		
1930	612	40.5		
1931	612	56.0		
1932	608	61.9		
1933	610	57.0		
1934	591	72.9		
1935	605	87.5		
1936	632	107.6		
1937	685	144.1	117.9	
1938	721	150.1	117.4	40.8
1939	764	171.1	130.0	45.2
1940	814	208.0	155.7	50.1
1941	882	237.6	179.8	56.0
1942	923	254.8	192.0	59.3
1943	917	307.2	233.9	57.0

TABLE 3—1943 NET TIME SALES BY STATION POWER

Power Watts	Stations Operating	Stations Reporting	Net Time Sales Total $ Million	Incr. Over 1942 %	Net Time Sales Average $/Sta.
50,000	52	52	49.8	18	958,000
5,000–20,000	221	171	51.2	22	300,000
1,000– 2,500	160	125	14.5	22	116,000
200– 500	435	358	22.2	24	62,000
100	39	29	0.9	22	30,000
	907	735	138.6		

plication. The FCC will not show favor as between individual, partnership and corporate ownership. The Commission will probably give due weight to prior experience in broadcast station operation.

The construction permit application Form 319 can be obtained from the Washington offices of the FCC or from a local radio inspector. The form requires detailed information as to the applicant's financial qualifications, the corporate structure if the applicant is a corporation, other business interests, statement of citizenship, signal coverage calculations, nature and extent of public service which applicant expects to render, a topographical map showing the 1,000-microvolt and 50-microvolt-per-meter contours, topographical profiles along each of the eight radials, a drawing of the antenna, statement of its proximity to airports, location of the transmitter and studio, and technical descriptions of the antenna, transmitter and studio equipment. The purchase of an existing license or construction permit requires the filing of Form 314 or Form 315.

The FCC has allocated 35 frequency channels to FM broadcasting and 5 for non-commercial educational broadcasting, each channel being 200 kilocycles wide. The FM broadcasting channels lie in the frequency band from 42,000 to 50,000 kilocycles and the number of stations permitted in the same general locality is approximately 20. The total number of FM stations possible in this band is about 3,000, whereas the existing 918 stations is close to the maximum possible in the AM band. It is expected that the band will be widened by raising the upper frequency limit when the new allocations are announced.

The Growth of Broadcasting ★ The broadcast industry has enjoyed a steady and rapid growth as shown in Table 1, which gives the number of broadcast stations, industry sales and the receivers in use by years.

Net time sales are the station receipts less regular advertising agency, station representative and other commissions. The total of these sales for 1943 is broken down by station classification in Table 2.

A different breakdown of net time sales by size of station is given in Table 3 above.

As shown in the above table, the average net time sales per station vary from $30,000 per annum for 100-watt stations to $958,000 per annum for 50,000-watt stations. This wide variation is due to the much greater market areas served by the larger stations because of their greater range and relative freedom from interference.

TABLE 2—1943 NET TIME SALES BY STATION CLASS

National Networks	$104,900,000
Regional Networks	3,000,000
National and Regional Non-Network	60,600,000
Local	65,400,000
Total	$233,900,000

The Growth of FM ★ Just prior to 1914, FM was seriously considered as a suitable means for the transmission of intelligence by the American Telephone and Telegraph Company and others. However, it was shown mathematically that frequency modulation methods offered no advantages, and no commercial applications were attempted.

However, Major Edwin H. Armstrong, working on the elimination of static, realized that FM signals had the advantage of being different in character from static impulses, while AM signals are similar. In 1933, Major Armstrong made his first laboratory demonstration of the advantages of FM over AM. Since then, Major Armstrong has taken out many patents embodying his invention, known as the Armstrong Wide-Swing Frequency Modulation System. FM broadcasting stations are licensed by Major Armstrong to operate under these patents, in accordance with a single-payment royalty schedule which varies with the size of the transmitter. Although the validity of these patents has not been adjudicated, the royalty fees are nominal, and it has been the practice to take out licenses under these patents.

The growth in FM broadcasting has been rapid since the first FM station was granted a commercial license in May, 1941. The number of FM stations and receivers by years is shown in Table 4.

In addition to the 44 active commercial stations listed for 1944, there are seven stations under construction, making a total of 52 operating or under construction.[2]

As may be expected, quantitative estimates of the future in the broadcasting industry vary widely. A combination of some of these estimates as to the number of broadcasting stations and receivers in use five years after the end of the war is given in Table 5.

Most economists are agreed that there is a large pent-up demand for consumers' goods which will be released as soon after the end of the war as manufacturers can resume production. Included in this general demand for consumers' goods is the desire to buy new and better radio receivers to the extent of some 25 million units. Of these new receivers, it is estimated that all but the very cheap models will be capable of receiving both FM and AM. As soon as these receivers are in the hands of the public, FM audience-building can be carried forward rapidly. At the present time, most of those stations broadcasting simultaneously on AM and FM receive no additional revenue for this duplication, and it is expected that, generally speaking, no revenue will accrue from this source, even though some increase in audience results therefrom. It is expected that the majority of AM broadcasters will gradually convert their listeners from AM to FM preparatory to shutting down their AM transmitters. In the meantime, there is at least one example of an FM station successfully building an audience during the war period.

[2] See Page 34 for names and locations and for list of stations for which applications have been filed.

TABLE 4—GROWTH OF FM BROADCASTING

Year	Experimental	Non-Commercial	Commercial	Total	Receivers
1938	1			1	
1939	7			7	
1940	11			11	
1941	14	2	18	34	
1942	9	3	36	48	
1944	3	5	44	52	500,000

That is WBCA, Capitol Broadcasting Company, Schenectady. This station, broadcasting on FM only, is now breaking even, although the number of FM receivers in its service area is not very large. One contributing factor is that the station was able to make a contract with the Mutual Network because Mutual had no outlet in the Schenectady-Albany-Troy area.

As of November, 387 applications [4] for construction permits and licenses were before the FCC, and of these more than three-fourths were filed in 1944. It is estimated that over 100 more are in the course of preparation. It is apparent that suitable locations are being tied up rapidly, indicating that if FM broadcast operation is contemplated, action should not be deferred to the end of the war.

Manufacturers state that FM will dominate their radio product design, merchandising, and advertising in the postwar period. This is in line with the general policy of preventing saturation of a market by the development of improvements. Prior to the war the population of the country was increasing about 1% per annum, while the number of receivers in use was increasing 10% per year. These relative trends would before long result in market saturation and reduction in manufacturers' sales if new developments such as FM and television were not made. It may, therefore, be expected that the large manufacturers will coöperate with the FM station owners and operators in a number of important ways.

Competition ★ The consensus of opinion is that the advantages of FM over AM are sufficient to cause a rapid increase in the number of FM transmitting stations and receivers and a gradual decrease in the number of AM stations. Opinion is divided as to whether FM will supplant AM entirely in the future. The attitude of the FCC will be an important factor as the Commission could rule that FM broadcasting, when well developed, is adequate to take care of the public need and that AM transmission is no longer in the public interest, that its channels are required for other services, and thereupon order the closing down of all AM stations. On the other hand, as the conversion from AM to FM proceeds, the service coverage of some of the AM stations remaining will be increased, due to the elimination of interference, which, in turn, will mean lower cost in reaching the unit-audience. Some are of the opinion that there will always be a place for a few high-power AM stations. In comparison to present coverage by the majority of AM stations, FM stations having approximately equal primary coverage, would be somewhat cheaper to construct and operate, besides having important technical advantages.

In November, 1943, the FCC promulgated what is termed its duopoly order, which bans control of more than one station in the same area or in overlapping areas. The order set May 31st, 1944, as the deadline. This caused considerable worry among the forty or fifty owners of duplicating stations. Prior to the deadline, the Commission suspended this order indefinitely in order to prevent losses due to forced sales. However, a number of duopoly sales have been consummated, both before and after the suspension of the order.

The FCC Rules and Regulations provide that no person shall control more than one FM station except on a showing that it will foster competition, and in no event shall a person control more than six stations.

To prevent self-competition of affiliated stations, network programs are now made available to FM stations owned and operated by the network's affiliates, without charge to them and, in the case of commercial shows, without additional charges to network advertisers.

The second and concluding part of this article will appear in the January issue. In it, the author presents data for estimating the cost of FM stations, and compares potential operating expense and revenue with AM stations.

TABLE 5—THE INDUSTRY IN VE+ 5

	Present	V + 5
AM Broadcasting Stations	918	750
FM Broadcasting Stations	52	500
Television Broadcasting Stations	9	100
Total AM Receivers	57,000,000	40,000,000[3]
FM-AM Receivers	500,000	25,000,000[3]
Television Receivers	10,000	——

As to the relationship of FM and television: This is really a question of competition between sound broadcasting and television broadcasting. Each performs a distinct and virtually non-competitive service. Although television combines sight and sound, the technique of television programs must assume that the audience is listening *and* looking. As a result, the sound part of television programs supplements sight, and there is little use in *listening* to a television performance unless it is possible to *look*, also. That television may add to the total number of those listening to sound programs and attending movies is indicated by the fact that the radio audience is largest during the evening hours when the moving picture theatres are filled. It should also be pointed out that, while radio undoubtedly ruined both the phonograph and piano industries, the former is greater today than ever before, and the latter was growing rapidly when it was interrupted by the war. There is no background of experience on which to predict the future growth of television, but it does not appear that it will bring about a net reduction in the audience of sound broadcast stations.

One of the most important factors in favor of FM is that at present, television transmitting equipment costs at least twice as much as FM equipment and the cost of program production is four to five times as much. A little-publicized feature of FM is that equipment has been developed for the transmission of home facsimile simultaneously with sound programs, using the same broadcast transmitter and the same FM carrier frequency. If the equipment cost can be reduced to a reasonable figure, facsimile transmission in conjunction with FM programs would have tremendous advertising value and audience appeal. While facsimile is not animated, as is television, it has the advantage to sponsors and listeners of leaving a permanent record. Therefore, it does not require attention at the time it is being received.

[3] The number of sets capable of receiving AM only is expected to decrease because set manufacturers now plan to combine FM and AM circuits in all but their cheapest postwar models.

[4] See Page 34 for names and locations.

No Miracles: Now that resumption of civilian radio production is imminent, RMA is planning an advertising campaign to explain that no miracle sets can be expected, but merely improvements from war experiences. It would be an excellent idea if the RMA would also tell the public that any claims for high quality reproduction from cigar-box sets are still completely false. The miracle of fine reproduction from a small package has not yet come to pass, nor is it even in prospect.

New Competition: Word comes from the South that mountaineer moonshiners are faced with a new dilemma. As if the revenooers didn't make trouble enough, prospective FM broadcasting station operators are buying up entire mountains where they plan to erect transmitters as soon as they can get construction permits and equipment.

WHAT'S GOING ON IN RAILWAY RADIO

Railway Communications Projects on Which Radio Manufacturers Are at Work

BY JOHN A. CURTIS*

MANY far-sighted railroad executives are seriously considering radio as a potentially important means to increase the safety, efficiency, and speed of their post-war operations. Many radio manufacturers believe that the railroad communications field offers a sizeable new market for equipment, and for the employment of specially war-trained radio personnel. Now the question arises as to what American radio manufacturers can do to be helpful in establishing this new radio service on a sound economic basis.

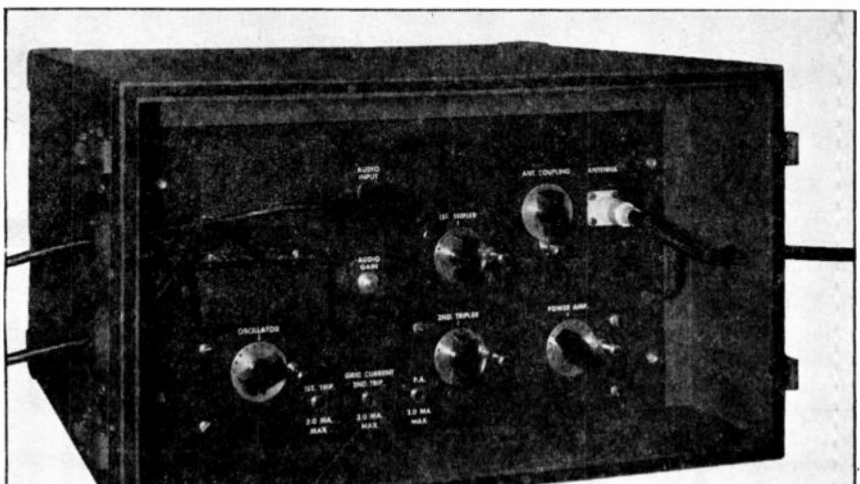
Before railroad executives can recommend comprehensive radio installations, equipment must be standardized under railroad supervision, and basic cost formulas for this equipment must be established. Finally, and not by any means the least important factor that must be settled before railroad radio arrives, is the matter of Brotherhood or union coöperation.

While some manufacturers have decided to await the definite allocation of frequencies for railroad communications purposes by the Federal Communications Commission before proceeding with the design of specific equipment, others including Aircraft Accessories, Bendix, Halstead, and the Union Switch and Signal, are utilizing the present waiting time by setting up and executing definite engineering projects in the railroad radio field. Several radio communications projects have also been set up by individual railroads, under the direction of both railway and communications engineers. Those projects should produce the additional technical and operational data which will be required before railroad executives are ready to purchase radio equipment in substantial quantities.

Based on the recently-completed testimony before the Federal Communications Commission concerning railroad radio experiments, it would appear that much technical work remains to be done before railroad radio can be standardized. There was, for instance, a definite difference of opinion concerning the relative values of Amplitude and Frequency Modulation. Some engineers testified that, in their opinion, they saw no reason for using FM in preference to AM for equipment operating above 100 mc.

The advantages of FM were particularly emphasized by E. A. Dahl, electronic engineer of the Rock Island Railroad. Mr. Dahl testified that FM had proven especially useful in connection with tests in the Chicago area of equipment operating in the 2,000 to 3,000-mc. band. He testified that FM had demonstrated its superiority in the elimination of flutter and other undesirable effects. However, he stated that his tests were not conclusive, and that the Rock Island planned to continue its experimentation to determine the comparative usefulness of these two methods of modulation.

* Vice president, Halstead Traffic Communications Corporation, 155 E. 44th Street, New York City.



140 TO 190-MC. HALSTEAD RAILROAD RADIO TRANSMITTER NOW IN SERVICE

Experiments in the railroad radio field conducted over a long period of years by Halstead engineers are in agreement with Mr. Dahl's initial deductions. However, since agreement on this subject is by no means settled among leading railroad executives, the Halstead Corporation is at present engaged in setting up both AM and FM stations, operating side by side, under the same conditions of terrain, power and frequency, so that there will be available for study by railroad engineers a direct comparison of the merits of the two techniques.

For reasons of privacy, and to avoid the problems of radio transmitting frequencies, some railroad executives are hopeful that induction methods can be utilized for mainline and, perhaps, even yard communications. The induction technique may be adaptable to electrified lines using overhead catenary systems, and to those railroads where telephone and telegraph wires closely parallel their trackage.

It is believed, however, that much research and development work still remains to be done before induction methods can provide the comprehensive communications desired at low cost without interference with existing carrier and telephone services. For instance, more efficient means of coupling between mobile units and wayside wires would seem immediately desirable. The loops which have been suggested are at best cumbersome and hazardous to operating personnel.

With the progress already made in induction techniques during the war period for military purposes, requiring compactness and extreme reliability, there is, however, reason to believe that this technique can be efficiently and economically applied to railroad use for some purposes, and under certain conditions. Recently, the Halstead Corporation has been testing commercial models of its military and naval induction equipment on the West Shore Division of the New York Central System. It is believed that this equipment, in association with repeaters now being tested, will provide compact, low-powered equipment that will prove effective for coverage along right-of-ways with a minimum of interference to existing carrier services.

Included in the experiments is the very latest pocket-size, 2-way induction equipment, developed for the Armed Services.

One important feature of this equipment is that no projecting antenna is required. It is believed that this equipment will be of special interest to railroad executives, in view of the fact that the lack of its availability was discussed during the recent Commission hearings and the need for it was emphasized by railroad executives and Brotherhood representatives.

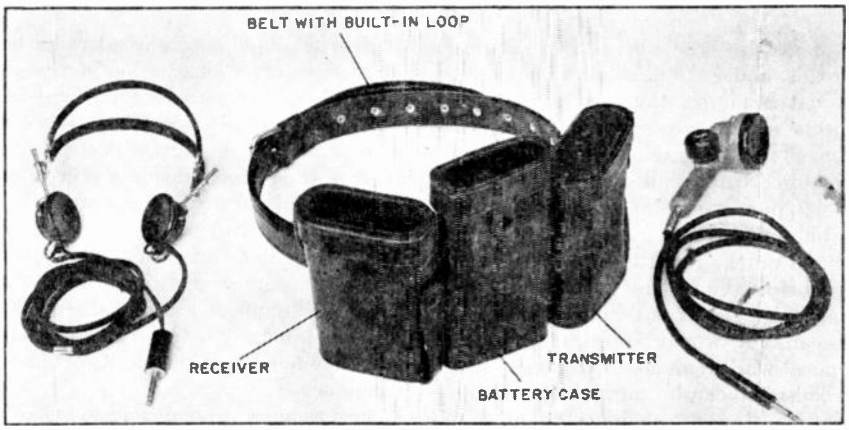
The waiting period before definite assignment of frequency allocations for railroad use is also being very profitably employed by radio manufacturers to consider the protection of personnel. The inclusion of such techniques in railroad radio equipment is not only a matter of considerable interest to railroad executives, but it is also a matter of utmost importance to the railroad Brotherhoods.

In this connection Mr. J. G. Luhrsen, one of the final witnesses at the railroad hearings before the Federal Communications Commission, who ably represented over a million railroad workers, made the following statement:

"With respect to the use of radio by the railroads, I think that I can state unequivocally that we would approve any new use of radio which contributes to safety. And we would oppose any new use of radio which will reduce safety and imperil the lives of railroad men or passengers, no matter how much it may speed schedules or reduce cost of operation. My primary theme, accordingly, is to stress the need of viewing any new use of radio on the railroads first and foremost from the point of view of safety. Indeed, I feel so strongly on this point that I believe if it can be shown that the introduction of radio in certain ways will increase railroad safety, then the introduction of such devices should be adopted in addition to and not in lieu of present safety measures.

"Moreover, I am concerned that if radio is introduced it will be in accordance with standards of equipment and operating rules which will insure that it is in fact a safety measure and not an added hazard. . . . It would be unfortunate indeed if we would have to wait for a few tragic accidents resulting from improper installations or improper use of radio before rules are laid down which will capitalize on radio's safety possibilities and guard against possible shortcomings."

One such protective measure was developed by Halstead engineers early in their railroad radio development program. This provides for continuous aural and visual indication to train personnel that fixed station transmitters and mobile receivers are in normal operating condition. Safety equipment of this type is employed for the reason that the locomotive engineer is dependent upon instructions given him by a control authority, such as yardmasters or dispatchers. Instructions given by radio telephone to an engineer must be followed, therefore, in minute detail unless they are countermanded. Should central station equipment fail after issuance of orders, or should locomotive receiving apparatus become inoperative for any reason, the engineer, if not advised of such failure, would proceed to follow his original instructions.



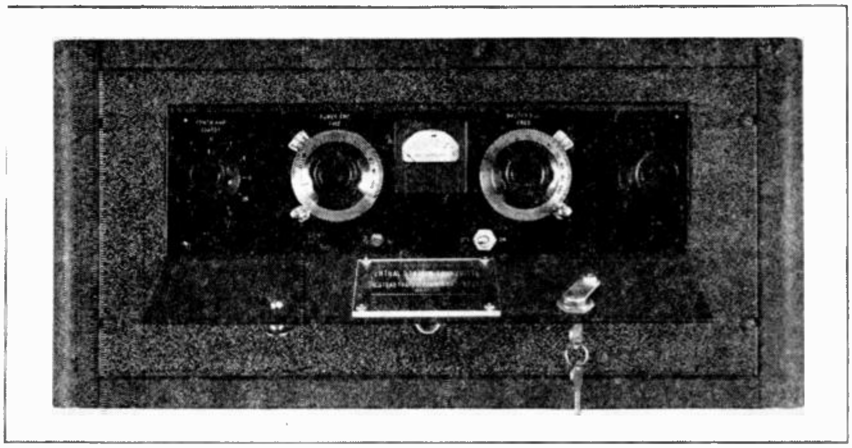
EXPERIMENTS ARE NOW BEING MADE WITH THIS PORTABLE TRANSMITTER-RECEIVER

In order to guard against apparatus failures, conventional signaling equipment operates on the normally closed-circuit principle and, in the event of failure of any part of the system, a positive indication is given the engineer. Railroad radiotelephone systems must include similar failure-indicating equipment if they are to provide safety factors comparable to present railway signaling standards.

As an indication of the importance of audio-visual checking for constantly monitoring the integrity of the radiotelephone system, it may be of interest to note that it was the development of this checking device which persuaded the United States Army Ordnance Department and the operators of the Kingsbury Ordnance Plan to make the first permanent railway radiotelephone installation for dispatching at the Kingsbury Ordnance Plant. The Army officers and operators at Kingsbury, some of whom had long experience in the railroad field, did not consider it safe to depend on radio for dispatching trains carrying high explosives unless some infallible checking system was employed.

It was also emphasized at the recent hearings that methods of recording train orders, whether given verbally or graphically by a control point to train, will be required. Recording equipment of various types, including those utilizing wire, film, steel tape and facsimile method, have been developed during the war period, and it is believed that equipment suitable for railroad use will be available.

Though it is difficult to execute the comprehensive development programs discussed above during the war period, the task is made considerably easier by the fact that many of our leading radio manufacturers have been and are developing new and improved mobile communications equipment and systems for the Armed Services. Since the matter of railroad communications is of utmost importance to America's war effort, as well as to peace-time employment and public safety and convenience, it is desirable to continue present programs aggressively.



EXPERIMENTAL CENTRAL STATION INDUCTION TRANSMITTER UNDER TEST ON N.Y.C.

WILL $16.50 RADIOS SET POSTWAR STANDARDS?

Or Will the Public Be Told: "It's Time to Trade in Your Old Set Because You Can Get a Better One Now"?

BY MILTON B. SLEEPER

A FEW days ago, the morning's mail included a surreptitious-looking little booklet bearing the title *Unpublicized Facts About Frequency Modulation Broadcasting.* That title would have been taken in this office as a promise of highly interesting contents except for the fact that its appearance was similar to other literature we have seen, distributed to foster whispering campaigns. And, sure enough, there was the usual coupon at the back, soliciting the payment of ten cents for copies to be sent to others, presumably so that the campaign could be spread farther.

The name of the author was unfamiliar, although he described himself as a Consulting Engineer. The pamphlet might have gone unread but for the statement on the first page: "Intended for delivery at the Institute of Radio Engineers Rochester Fall Meeting, November, 1944."

That sounded interesting. If the text had been accepted for the Rochester Meeting,[1] it ought to be worth reading. At least, it could be expected that the author knew what he was talking about, and that the "unpublicized facts" would be facts indeed. Both assumptions proved to be in error. He didn't, and they weren't. Looking up Bloomington, Indiana, the author's address, it was not surprising to find it located over 100 miles from the nearest FM transmitters at Evansville and Cincinnati, hardly a spot where one could learn about FM reception first hand. Moreover, we were told that the author had returned recently from some two years in Switzerland where, according to the best grapevine sources, FM waves have never disturbed the ether. We even stopped sending this Magazine to subscribers in Switzerland after Pearl Harbor, because all the addresses had company names which indicated that they were branches of German firms.

So perhaps we should have forgotten all about the little pamphlet—except for the single fact that the contents was offered as being intended for delivery at the Rochester Meeting. If this Consulting Engineer could be so misguided in his thinking, he might lead others astray, too. Consequently, it may serve a useful purpose to publicize some of the "unpublicized facts," and to examine them in broad daylight. Here they are:

By way of introduction the pamphlet began: "After a period of about 20 years, the radio broadcasting system as we know it has reached maturity. We cannot grant many more licenses for new stations without creating serious reception interferences, so that instead of hearing one program clearly the listener would be annoyed by simultaneous reception of several programs. This fact limits the production of broadcasting station equipment by manufacturers. It also hinders the FCC from satisfying the desire of those people who want to get into the broadcasting business by putting up new stations."

Webster's New International Dictionary, Second Edition defines "fact" as: *physical actuality or practical experience as distinguished from imagination, speculation, theory.* By that definition, the statement above can be accepted as *fact*, but it has been so widely publicized as to be common knowledge, surely.

Next is the statement: "The ardent advocates of FM claim the following points of superiority for their system.

"1) High fidelity (so-called more realistic reproduction).

"2) Noise-free reception.

"For the past ten years, radio engineers have attempted with the help of Sales Promotion to have the public buy so-called High Fidelity radio receivers. To date, these efforts have been a failure. Evidently the masses do not care whether the radios they buy have High Fidelity or not. Indeed, there even seems to be a certain dislike for High Fidelity. The public apparently finds some of its characteristics annoying, due to reasons that engineers have been unable to ascertain.

"In contradiction to the claims that FM is superior on the basis of High Fidelity one reads, curiously enough, in the February issue of *Radio* Magazine an editorial cautioning radio engineers not to design FM receivers so they will be High Fidelity. The editor advises the engineers to give the public the type of tone quality they like rather than High Fidelity, which by past experience, is known to be unpopular. Therefore, claims for High Fidelity have no practical value."

This notion, with variations, has certainly been given considerable publicity, even to the point where some people may have come to believe it, but facts are not the mere products of repetition, and no amount of repetition can establish the statement above as a fact. The facts are these:

It is true that some manufacturers built AM sets with high-quality amplifiers. But it is also true that telephone lines used by AM stations, according to AT & T, are only equalized to 5,000 cycles. Consequently, an AM receiver capable of receiving 8,000 cycles with the tone control full on can reproduce only noise from 5,000 to 8,000 cycles, since no signals are transmitted above 5,000 cycles.

High fidelity AM receivers have "no practical value" because there are no high fidelity AM signals to receive, but FM transmitters, before they are licensed by the FCC must show, by actual measurement, that they not only can transmit 15,000 cycles but that the noise level is below the point where it can interfere with high fidelity transmission. Thus, on FM, a good receiver can deliver "realistic reproduction" of the original speech and music! Even a radio editor should be able to grasp this single difference between AM and FM, although the truth is that some radio engineers still do not, and will not until they learn by the experience of listening to FM stations when they are transmitting at full fidelity.

It should not be necessary to add that it is impossible to reproduce high fidelity FM transmission on a $60 receiver. William A. Ready, president of National Company, Inc., stated the case for high audio quality very clearly in these words: "We take it to mean that fidelity refers to the ability of a system to reproduce the original sound faithfully. The more the reproduction sounds like the original, the higher the fidelity. We think there is not much argument here.

"For the reproduction to be a perfect replica of the original, nothing must be added or taken away. Unless the system can reproduce a wide range of frequencies, something is taken away. The 'highs' are missing. Unless the system is free from distortion, something is added. Harmonics are present. In our experience, distortion is more important, and much more diffi-

(CONTINUED ON PAGE 69)

[1] The Rochester Meeting is not held under the auspices of the I.R.E., but is separately incorporated.

387 FM STATIONS NOW OPERATING OR PROJECTED

With 61 More Applications, 220 Cities in 41 States Are Now Represented Up to November 22, 1944

ALABAMA

Station	Call	Sq. Mi.	Mc.
Birmingham			
Birmingham News Co		17,700	44.5
Voice of Ala Inc[1]		17,200	45.9
Birmingham Bcstg Co Inc		18,580	46.9
Huntsville			
Huntsville Times Co Inc		12,900	48.9
Mobile			
Pape Bcstg Co		10,000	46.1
Montgomery			
Montgomery Bcstg Co Inc		17,299	43.5
G W Covington Jr (WCOV)		4,761	45.5

[1] C.P. granted for new Dev station.

CALIFORNIA

Station	Call	Sq. Mi.	Mc.
Alameda			
Times-Star Pub Co		6,450	49.1
Avalon			
So Catalina Id Co		34,500	43.7
Fresno			
J E Rodman (KFRE)		24,752	44.1
Hollywood			
C B S Inc		34,000	43.1
Warner Bros Bcstg Corp		3,118	44.9
Los Angeles			
Univ of Southern Calif		.....	42.9
Blue Network Co Inc		21,024	43.1
Times-Mirror Co		15,857	43.3
Earle C Anthony Inc (KECA KFI)		34,000	43.7
N B C Inc		.....	44.1
Don Lee Bcstg Sys (KHJ)[1]	KHJ-FM	.....	44.5
KJBS Bcstrs		6,574	44.7
Standard Bcstg Co (KFVD)		7,000	45.3
Cons Bcstg Corp Ltd		7,000	45.7
MGM Studios Inc		.....	46.1
Oakland			
Tribune Bldg Co (KLX)		1,216	46.5
Ontario			
The Daily Report		2,240	49.9
Richmond			
Contra Costa Bcstg Co		4,490	49.5
Riverside			
Bcstg Corp of Amer (KPRO)		48,000	43.5
San Bernardino			
High School District (Ed)		250 w	42.9
Sun Co of San Bernardino		17,101	44.1
San Francisco			
Board of Education (Ed)	KLAW	.....	42.1
Associated Bcstrs Inc (KSFO)		.....	43.1
Don Lee Bcstg Sys (KFRC)		18,050	43.5
N B C Inc (KPO)		.....	43.9
Hearst Publications Inc		.....	44.3
Stockton			
E F Peffer (KGDM)		19,696	45.9
Ventura			
Supt of County Schools (Ed)		1 kw	....

[1] Application has been made for change to 34,000 sq. mi. 43.5 mc.

COLORADO

Station	Call	Sq. Mi.	Mc.
Denver			
KLZ Bcstg Co (KLZ)		31,400	43.5
Satellite 100 w		.....	43.5
N B C Inc (KOA)		.....	43.9

CONNECTICUT

Station	Call	Sq. Mi.	Mc.
Hartford			
Hartford Times Inc (WTHT)		21,900	43.7
Travelers Bcstg Svc Corp (WTIC)	WTIC-FM	6,100[1]	45.3[1]
WDRC Inc (WDRC)	WDRC-FM	.....	46.5
New London			
Thames Bcstg Co (WNLC)		3,500	44.5

[1] Application filed to change to 15,563 sq. mi., 43.3 mc.

DELAWARE

Station	Call	Sq. Mi.	Mc.
Wilmington			
WDEL Inc (WDEL)		6,400	44.5

DISTRICT OF COLUMBIA

Station	Call	Sq. Mi.	Mc.
Washington			
Jansky & Bailey (Exp)	W3XO	1 kw	43.2
N B C Inc (WRC)		.....	44.3
Comml Radio Equip Co (Dev)[1]		250 w	44.7
Times Herald		.....	46.3
Capital Bcstg Co (WWDC)		8,020	46.7
Eve Star Bcstg Co (WMAL)		5,600	47.1
Cowles Bcstg Co (Dev)		1 kw	49.1

[1] Satellite, Washington area, on 44.7 mc 100 w

FLORIDA

Station	Call	Sq. Mi.	Mc.
Jacksonville			
Florida Bcstg Co (WMBR)		11,700	44.7
Miami			
Miami Bcstg Co		3,630	46.5
Tampa			
Tribune Co (WFLA)		.....	....
Tampa Times Co		8,100	45.1

GEORGIA

Station	Call	Sq. Mi.	Mc.
Atlanta			
Board of Education (Ed)		1 kw	42.5
Atlanta Journal Co (Dev)		700 w	43.7
Constitution Pub Co		7,380	45.3
Macon			
Middle Georgia Bcstg Co		12,600	45.7
Macon Telegraph Pub Co		12,000	46.7
Southeastern Bcstg Co		12,600	47.7

IDAHO

Station	Call	Sq. Mi.	Mc.
Boise			
Boise Bcstg Sta		1,148	48.5

ILLINOIS

Station	Call	Sq. Mi.	Mc.
Bloomington			
WJBC Radio Station		6,660	45.3
Champaign			
Champaign News-Gazette Inc		4,660	49.1
Chicago			
Board of Education (Ed)	WBEZ	.....	42.5
Agricultural Bcstg Co		10,624	44.7
WJJD Inc (WJJD)		10,800	44.7
Zenith Radio Corp	WWZR	10,800	45.1
WGN Inc (WGN)	WGNB	10,800	45.9
N B C Inc (WMAQ)		10,800	46.3
C B S Inc (WBBM)	WBBM-FM	10,800	46.7
Moody Bible Inst	WDLM	.....	47.5
Chicago Fed of Labor (WCFL)		10,800	47.9
Oak Park Real & Am Co		10,800	47.9
WHFC Inc (WHFC)		.....	48.3
Blue Network Co Inc (WENR)		11,000	48.7
Drovers Journal Pub Co (WAAF)		10,800	48.7
Decatur			
Commodore Bcstg Inc (WSOY)		15,708	46.5
Evanston			
Board of Education (Ed)		.....	....
Macomb			
W Ill State Teachers Col (Ed)		1 kw	....
Peoria			
Peoria Bcstg Co (WMBD)		11,613	48.7
Quincy			
Illinois Bcstg Corp (WTAD)		15,300	44.1
Rockford			
Rockford Bcstrs Inc (WROK)		3,900	47.1
Rock Island			
Rock Island Bcstg Co (WHBF)		3,000	44.5
Springfield			
WCBS Inc		12,918	46.1
Commodore Bcstg Inc		8,050	49.9
Urbana			
Board of Education (Ed)	WIUC	.....	42.9
Waukegan			
Keystone Printing Service		2,890	47.1

INDIANA

Station	Call	Sq. Mi.	Mc.
Bloomington			
Indiana Univ (Ed)		.....	42.9
Evansville			
Evansville on the Air[1]	WMLL	.....	44.5
Fort Wayne			
Westinghouse Radio Stations Inc	WOWO-FM	.....	44.9
Farnsworth Tele & Radio Corp		8,500	46.1
Glenwood			
Evansville on the Air (Dev)		1 kw	43.3
Hammond			
WJOB Radio Station (WJOB)		2,241	49.9
Indianapolis			
Indianapolis Bcstg Inc (WIRE)		13,640	45.3
Scripps-Howard Radio Inc		8,400	46.9
Assoc Broadcasters Inc		.....	47.3
WFBM Inc (WFBM)		16,600	47.7
Capitol Bcstg Corp (WISH)		14,120	48.7
Muncie			
Donald A Burton (WLBC)		9,600	46.5
Shelbyville			
Shelbyville Radio Inc		3,730	46.1
South Bend			
South Bend Tribune	WSBF	.....	47.1
Terre Haute			
Banks of Wabash Inc		7,440	48.7
West Lafayette			
Purdue University (Ed)		.....	42.7

[1] Application filed for new station, 17,458 sq. mi., 43.1 mc.

IOWA

Station	Call	Sq. Mi.	Mc.
Ames			
Iowa State College (Ed)		1 kw	42.9
Cedar Rapids			
Gazette Co		7,400	44.7
Davenport			
Tri-City Bcstg Co		7,400	46.3
Des Moines			
Central Bcstg Co (WHO)		18,200	46.1
Cowles Bcstg Co		1 kw	49.1
Dubuque			
Telegraph Herald (KDTH)		8,060	46.5
Waterloo			
Josh Higgins Bcstg Co (KXEL)		26,943	44.3

KANSAS

Station	Call	Sq. Mi.	Mc.
Hutchinson			
Hutchinson Pub Co		15,200	43.3
Lawrence			
Univ of Kansas (Ed)		1 kw	42.9
Topeka			
Topeka Bcstg Assn Inc		4,804	45.5

KENTUCKY

Station	Call	Sq. Mi.	Mc.
Ashland			
Ashland Bcstg Co (WCMI)		4,160	46.1
Beattyville			
Univ of Ky (Ed)	WBKY	.....	42.9
Lexington			
Amer Bcstg Corp of Ky		6,300	45.1
Louisville			
Courier-Journal, L'v'le Times		13,200	45.5
Northside Bcstg Corp		8,665	46.3
Wave, Inc (WAVE)		13,300	46.9
Owensboro			
Owensboro Bcstg Co		7,250	47.9

LOUISIANA

Station	Call	Sq. Mi.	Mc.
Baton Rouge			
Baton Rouge Bcstg Co	WBRL	.....	44.5
New Orleans			
Loyola Univ (WWL)		8,478	44.9
Times Picayune Pub Co		13,188	45.7

MAINE

Station	Call	Sq. Mi.	Mc.
Augusta			
Gannett Pub Co Inc		3,968	49.1
Portland			
Portland Bcstg Sys Inc[1] (WGAN)		3,980	47.1

[1] Application has been made for new station on 45.1 mc, 6512 sq. mi. for Bangor Area.

MARYLAND

Station	Call	Sq. Mi.	Mc.
Baltimore			
Maryland Bcstg Co (Dev)		1 kw	43.2
Hearst Radio Inc		8,857	43.7
Md Bcstg Corp (WITH)		28,898	44.1
Balt Radio Show Inc (WFBR)		19,135	45.9
Monumental Radio Co (WCAO)		4,520	47.9
Baltimore Bcstg Corp		3,600	48.3
Olney			
FM Devel Foundation		18,844	43.9
Salisbury			
Peninsula Bcstg Co (WBOC)		6,000	48.9

MASSACHUSETTS

Station	Call	Sq. Mi.	Mc.
Boston			
Filene's Television Inc		21,709	43.1
E Anthony & Sons Inc		19,650	43.3
C B S Inc (WEEI)		20,200	43.5
Yankee Network	WGTR	.....	44.3
Worcester Tele Pub Co		7,000	45.3
Westinghouse Radio Stations Inc (WBZ)	WBZ-FM	.....	46.7
Fidelity Bcstg Corp		3,600	47.1
Matheson Radio Co Inc[1] (WHDH)		3,600	47.7
Mass Bcstg Corp (Dev)		1 kw	49.1
Fall River			
Doughty & Welch Elec Co		2,120	47.3

[1] C. P. granted for Dev station 49.9 mc, 1 kw.

	Call	Sq. Mi.	Mc.
Greenfield			
J W Haigis		3,556	49.9
Holyoke			
Hampden-Hampshire Corp (WHYN)		14,340	44.1
Lawrence			
Hildreth & Rogers Co (WLAW)		2,970	44.9
New Bedford			
E Anthony & Sons Inc (WNBH)		1,787	45.7
Pittsfield			
Monroe B England (WBRK)		950	45.7
Springfield			
Westinghouse Radio Stations Inc (WBZA)	WBZA-FM		48.1
Waltham			
Raytheon Mfg. Co.		6,530	45.5
Worcester			
Worcester Tele Pub Co (WTAG)	WTAG-FM		[1]46.1

[1] Application has been made for new station on 43.5 mc., 20,437 sq. mi.

MICHIGAN

	Call	Sq. Mi.	Mc.
Ann Arbor			
Univ of Michigan (Ed)		50 kw	42.9
Battle Creek			
Federated Pubs Inc (WELL)		4,100	48.1
Bay City			
Bay City School District			
Bay Bcstg Co Inc		8,157	46.1
Benton Harbor			
Palladium Pub Co		1,825	46.1
Dearborn			
Herman Radner (WIBM)			49.5
Detroit			
Board of Education (Ed)		1 kw	42.7
Evening News Assn (WWJ)	WENA		44.5
John Lord Booth (WMBC)	WLOU		44.9
WJR Goodwill Station (WJR)		6,800	45.3
James F Hopkins Inc (WJBK)		6,790	46.5
King-Trendle Bcstg Corp.		6,750	47.3
Grand Rapids			
Fetzer Bcstg Co		18,250	43.9
Leonard A Versluis		6,460	46.1
King-Trendel Bcstg Corp.		5,300	46.9
Houghton			
Mich Col of Mining & Tech			42.1
Jackson			
Board of Education (Ed)			
WIBM Inc (WIBM)			49.5
Kalamazoo			
West Mich Col of Ed (Ed)			42.5
Lansing			
WJIM Inc (WJIM)		3,800	47.7
Mt. Pleasant			
Board of Education (Ed)			
Muskegon			
Ashbacker Radio Corp (WKBZ)		2,290	45.7
Port Huron			
Times, Herald Co		5,600	47.7
Saginaw			
Saginaw Bcstg Co (WSAM)		2,100	45.5
Wyandotte			
Wyandotte News Co		775	46.1

MINNESOTA

	Call	Sq. Mi.	Mc.
Minneapolis			
Minnesota Bcstg Corp		16,155	45.3
Northwest Bcstg Co		1 kw	49.1
Rochester			
So Minn Bcstg Co		15,400	43.7
St. Paul			
WMIN Bcstg Co		13,273	45.7

MISSOURI

	Call	Sq. Mi.	Mc.
Clayton			
School District (Ed)		1 kw	
Kansas City			
School District (Ed)		1 kw	42.5
Kansas City Star Co		26,400	44.5
Commercial Radio Equip Co	KOZY		44.9
Midland Bcstg Co (KMBC)[1]	KMBC-FM	6,700	46.5
WBH Bcstg Co (WBH)		9,200	46.9

[1] Application filed for new station, 43.9 mc.

	Call	Sq. Mi.	Mc.
St. Joseph			
KFEQ Inc (KFEQ)			46.9
St. Louis			
Board of Ed (Ed)		3 kw	42.5
Star-Times Pub Co (KXOX)		13,083	44.7
St Louis Univ (WEW)		13,000	45.1
Missouri Bcstg Corp		13,200	45.1
Pulitzer Pub Co (KSD)		13,391	45.5
C B S Inc		13,400	45.9
Globe-Democrat Pub Co.		13,083	46.3

NEBRASKA

	Call	Sq. Mi.	Mc.
Lincoln			
Cornbelt Bcstg Corp		18,300	47.3
Omaha			
World Pub Co (KOWH)		11,660	45.5

NEVADA

	Call	Sq. Mi.	Mc.
Las Vegas			
Nevada Bcstg Co		560	49.5

NEW HAMPSHIRE

	Call	Sq. Mi.	Mc.
Manchester			
Radio Voice of N H Inc (WMUR)		31,630	43.5
Mt. Washington			
Yankee Network	WMTW		43.9

NEW JERSEY

	Call	Sq. Mi.	Mc.
Brunswick			
Home News Pub Co		3,420	49.9
Jersey City			
N J Bcstg Corp (Dev)		1 kw	49.1
Bremer Bcstg Co			49.5
Newark			
Board of Ed (Ed)			42.5
Evening News Pub Co		19,851	43.5
Fidelity Media Bcstg Corp		5,100	49.1
N J Bcstg Corp (WHOM)		6,200	49.1
Paterson			
N Jersey Bcstg Co Inc		4,928	49.9
Passaic Daily News		3,878	49.9
Trenton			
Mercer Bcstg Co		3,200	49.9

NEW MEXICO

	Call	Sq. Mi.	Mc.
Albuquerque			
Univ of N M (Ed.)		250w	

NEW YORK

	Call	Sq. Mi.	Mc.
Albany			
WOKO Inc (WOKO)		7,164	45.1
Binghamton			
Wylie B Jones Advt Agency (WNBF)	WNBF-FM		44.9
Brooklyn			
Frequency Bcstg Corp		14,400	43.7
Buffalo			
Board of Education (Ed)			42.9
WBEN Inc (WBEN)		21,830	43.3
WEBR Inc (WEBR)		3,420	46.5
Corning			
Evening Leader		5,213	49.7
Floral Park			
Sewanhaka High School (Ed)			
Ithaca			
Cornell University (WHCU)		15,000	43.3
Jamestown			
James Bcstg Co			46.1
New York			
Board of Education (Ed)	WNYE		42.1
Edwin H Armstrong (Exp)	W2XMN		42.8
Municipal Bcstg Sys (WNYC)	WNYC-FM		43.9
Musak Corp	WGYN		44.7
NBC Inc (WEAF)			45.1
WGH Finch			45.1
N Y Times	WQXQ		45.9
Marcus Loew Bkg Agency (WHN)	WHNF		46.3
C B S Inc (WABC)	WABC-FM		46.7
Bamberger Bcstg Svc (WOR)	WBAM		47.1
Metro Television Inc	WABF		47.5
Blue Network Inc (WJZ)		8,950	47.9
News Syndicate Co Inc		8,500	47.9
WBNX Bcstg Co Inc (WBNX)		8,730	48.3
WMCA Inc (WMCA)		8,550	48.3
Hearst Radio Inc (WINS)		8,570	48.7
Debs Mem Radio Fund Inc		8,600	48.7
Greater N Y Bcstg Corp		8,500	48.7
Bernard Fein		8,500	48.7
Ogdensburg			
St Lawrence Bcstg Corp			
Oswego			
Palladium-Times Inc		2,392	48.9
Poughkeepsie			
P'kpsie Newspapers Inc		10,198	44.3
Rochester			
WHEC Inc (WHEC)	WHEF		44.7
Stromberg-Carlson Tel Co (WHAM)	WHFM		45.1
Schenectady			
Capitol Bcstg Co	WBCA		44.7
General Electric Co	WGFM		48.5
Syracuse			
WAGE, Inc (WAGE)		7,780	45.5
Onondaga Radio Bcstg Corp		6,745	45.9
Central N Y Bcstg Corp (WSYR)		6,800	46.3
Utica			
WIBX Inc		10,290	45.7
Watertown			
Brockway Co (WWNY)		4,145	47.3
White Plains			
Westchester Bcstg Corp (WFAS)		3,540	49.9

NORTH CAROLINA

	Call	Sq. Mi.	Mc.
Durham			
Durham Radio Corp (WDNC)			
Greensboro			
N C Bcstg Co Inc		13,200	43.9
Greensboro Bcstg Co		11,130	44.5
Greensboro News Co		5,820	45.5
High Point			
Radio Sta WFMR Inc (WFMR)		5,030	45.1
Raleigh			
WPTF Radio Co (WPTF)		23,343	43.3
Roanoke Rapids			
Telecast Inc		5,198	49.1
Salisbury			
Piedmont Bcstg Corp		6,950	49.3
Winston-Salem			
Gordon Gray	WMIT		44.1
Piedmont Pub Co (WSJS)		4,600	46.7
Wm Henry Alford			

NORTH DAKOTA

	Call	Sq. Mi.	Mc.
Fargo			
KVOX Bcstg Co		5,800	44.5
Grand Forks			
University of N D (Ed)			

OHIO

	Call	Sq. Mi.	Mc.
Akron			
Summit Radio Corp (WAKR)		922	46.5
Ashland			
Beer & Koehl		8,494	48.9
Astabula			
WICA Inc (WICA)		4,116	48.9
Canton			
Ohio Bcstg Co		8,499	46.1
Cincinnati			
Cincinnati Bcstg Co		19,100	43.7
Crosley Corp (WLW) (Exp)	W8XFM	13,700	45.5
L B Wilson Inc (WCKY)		13,700	45.9
Cin Times Star Co		13,700	46.7
Scripps Howard Radio Inc		13,700	47.9
Cleveland			
Board of Education (Ed)	WBOE		42.5
N B C Inc (WTAM)			43.7
WGAR Bcstg Co (WGAR)		8,500	45.5
United Bcstg Co (WCLE WHK)		8,420	48.5
Columbus			
Central Ohio Bcstg Co		21,010	43.1
WBNS Inc (WBNS)	WELD		44.5
Crosley Corp		12,400	46.5
United Bcstg Co (WHCK)		12,400	48.1
The Pixleys		12,500	48.5
Dayton			
Crosley Corp		8,000	46.1
Newark			
Advocate Ptg Co			45.7
Steubenville			
Valley Bcstg Co (WSTV)		5,360	46.9
Toledo			
Board of Education (Ed)			
Fort Industry Co		19,350	43.5
Toledo Blade Co		7,780	47.9
Warren			
Nied & Stevens		262	49.1
Wooster			
Wooster Rep Ptg Co		7,780	49.3
Youngstown			
WKBN Bcstg Co (WKBN)		15,690	43.3
WFMJ Bcstg Co (WFMJ)		15,610	44.1

OKLAHOMA

	Call	Sq. Mi.	Mc.
Lawton			
Ned Shepler		4,500	48.9
Norman			
State Univ of Okla (Ed)		3 kw	42.3
Oklahoma City			
Plaza Court Bcstg Co (KOCY)		15,394	
WKY Radiophone Co (WKY)		21,000	44.5
Tulsa			
Fred Jones Bcstg Co		22,000	45.3
World Pub Co, Tulsa Tribune Co		23,850	45.7

OREGON

	Call	Sq. Mi.	Mc.
Medford			
Mrs W J Virgin		3,121	49.5
Portland			
T V Ehmsen		1 kw	45.5
KOIN, Inc (KOIN)		12,856	45.7
Oregonian Pub Co		13,382	46.1
Bcstrs Oregon Ltd		5,826	48.5

PENNSYLVANIA

	Call	Sq. Mi.	Mc.
Bethlehem			
Associated Bcstrs Inc (WEST)		2,800	48.5
Butler			
Eagle Printing Co			
Easton			
Associated Bcstrs Inc		2,800	48.5
Harrisburg			
Keystone Bcstg Corp (WKBO)		4,000	44.7
Johnstown			
WJAC Inc (WJAC)		21,792	45.1

	Call	Sq. Mi.	Mc.
Lancaster			
WGAL Inc (WGAL).....	....	1,200	45.5
Philadelphia			
Penn Bcstg Co (WIP)....	WIP-FM	.....	44.9
WFIL Bcstg Co (WFIL).	WFIL-FM	.....	45.3
Westinghouse Radio Stations Inc (KYW)......	KYW-FM	.....	45.7
Gibraltar Svc Corp......	....	9,318	46.1
WCAU Bcstg Co (WCAU)	WCAU-FM	.....	46.9
Wm Penn Bcstg Co (WPEN)..............	WPEN-FM	.....	47.3
WDAS Bcstg Station Inc (WDAS)...............	....	9,300	47.7
Triangle Pubs (Phila-Inquirer).............	....	12,850	48.1
Pittsburgh			
Liberty Bcstg Co.........	....	.....	....
Walker-Downing Corp (WWSW)............	WTNT	.....	44.7
WCAE Inc (WCAE).....	....	8,650	45.5
Pitts Radio Sup House (WJAS)...............	....	8,400	46.5
Westinghouse Radio Stations Inc (KDKA).....	KDKA-FM	.....	47.5
Reading			
Hawley Bcstg Co.........	....	4,275	46.5
Scranton			
Scranton Bcstrs Inc......	....	19,557	48.1
Sharon			
Sharon Herald Bcstg Co (WPIC)..............	....	11,030	45.9
Uniontown			
Fayette Bcstg Corp......	....	10,240	48.1
Westchester			
State Teachers Col (Ed)..	....	.....	....
Wilkes-Barre			
Louis G Baltimore (WBRE)	....	.....	....
Williamsport			
WRAK Inc.............	....	11,675	47.7
York			
Susquehanna Bcstg Co (WSBA)...............	....	3,060	44.5
York Bcstg Co (WORK).	....	1,550	45.1
RHODE ISLAND			
Pawtucket			
Pawtucket Bcstg Co.....	....	3,760	45.1
Providence			
A A Schechter..........	....	3,950	45.1
Providence Journal Co...	....	7,780	46.9
Cherry & Webb Bcstg Co (WPRO)..............	....	6,207	47.5
Outlet Co (WJAR)......	....	6,412	48.5
SOUTH CAROLINA			
Charleston			
Atlantic Coast Bcstg Co..	....	6,400	47.7
Columbia			
Surety Life Ins. Co......	....	16,230	43.1
Greenville			
Greenville News-Piedmont Co..................	....	23,678	44.1
Greenwood			
Grenco Inc.............	....	5,305	44.7
Spartanburg			
Spartanburg Adv Co (WSPA).............	....	26,600	43.5
TENNESSEE			
Chattanooga			
WAPO Bcstg Svce (WAPO) (Dev).......	....	1 kw	43.7
WDOD Bcstg Corp (WDOD)............	....	23,800	47.5
Jackson			
Sun Pub Co Inc.........	....	13,400	47.1
Knoxville			
Amer Bcstg Corp (WBIR)	....	3,230	45.1
Nashville			
Ntl Life & Acc Ins Co (WSM)..............	WSM-FM	.....	44.7
Nashville Radio Corp....	....	16,000	46.5
TEXAS			
Abilene			
Reporter Bcstg Co......	....	6,936	45.7
Amarillo			
Amarillo Bcstg Corp (KFDA).............	....	5,600	45.1
Austin			
Frontier Bcstg Co Inc....	....	12,900	47.1
Beaumont			
KRIC Inc (KRIC)......	....	6,650	43.1
Dallas			
A H Belo Corp..........	....	22,700	43.7
KRLD Radio Corp......	....	20,000	45.7
Harlingen			
Harbenito Bcstg Co......	....	2,400	48.9
Houston			
Houston Printing Corp (KPRC)..............	....	10,500	46.5
KTRH Bcstg Co........	....	14,300	47.7
San Angelo			
KGKL Inc.............	....	6,936	45.3
San Antonio			
Southland Industries Inc (WOAI)...............	....	16,500	44.5
Walmac Co.............	....	10,506	45.3
Waco			
Frontier Bcstg Co.......	....	13,700	46.1
Wichita Falls			
Rhea Howard..........	....	12,800	46.5
UTAH			
Salt Lake City			
Radio Serv Corp of Utah (KSL)..............	....	.....	44.7
Intermountain Bcstg Corp	....	800	46.7
VIRGINIA			
Newport News			
Hampton Roads Bcstg Corp.................	....	5,950	44.7
Norfolk			
WTAR Radio Corp (WTAR).............	....	5,702	46.5
Portsmouth			
Portsmouth Radio Corp..	....	5,250	47.3
Richmond			
Havens & Martin Inc (WMBG)............	....	12,130	46.1
Richmond Radio Corp...	....	11,269	46.3
WASHINGTON			
Seattle			
Radio Sales Corp........	....	8,200	44.5
Spokane			
Louis Wasmer Inc (KHQ)	....	12,609	45.7
WEST VIRGINIA			
Beckley			
Beckley Newspapers Corp	....	8,500	....
Charleston			
Charleston Bcstg Co (WCHS).............	....	.....	....
Morgantown			
W Va Radio Corp.......	....	33,244	43.3
Satellite on 49.9 mc. at Pittsburgh 1,620 sq. mi.			
Satellite on 49.9 mc. at Wheeling 344 sq. mi.			
WISCONSIN			
Green Bay			
Green Bay Newspaper Co	....	.....	....
Madison			
Badger Bcstg Co........	....	31,640	43.3
Milwaukee			
Hearst Radio Inc........	....	17,791	43.5
Journal Co (WTMJ).....	WMFM	[1]8,500	[1]45.5
Milwaukee Bcstg Co....	....	1,279	48.9
[1] Application filed to change to 17,829 sq. mi., 43.9 mc			
Oshkosh			
Oshkosh Bcstg Co (WOSH)	....	3,810	44.5
Racine			
Racine Bcstg Corp......	....	2,540	49.1
Sheboygan			
Press Pub Co...........	....	2,360	48.5
Superior			
Head of the Lakes Bcstg Co (WEBC)..........	WDUL	.....	44.5
Wausau			
Record Herald..........	....	.....	46.5

ELECTRONIC MANUFACTURERS ASSOCIATION IS FORMED

THE Electronics Manufacturers Association has been formed by manufacturers in the New York and New Jersey area to exchange information on labor rates, and to consider questions arising from CIO-AFL agreements. Union representatives and an EMA committee are already exploring the possibilities of a master agreement. It is contemplated that industry-wide, impartial machinery will be set up to handle disputes between member companies and the unions, supplanting present arrangements provided in the separate and widely different agreements now in effect.

EMA will also consider all questions involving War Labor Board procedures, War Manpower Commission regulations, and related matters arising from Government rulings on labor problems. A regular bulletin service to members has been established to make available detailed analyses and comparisons of labor rates and other provisions of prevailing labor contracts.

Officers of EMA are:

President, I. Walter Wyckoff, Pilot Radio
Vice president, Leslie G. Thomas, Solar
Vice president, Arthur Freed, Freed Radio
Secretary, J. J. Kuscher, DeJur-Amsco
Treasurer, Samuel J. Novick, Electronic Corp. of Amer.

The directors include the officers listed above together with:

David Wald, United Scientific Labs.
Jack M. Marks, Fada Radio & Electric
Harold Shevers, Espey
Arthur C. Ansley, Ansley Radio
David H. Engelson, Federal Mfg. & Eng.
Harold Golden, United Transformer

Offices of the Association are being set up in the Empire State Building, New York City, and will be ready for occupancy soon after January 1st. Counsel for EMA is Erwin Feldman.

At the time of the Annual RMA Conference in Chicago last summer, the opinion was expressed that RMA should undertake the exchange of information on labor contracts, so that the problems arising from reconversion could be anticipated. However, with characteristic reluctance to undertake anything requiring action beyond the formation of a committee, this very important matter was side-stepped.

If the collective agreement negotiations of EMA proceed, it will be the first time in many years that any representative group of the industry has undertaken such a program.

The Association will divide its work into problems relating to the manufacture of sets and parts. Executive head of the radio set division is I. Walter Wyckoff, with Leslie G. Thomas heading the parts division. Radio executives desiring further information concerning EMA should address I. Walter Wyckoff, Pilot Radio Corporation, 37-06 36th Street, Long Island City 1, N. Y.

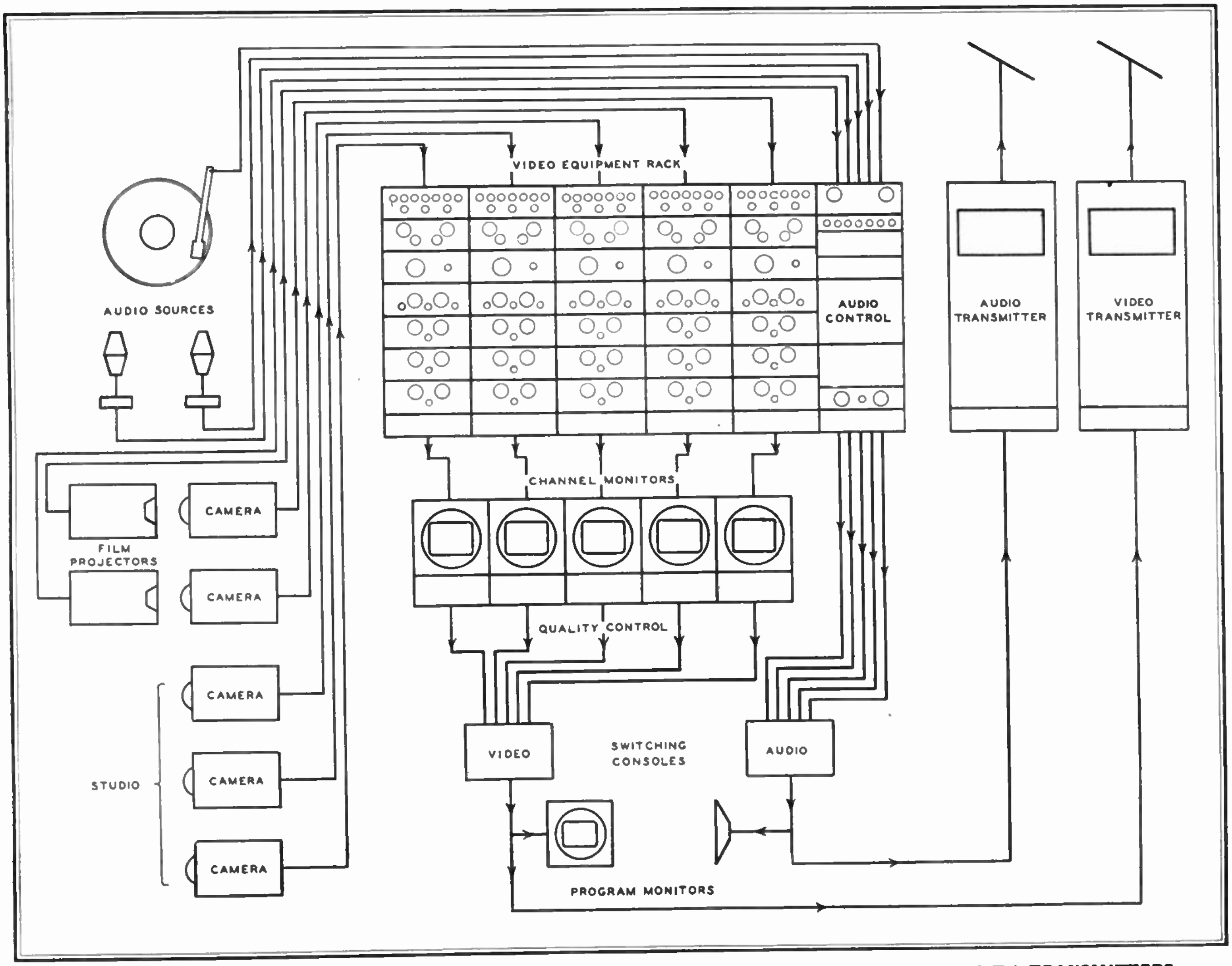


FIG. 10. ARRANGEMENT OF VIDEO AND AUDIO SOURCES, MONITORS, MONITORING CONTROLS, AND S-T-L TRANSMITTERS

DETAILS OF TELEVISION STATION WRGB

Part 2. The Studio Equipment and the Layout of the Operating Controls

BY JAMES D. McLEAN*

EDITOR'S NOTE: *Part 1 of this series, published in the November issue, covered the physical facilities at General Electric's Schenectady station WRGB. Plan and elevation drawings showed the arrangement and locations of the various rooms in the building and the different elements of the video and sound equipment.*

Operating Circuits ★ Fig. 10 shows, in simplified form, the different parts of the studio equipment at station WRGB, and the paths through which the sound and picture signals travel.

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

There are five cameras available in the studio. Three are for picking up live talent programs in the main studio room, while two are used in conjunction with the film and slide projectors, Figs. 7 and 8.

Microphone outlets, located at convenient intervals in the studio, permit the simultaneous operation of three microphones for live talent pickup. Audio channels are also provided for the sound heads on the motion picture projectors, and for the transcription turntables. All these audio sources appear at the left in Fig. 10.

As the block diagram shows, the cameras feed into the video equipment racks located in the control room. Each camera has its own video equipment rack. These will be described in detail later. Each video equipment rack feeds a channel monitor, permitting the simultaneous monitoring of any number of cameras operating in the studio or projection room. The camera shading controls are on the monitoring desk, while the video controls are on the switching console. These are shown in Fig. 9. Switching facilities are so arranged that the particular camera on the air is automatically connected to the program picture monitor and to the studio-to-transmitter link transmitter, which is located in the control room, behind the operators.

Electronic Television is

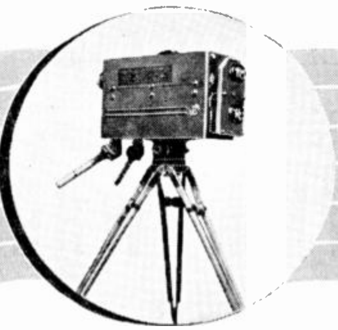
This is a story of leadership—as clean-cut, unassailable and complete as any industry can show.

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

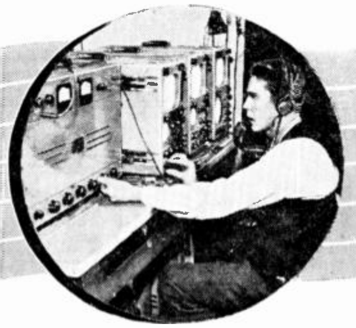
RCA factories built the first transmitters and the first receivers of the type now almost universally used. The Radio Corporation of America through its broadcasting service—the National Broadcasting Company—installed the *first commercial television station*—a station whose operating and programming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

ELEMENTS OF THE TELEVISION SYSTEM

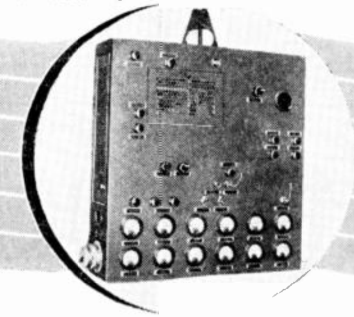
1. THE ICONOSCOPE—The "electric eye" of the television camera. Developed by Dr. V. K. Zworykin, RCA scientist, and brought to a high degree of perfection by RCA engineers.



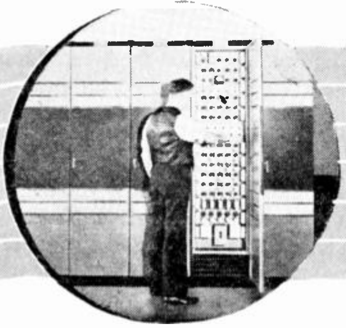
5. THE FIELD CAMERA — The RCA field pickup camera shown here is the first camera to use the "orthicon" pickup tube—by far the most satisfactory for "outside" pickups.



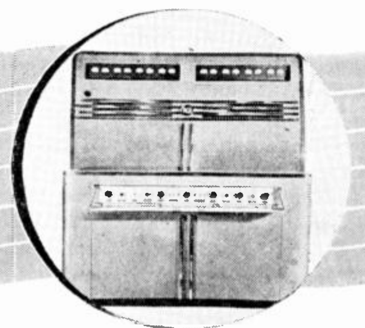
6. REMOTE PICKUP EQUIPMENT — RCA engineers built the first television equipment for field pickups—and the first such equipment (shown here) for use with the "orthicon" camera.



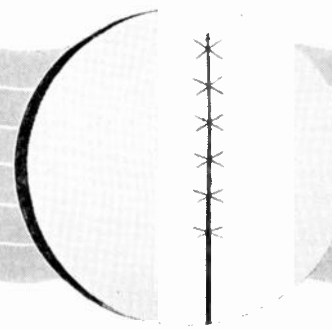
7. THE RELAY TRANSMITTER — The first transmitters to be used for television relaying were built by RCA engineers—the one shown here is for relaying from a remote pickup point.



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



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



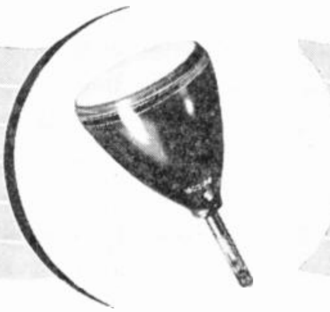
13. THE TELEVISION ANTENNA—RCA engineers have designed a large number of antennas for television. The turnstile antenna, shown here, was developed by Dr. G. H. Brown of RCA Laboratories.

an RCA Development

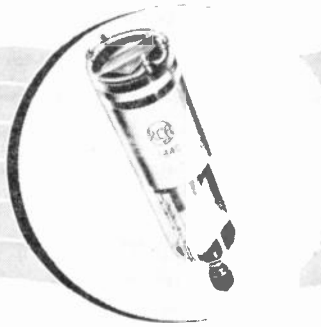
RCA and NBC engineers, working together, established the *first television relay system*, put on the first outdoor program, the first "theatre" television, the first Broadway play, the first baseball game, the first television from an airplane.

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

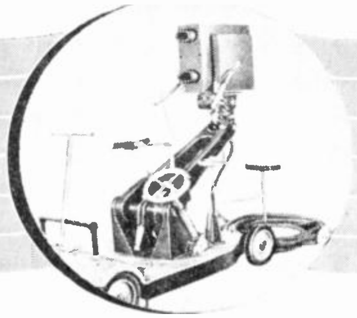
You can expect the best of all kinds of television transmitting and receiving equipment from RCA—the leader from start to finish.



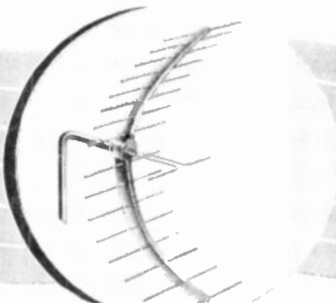
2. *THE KINESCOPE* — The reproducing tube used in all present-day receivers. Developed by Dr. V. K. Zworykin of RCA Laboratories as part of his "all-electronic" television system.



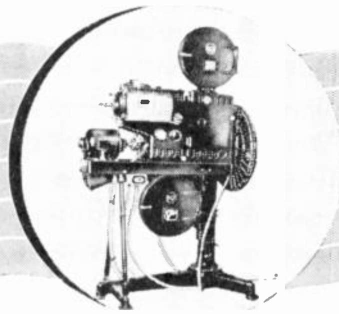
3. *THE "ORTHICON"* — The high-sensitivity pickup tube, which requires much less light and hence makes outside pickups practical. Developed by Dr. Rose and Dr. Iams of RCA Laboratories.



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.

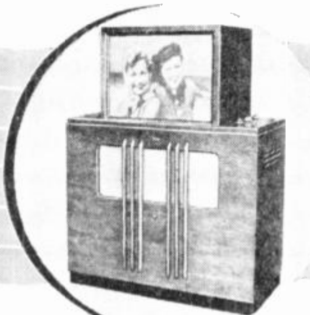


8. *BEAM ANTENNAS* — Beam antennas such as the one shown here, which may be used with the relay transmitter shown at left, are largely based on original RCA research.



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

RCA

For Everything in Television

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

In a similar manner, the audio sources feed into a rack which contains the necessary pre-amplifiers and line amplifiers. Associated with this rack is an audio control console, also shown in Fig. 9, similar to that used in the operation of a sound broadcast station. A loudspeaker is located in the control room, so that the sound can be monitored at all times. The audio control console provides complete facilities for fading and switching from one audio source to another. The output feeds directly to the audio transmitter used for the studio-to-transmitter link.

Studio Cameras ★ Normally, three studio cameras are used for the production of live talent programs. One of these cameras is illustrated in Fig. 11, and is shown in action at the left of Fig. 12. All the studio cameras are mounted on dollies to provide the necessary flexibility and convenience for the operators when multiple-scene operation calls for rapid changes in the viewing angles.

The No. 1 camera is mounted on a Fearless Panoram dolly, manufactured by the Fearless Camera Company, in Hollywood. This is the dolly illustrated in Fig. 11. It is equipped with a steering mechanism for the rear wheels, and a tongue so that it can be moved rapidly to any part of the studio. The camera boom carries a seat for the operator, and is counterbalanced with a spring so that it can be raised and lowered quickly and easily by means of a hand wheel. Further, the whole camera can be turned for the purpose of producing special effects and "Chinese" shots.

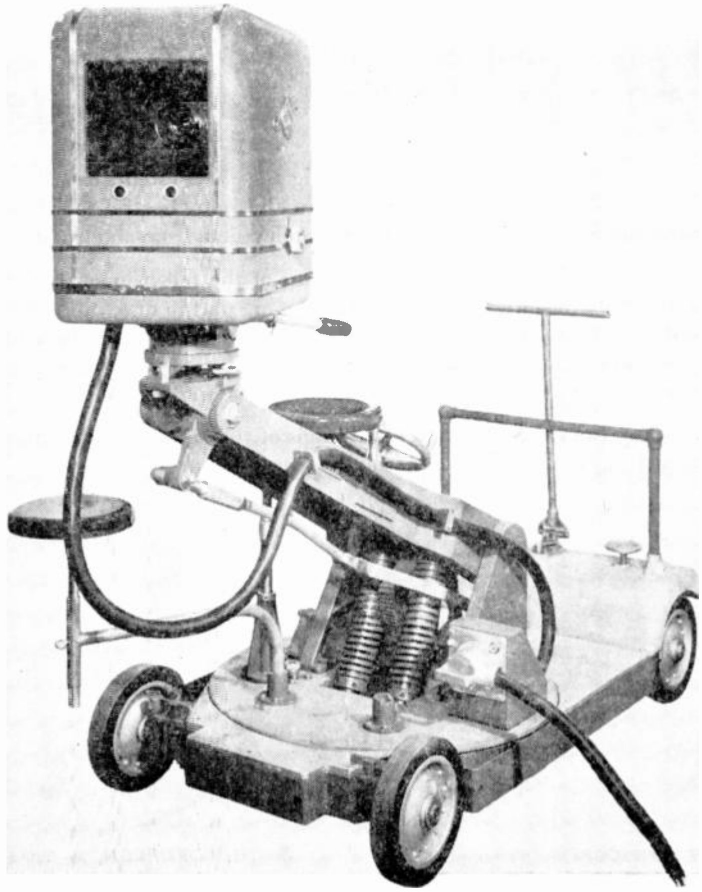


FIG. 11. CLOSE-UP OF NO. 1 CAMERA AND THE FEARLESS TYPE OF DOLLY

The camera itself is equipped with two lenses, one of which is used for the picture and the other for the view-finder. Both lenses are Bausch & Lomb Tessar f4.5, 6⅜-in. focal length units. One lens focuses the picture on the mosaic of a type 1850 iconoscope, while the other simultaneously focuses the image on a ground glass view-finder. The lenses are mechanically interconnected for single control. A movable frame on the ground glass view-finder provides parallax correction. This is operated by gearing its adjustment to the focusing control.

By means of this lens and view-finder arrangement, a brilliant inverted image is obtained on the ground glass, making it easy to focus the camera. A larger area appears on the view-finder than is actually picked up by the iconoscope. This allows the cameraman to anticipate the action, particularly when making panoramic shots, so that he will not bring unwanted objects into the field of the camera.

Camera No. 2 employs a single lens, similar to those used in the No. 1 camera. This second camera is mounted on a pedestal-type dolly which can be operated by one man. The design of the dolly permits the camera to be panned and tilted, but does not provide the extreme flexibility of the Fearless dolly. Instead of using a second lens for the view-finder, a mirror is mounted in such a way that the cameraman can examine the picture di-

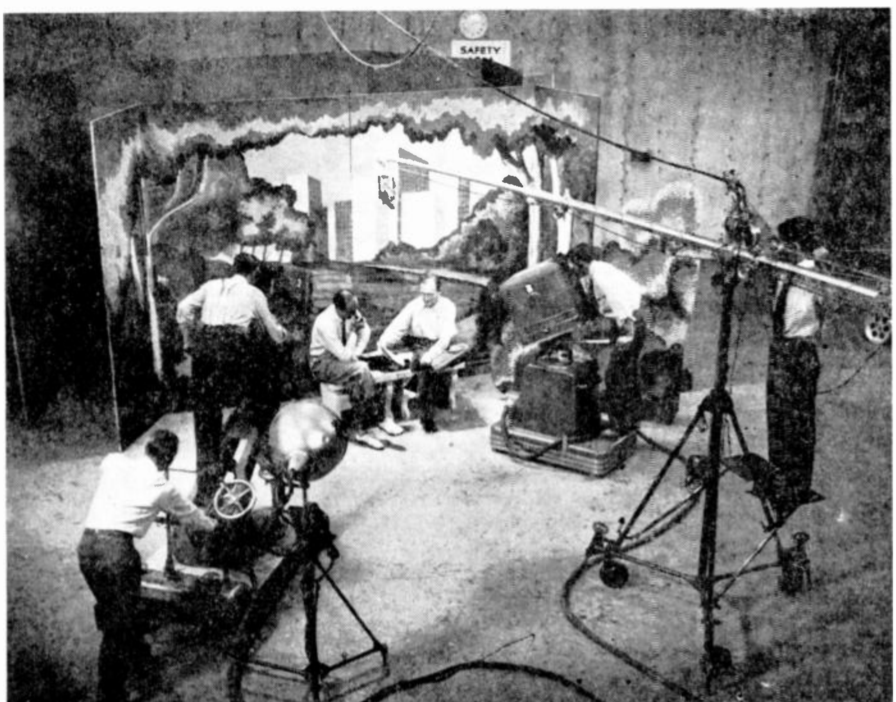


FIG. 12. CAMERAS NO. 1 AND 2 IN ACTION AT THE WRGB STUDIO. THIS ALSO SHOWS THE CONSTRUCTION DETAILS OF THE RICHARDSON MICROPHONE BOOM

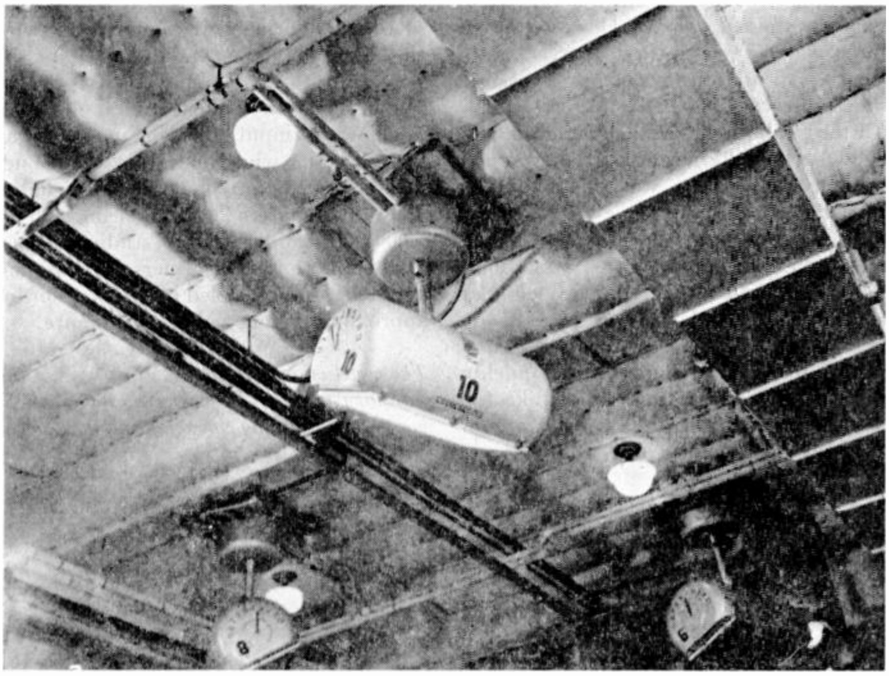


FIG. 13. EACH OF THESE LIGHTING UNITS CONTAINS THREE MERCURY-VAPOR LIGHTS, CONSUMING A TOTAL OF 3 KW. HEAT RADIATION IS VERY LOW

rectly as it appears on the mosaic of the iconoscope. In Fig. 12, this camera can be seen at the right.

Camera No. 3 is mounted on an experimental motion picture type of dolly supplied by Camera Equipment, Inc., of New York City. It is equipped with a boom so that the camera can be raised or lowered with a hand wheel. The camera uses a Zeiss Tessar f3.5, 10-in. focal length lens. The view finder is of the reflection type which shows the picture on the iconoscope mosaic.

All three cameras are equipped with iris diaphragms for regulating the size of the aperture. This is necessary to permit operation either in the studio or outdoors.

Inside each camera head are located the iconoscope tube, view-finder, head amplifier, and sweep amplifier.

The lenses with which the different cameras are fitted make cameras 1 and 2 particularly suited for long and medium shots, while camera 3, with its long focal length lens, is used mainly for medium and close-up shots.

A heavy cable runs from each camera to a receptacle through which it is connected to the video equipment in the control room. The cable has 28 conductors for power supplies and supervisory lights, and four coaxial cables. The latter are used to carry the picture signals from the camera to the control room, and to bring the sweep, blanking, and shading signals from the control room to the camera.

There are 8 supervisory lights, four red and four green, on each 2-man dolly. Two are located on the front of the camera, two on the top, two inside the camera adjacent to the view-finder, and two on a small box at the rear of the dolly, visible to the dolly operator. These supervisory lights are operated from the control room. When the green lights go on, they are visible to the performers, cameraman, and dolly operator, and indicate that the camera is ready to go on the air. When the camera is switched over to the video transmitter, the green lights go out, and the red lights go on, signaling to all personnel that the camera is on the air.

Up in the operating room, the video operator takes his cues for operating the lights by following the script. In this way, he knows just when to bring up the green preview lights. When a camera is switched on the air, relays interlocked with the video switching relays automatically extinguish the green lights and bring up the red on-the-air lights. As soon as a camera is cut off from the transmitter, the red lights go out, and the circuits return to normal, in readiness to repeat the cycle.

Camera No. 2, which requires only one man to operate it, has lights on the front and top, and adjacent to the view-finder.

Microphones and Booms ★ Normally, sound pickup is accomplished with an RCA type 77-C microphone, adjusted for uni-directional operation. It is mounted on a motion picture type of microphone boom, manufactured by the Richardson Company, of Hollywood. This type 103-B boom, shown in Fig. 12, has controls which permit the operator, who sits on a small platform, to follow the action as it progresses from scene to scene. The boom has a maximum extension of 17 ft., and the microphone can be moved rapidly and quietly to any position in the studio. Controls are also provided by which the microphone itself can be turned to follow the action in any part of a scene.

For fixed sound pickups in the studio, various types of broadcast microphones are mounted on overhead pedestal stands or on ordinary floor microphone stands. A number of microphone outlets are available around the studio for convenience in getting connections to the control room.

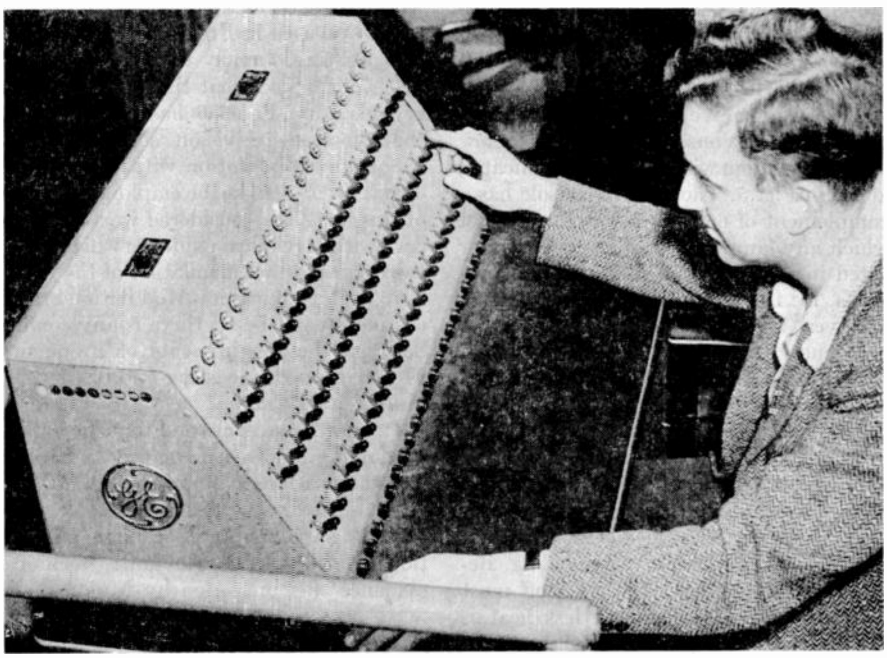


FIG. 14. FROM THIS CONSOLE, UNDER THE CONTROL ROOM WINDOW, THE CEILING LIGHTS CAN BE ROTATED AND TILTED TO ANY REQUIRED ANGLE

Studio Lighting Equipment ★ Studio illumination is furnished by 12 water-cooled mercury-vapor ceiling lamps and 4 portable water-cooled mercury-vapor floor units. For some scenes, 2-kw. and 5-kw. incandescent spotlights are used for edge, rim, and back lighting.

Each mercury-vapor luminaire employs three A-H6 1-kw. H type Mazda lamps. Each lamp, slightly smaller in size than a cigarette, is mounted in a water jacket. Fig. 13 shows the appearance of the ceiling units. The 3 lamps are located along the axis of a paraboloidal etched Alzak-finished aluminum trough reflector. A motor for rotating the entire unit in the horizontal plane is installed in a canopy mounted against the ceiling, while a second motor inside the reflector housing rotates the reflector to any required angle, as indicated by the scale and pointer on the end of the housing. This can be seen in Fig. 13. The lamps remain stationary when the reflector is rotated.

The opening on the reflector housing, approximately 21 by 33 ins., is covered with Peblex diffusing glass. The power supply cable and water feed hose are fixed rigidly to the reflector housing. This eliminates the use of slip-rings on the cable and gaskets on the hose, either of which might create one of those embarrassing moments against which every precaution must be taken in the television studio. Sufficient slack is allowed in the cable and hose to permit each unit to be rotated through one complete turn, while the reflector can be swung through an angle of 180 degrees.

A solenoid valve and a flow switch are mounted in the canopy. Thus the lamps are cut off if the water pressure fails. In addition, a door switch in the same interlock circuit makes it impossible to service the lamps with the power on.

All of the twelve ceiling lights are controlled from a console located just below the control room window. This is indicated at 2E in Fig. 5. The control console has a complement of 66 lever keys by means of which any lamp can be silently turned or tilted in any direction as the action proceeds in the studio. The floor lamps, however, are adjusted by the operating personnel.

At the WRGB studio, the ceiling lamps are mounted in rows 9½ ft. apart across the building, and 6¼ ft. apart in each row. Each lighting unit, therefore, serves approximately 120 sq. ft. of floor space.

An outstanding feature of the mercury-vapor lighting units, in addition to their efficiency, is the use of water cooling. Because the water effectively cuts off most of the infra-red rays, much less heat is emitted than by conventional types of lamps. To conserve space and to keep the heat from the studio, as well as to maintain the noise level at a low value, all transformers, relays, and power equipment for the lighting system are located in the transformer room in the basement. All the studio lights are operated on 220-volt, 3-phase alternating current through suitable transformers, with one lamp connected to each phase.

The four portable floor lamps used in the studio also contain three 1-kw. mercury-vapor units mounted with circular reflectors. These lamps are carried on light stands equipped with rubber-tired casters, so that they can be moved quickly and quietly around the studio. Like the ceiling units, power and water are supplied through flexible cables and hose.

All the lighting units have about twice the efficiency of incandescent lamps, so that the total light obtained from the 12 ceiling lights is equivalent to about a 72-kilowatt input for an incandescent lamp system, while liberating about one-fourth the amount of heat. These lights allow illumination levels of from 300 to 1,000 foot-candles in the studio without discomfort to the performers. Each ceiling and floor lamp is cooled by a water flow of approximately one gallon per minute.

The conclusion of Part 2 will appear in the January issue. It describes the film equipment, the operating consoles, and the studio-to-transmitter link.

CONSIDERATIONS OF FM CHANNEL WIDTH

Effects Which Would Result from Reducing FM Broadcast Channel Width Below 200 KC

BY W. F. COTTER*

At ITS first meeting, RTPB Panel 5 voted unanimously to recommend the retention of the present FCC standards with respect to maximum frequency deviation to be used in Frequency Modulation broadcasting, namely that this deviation be ±75 kc. Since that time Committees 3 of Television Panel 6 has recommended that, in the television sound channel, Frequency Modulation with a maximum deviation of ±40 kc. be employed. In view of this fact, it is considered worthwhile to review the technical evidence which led to the original recommendation of the use of ±75 kc. for Frequency Modulation broadcasting, and to see if there is any conflict between the requirements of Frequency Modulation broadcasting and of the television sound channel.

During the hearings on Frequency Modulation which were held before the Federal Communications Commission in March, 1940, an extensive discussion took place regarding the preferable frequency deviation to be used. Elaborate technical evidence was presented by Major E. H. Armstrong, Paul DeMars, Dr. G. W. Pickard, D. W. Gellerup, M. L. Levy, I. R. Weir, J. E. Brown, Dr. H. H. Beverage, R. F. Guy, S. W. Seeley, and W. C. Lent. This evidence took into account both theoretical conclusions and the results of extensive field tests. After hearing this testimony, the Federal Communications Commission decided in favor of the present standards which include the standard that the maximum frequency deviation on modulation peaks be ±75 kc. and that, due to guard band considerations the channel width be 200 kc.

In the four years since these hearings, Frequency Modulation broadcasting has developed into an important factor in the American radio industry, and the practicability of the FCC standards has been well established. Very few new considerations with respect to the choice of frequency deviation have been brought to light in these four years and detailed data regarding practically all of the points summarized in this paper are available in the minutes of the FCC hearings on Frequency Modulation. Nevertheless, it has been felt worthwhile to summarize, in the light of the present day knowledge, the considerations which indicate the wisdom

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of the choice of a frequency deviation of ±75 kc. in order that the record of Panel 5 may be complete.

Receiver Oscillator Drift ★ It is the consensus of a number of manufacturers of Frequency Modulation equipment that the maximum allowable oscillator drift is approximately ±15 kc. If the maximum frequency deviation were to be halved, this tolerance would be reduced to ±7.5 kc. These figures are based on the assumption that no drift in transmitter carrier frequency is allowed. Under present FCC rules, the transmitter carrier frequency is permitted to vary by ±0.01 per cent or ±5 kc. at the high frequency end of the FM broadcast band. When this is subtracted from 15 kc. the maximum allowable receiver oscillator drift is ±10 kc. with the present standards.

If this is subtracted from the ±7.5-kc. drift permitted with a halved maximum deviation, the maximum allowable receiver drift is reduced to ±2.5 kc., which is one-half the permissible variation in transmitter carrier frequency.

The absurdity of this situation is obvious when it is remembered that a receiver must be tunable over the FM broadcast band, whereas the transmitter operates at a fixed carrier frequency. It is recognized that present day transmitters are held to a smaller variation than ±0.01 per cent, and that the practical limit of receiver oscillator drift would thus lie between the limits of ±2.5 kc. and ±7.5 kc. if the transmitter frequency deviation were halved.

It is the consensus of several receiver manufacturers that these limits would be difficult to attain in production. In this connection it should be noted that the maximum permitted receiver drift with ±75 kc. deviation, namely 15 kc. in the FM band, is only one quarter that permitted for equivalent performance in the standard broadcast band.

In considering this problem both short-time and long-time variations in oscillator frequency must be considered. Short-time drift results from the change in temperature when a receiver is turned on. In addition to this effect, the long-time variations due to aging of the components must be considered, and in this connection it should be remembered that high-Q components, which would be required as a result of narrowing the frequency deviation, change more rapidly than do low-Q components. It is recognized that if the Frequency Modulation broadcast band is extended to 56 mc., receiver drift problems will be more serious than at present. However, it is our belief that these difficulties are less serious than those which would be encountered in reducing the frequency deviation and thus assigning a larger number of stations in the present frequency band.

Receiver Oscillator Fluctuation ★ In addition to thermal and long-time drift, local oscillators in receivers fluctuate in frequency as a result of changes in the power line voltage and for other reasons. These fluctuations, in effect, place a further limitation on the permissible frequency drift. In the most favorable case, namely with no change in transmitter carrier frequency, the fluctuations in receiver oscillator frequency would have to be reduced by a factor of 2: 1 if the transmitter frequency deviation is halved.

Accuracy of Tuning ★ The considerations relating to accuracy of tuning of an FM receiver are similar to those relating to oscillator drift. The same general conclusion applies, namely that the receiver must be tuned at least twice as accurately if the transmitter deviation is halved. This problem is particularly serious in connection with push-button tuning, since push-button circuits must be satisfactorily stable for many months, while with manual tuning the receiver is retuned many times a day.

Automatic Frequency Control ★ Automatic frequency control of the local oscillator in a receiver is more satisfactory with wide transmitter frequency deviation than with narrow deviation. This results from the fact that a larger deviation in local oscillator frequency is permitted before the automatic frequency control can be captured by a signal from a station in an adjoining frequency channel.

Spurious Responses ★ In considering spurious responses, a comparison should be made between the use of eighty adjacent 200-kc. channels and eighty adjacent 100-kc. channels. It might be concluded that the adjacent channel selectivity would be the same in both cases. This conclusion would be incorrect, because of two factors:

In the first place, it would be extremely difficult to reduce the band width of the radio frequency circuits. In the second place, it is probable that the same intermediate frequency, namely 8.25 mc., would be used in any case since this is the recommendation of Committee 3 of Panel 5.

As a result, the higher selectivity required for a 100-kc. channel could be obtained only with added complexity of the receiver circuits. This added complexity would be only partially counter-balanced by an increase in stage gain, since this factor is limited by the grid-plate capacitance of available tubes.

Phase Distortion in Receivers ★ Due to the higher Q and consequent more rapid change in band pass characteristics required with a low transmitter deviation, phase distortion would be more serious than in circuits designed for use with high deviation.

Audio Circuits ★ Due to limitations imposed by the loading of discriminator circuits by the discriminator diode and by the inherent Q of such circuits, it is not possible to increase the slope of the discriminator response-frequency characteristic to any considerable extent. This means that the discriminator output into the audio amplifier is directly proportional to the transmitter deviation which is chosen. Consequently, if the transmitter deviation is halved, an additional 6 db would be required in audio gain. This introduces added problems due to hum, audio microphonics, etc.

Signal-to-Noise Ratio ★ Within the service range of a Frequency Modulation transmitter, the signal-to-noise ratio with respect to receiver hiss would be impaired by a factor of 6 db if the frequency deviation of the transmitter is halved. With respect to ignition noise, the signal-to-noise ratio would be likewise impaired. This impairment of signal-to-noise ratio would be serious in many locations. It should be noted that in a Frequency Modulation receiver, optimum conditions with respect to maximum signal-to-noise ratio are obtained only if the receiver is correctly tuned. Thus changes in oscillator frequency stability as a result of drift would result in an added impairment to signal-to-noise ratio if low transmitter deviation were employed.

Service Range ★ The problem of the range of an FM transmitter is a corollary of the signal-to-noise ratio problem. A loss in signal-to-noise ratio of 6 db might not appear to be serious. However, when it is realized that to obtain the same signal-to-noise ratio, it would be necessary to increase the power of the transmitter by four times if the transmitter deviation were halved, the problem appears more serious.

Common Channel Interference ★ Curves shown by R. F. Guy and R. M. Morris in the *RCA Review* for October, 1940 in an article entitled *NBC Frequency Modulation Field Test*, indicate that if the transmitter frequency deviation is halved, the protection against interference from an undesired station operating on the same carrier frequency with a desired station suffers by a factor of approximately 6 db. The result of this conclusion is that a greater geographical separation is required between transmitters operating on

(CONTINUED ON PAGE 61)

WEST COAST VIEW OF TELEVISION

(CONTINUED FROM PAGE 17)

coined by our friend Larry Fly in commenting on the relationship between the television broadcaster and manufacturer. That is the "lock-and-key" phrase which he developed some years ago. Unless we produce the programs, no one will have any desire to buy a receiver, and unless people buy receivers, there is no point in our broadcasting any television programs.

The concept of the broadcaster springs from an expression in his license, and a sincere desire to serve public interest, so that all his concepts originate from the thought of what the public wants and expects.

The manufacturer, on the other hand, is sometimes prone to think in terms of pure economics, of surveying a market as to its greatest potential in a price class. Then he decides to build a product to meet that price, and he works backward from there.

I am not discounting the fine American principles of the average American manufacturer who, not because of any moral virtue but from a spirit of enlightened selfishness, has a profound and lasting interest in seeing that the things he manufactures adequately and satisfactorily serve the purpose for which they were designed.

And it is my sincere hope that the manufacturers of television receivers will work from that viewpoint first, and ascertain what it is the public is going to expect to see on the television screens when they make the necessary investment to buy those devices.

You hear a great many statisticians quote very glibly a lot of figures. Somebody made a survey of the population in Iowa, and ten people were asked if they would like to have television sets after the war, and six of the ten said "Yes."

I do a lot of traveling. I yield first place to no man and only to one lady, who recently renewed her lease in Washington, and the thing that strikes me as I travel across the United States is the amazing number of little structures, about fifty feet in back of the houses along the right of way of the railroad, that have crescents and stars over the doors.

Somehow, particularly on this trip, I got to thinking about those poor citizens, and I can't picture Miranda rushing in from that little house out there, having torn a page from the one-volume library that it contains, and rushing in to Silas saying, "Daddy, before we do anything else, we must have a television set."

I have an idea that there are still a lot of people whose first call, postwar, may conceivably be indoor plumbing, may conceivably be refrigerators. It is astonishing how many homes in the United States still do not have any type of refrigeration whatsoever, and I have just given you an authentic survey on the plumbing situation.

So that any time a research expert — and there are a lot of them — takes a pattern of six out of ten and arbitrarily applies that to the 130 million people in the United States, he comes up with conclusions which my pragmatic soul must reject.

My own concept — and I expressed this during the Allocations Hearing before the Commission a short time ago — is that no city can support one television station unless it has a population of at least a half-million people.

My reason for saying this is that I further believe that not more than ten per cent of the people in the foreseeable future are going to be eligible to own television receivers, either from the viewpoint of income or the ability to get satisfactory reception from one or more television stations in their community.

At that point, I was challenged by the attorney for one of the manufacturers who wanted to know my idea about what the cost of a postwar television receiver is going to be. I indicated that it would be somewhere between $300 and $350, because it is my belief that the people who can buy such things are going to insist upon having a television receiver with a sufficiently large screen or projector element to give large and comfortably satisfactory pictures.

That set is also going to have to contain Frequency Modulation, and the manufacturers well know that the speaker system alone to adequately express the quality of Frequency Modulation costs as much as some of the prices they are talking about at retail for the total set.

No greater injury could be done to television or the broadcasting art than a scrimping for the mass market to turn out a cheap receiver, because the real impulse and expansion of the use of the broadcasting arts spring from the personal satisfaction enjoyed by the people who buy and use those things and create the envy in their neighbors to go out and do the same.

So in addition to having AM and FM in the television set, because the average family does not want to clutter up its house with seventeen different radio devices, there will undoubtedly be a demand also for a phonograph record player in this one instrument, and that instrument must be of such esthetic design and attractiveness that it fits into the scheme of a well-appointed and attractive living room.

Any manufacturer who can arrange to retail such an instrument in volume to measure up to those specifications for less than $350 will have provided something that is not yet known in the processes of manufacturing.

Naturally, I would like to believe all of the enthusiastic things that I have read about television. We have over a quarter of a million dollars of our own money invested in television now, and our program for the next two years contemplates a further investment of our own money of a half a million dollars in the business of broadcasting television.

I occupy the dubious privilege of having to account for the stewardship of those investments. Consequently, I must of necessity keep my feet on the ground and look coldly at the factors that will have to be overcome before that medium can be made to stand on its own feet and, possibly, ultimately, show a return on that investment to the owners of the business.

The suggestion of the free use of film for television springs not from the source of service of what the public wants, but because that seems to provide the simple, economical answer from the broadcasting viewpoint, and that isn't how things grow and prosper.

I can tell you from our experience in the business, as was well expressed by one of the distinguished speakers here this morning, that what the public reacts to is a realization that it is participating in an advance of the electronic art that provides a magic eye to see something while it is happening.

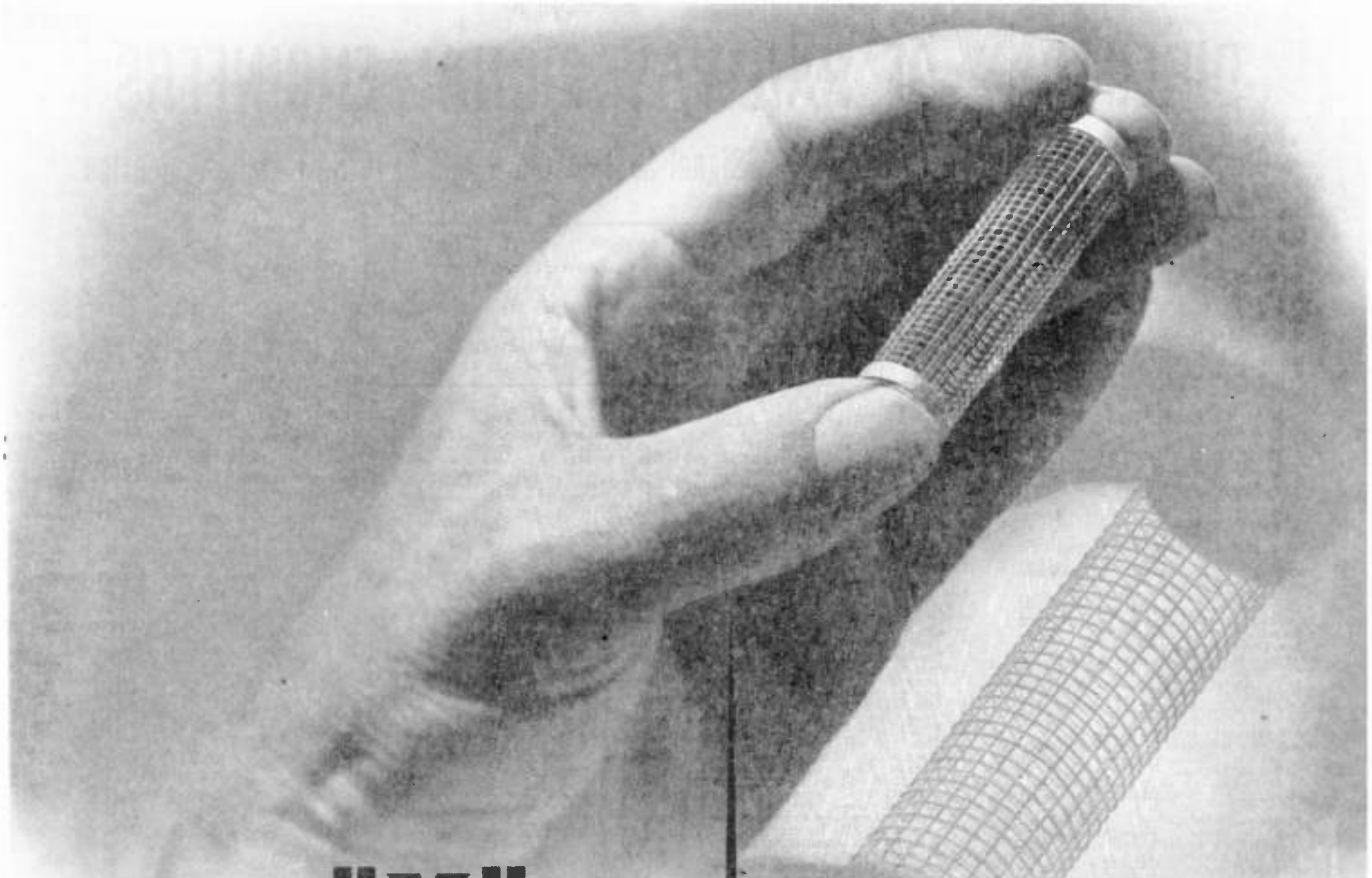
It is the fact that they have a new device in their living rooms, a magic carpet that carries them to places and events miles away, and it is the realization that they are sitting in the comfort of their homes and participating in those events and witnessing them more comfortably than, perhaps, they could if they were in the actual presence of them.

Those are the things of spontaneity to which people respond. Now, they will tolerate a certain amount of film as a filler, and economic necessity may compel the television broadcaster to make substantial use of film; but do not ever deceive yourself that the reason why anybody buys a television receiver is to look at film, and I do not care how good the film is.

The advertiser is going to be glad to pay a premium because television provides the third dimension. An animated, visual demonstration of a product, accompanied by sound, represents to the merchandising man the ideal combination of influences that he can bring to bear on potential customers.

But how much of a premium he is going to pay remains to be ascertained by actual experience.

(CONCLUDED ON PAGE 57)



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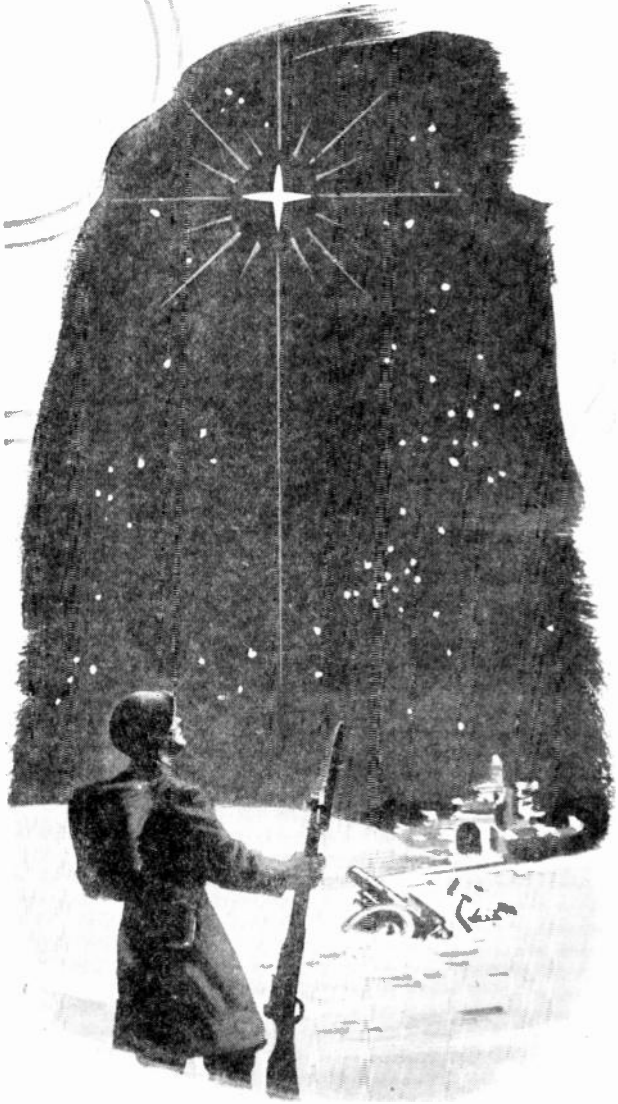
AKRON & BARBERTON BELT Barberton Ohio
23 Miles, 6 Steam
C M Potter Superintendent
AKRON CANTON & YOUNGSTOWN 12 E Exchange Akron 8 Ohio
171 Miles, 23 Steam, 1 Diesel
G A Haskins Eng Maint of Way
J V Preto Sig foreman
ALABAMA & VICKSBURG *See Illinois Central*
ALABAMA CENTRAL Jasper Ala
10 Miles, 1 Steam
C A Lee Superintendent
ALABAMA GREAT SOUTHERN *See Southern RR*
ALABAMA TENNESSEE & NORTHERN York Ala
220 Miles, 11 Steam, 2 Gas-Elec, 2 Diesel
G C Nichols General Manager
ALAMEDA BELT LINE Alameda Calif
20 Miles, 3 Oil, 2 Diesel-Elec
L L Davis Superintendent
ALASKA R R Anchorage Alaska
513 Miles, 31 Steam
W L Kinsell Supt Motive Power & Equip
ALBANY & NORTHERN Albany Ga
36 Miles, 5 Steam
J R Hackett General Manager
ALGERS WINSLOW & WESTERN Oakland City Ind
22 Miles, 5 Steam
W H Nichol General Superintendent
ALIQUIPPA & SOUTHERN Aliquippa Pa
44 Miles, 25 Steam
W C Van Blarcom Superintendent
ALLEGHENY & SOUTH SIDE So 10th St & Muriel Pittsburgh Pa
5 Miles, 3 Steam
G A Dietz General Superintendent
ALTON P R Bloomington Ill
959 Miles, 160 Steam, 11 Diesel
H C Sampson Supt Sig & Tele
C Kies Asst Supt Sig
A F Sampson Gen Sig Inspr
ALTON & SOUTHERN Box 270 E St Louis Mo
93 Miles, 18 Steam
W J Nuebling Chief Engineer
Geo H Dauer Signal Supervisor
A L Lenny Superintendent
AMADOR CENTRAL Martell Calif
12 Miles, 3 Oil
H W Loomis General Manager
ANGELINA & NECHES RIVER Keltys Texas
31 Miles, 2 Oil
E L Kurth General Manager
ANN ARBOR R R Decatur Ill
294 Miles, 31 Steam, 1 Diesel-Elec
R J Bellsmith Supt of Tele
APACHE R R McNary Ariz
72 Miles, 2 Oil
W R Fields Master Mechanic
APALACHICOLA NORTHERN Port St Joe Fla
99 Miles, 7 Steam
J L Sharit Superintendent
ARANSAS HARBOR TERM Aransas Pass Tex
7 Miles, 1 Diesel
W A Scrivner Pres
ARCADE & ATTICA Arcade New York
28 Miles, 1 Steam, 1 Diesel
R I Cartwright General Manager
ARKANSAS & LOUISIANA MISSOURI Monroe La
86 Miles, 4 Oil
E S Royster Chief Engineer
ARKANSAS R R Star City Ark
20 Miles, 5 Steam
W R Alsobrook General Manager
AROOSTOOK VALLEY Presque Isle Me
32 Miles, 2 Electric
G B Hallett Manager
ARTEMUS-JELLICO Artemus Ky
14 Miles, 2 Steam
R B Martin General Superintendent
ASHERTON & GULF *See Gulf Coast Lines*
ASHLEY DREW & NORTHERN Crossett Ark
41 Miles, 4 Steam
C L Finch Superintendent
ASPHALT BELT *See Gulf Coast Lines*
ATCHISON TOPEKA & SANTA FE Topeka Kan
13,147 Miles, 12,067 Oil, 159 Diesel-Elec
G K Thomas Signal Engineer
Comprising: Eastern Lines
Western Lines
Coast Lines
Also (Listed Separately)
Gulf Colorado & Santa Fe
Panhandle & Santa Fe
Eastern Lines 2,995 Miles
D W Fuller Signal Engineer Topeka Kan
C B Keers Asst Signal Engineer Topeka Kan
Signal Supervisors:
E H Hahn Newton Kan
F D Hartzell Chillicothe Ill
B R Olin Emporia Kan
E L Salisbury Arkansas City Kan
B F Smith Marceline Mo
Western Lines 3,612 Miles
H A Appleby Signal Eng Amarillo Tex
K Hanson Asst Sig Eng Amarillo Tex
R L Woodling Asst Sig Eng LaJunta Colo
Signal Supervisors:
E F Artman Clovis N M
H L Hutton Las Vegas N M
A N Jackson LaJunta Colo
R C LeHew Dodge City Kan
E H Robinson Amarillo Tex
O T Staley Wellington Kan
Coast Lines 2,500 Miles
E Winans Los Angeles Calif
W F Price Asst Sig Eng Los Angeles Calif.
T A Smith Gen Sig Sup Los Angeles
J N Friedman CTC Eng Los Angeles
Signal Supervisors:
J L Bartlett San Bernardino Calif
J C Bussey Needles Calif
W J Disney Winslow Ariz
W F Douglas Fresno Calif
ATLANTA & ST ANDREWS BAY Dothan Ala
82 Miles, 11 Oil, 5 Diesel-Elec
T L Nichols General Superintendent
ATLANTA & WEST POINT 4 Hunter SE Atlanta 3 Ga
227 Miles, 48 Steam
A T Miller Asst Supt Motive Power
ATLANTA BIRMINGHAM & COAST 26 Cain St NW Atlanta 3 Ga
639 Miles, 61 Steam
C E Brower General Superintendent
W A Spell Chief Engineer
ATLANTIC & CAROLINA Kenansville N C
10 Miles, 2 Steam
J E Jerritt General Manager
ATLANTIC & EAST CAROLINA Kinston N C
96 Miles, 14 Steam, 2 Diesel-Elec
E R Buchan President
ATLANTIC & WESTERN Sanford N C
24 Miles, 3 Steam
E T Ussery General Manager
ATLANTIC COAST LINE Wilmington N C
4962 Miles, 237 Steam, 71 Diesel-Elec
F W Brown Vice President Wilmington N C
J S Webb Signal Eng Wilmington N C
S J Davis Act Assistant Engineer Wilmington N C
L White General Superintendent Tele
Signal Supervisors:
W M Adams Rocky Mount N C
O L Chitwood Waycross Ga
J H Lackey Jacksonville Fla
D R Morris Savannah Ga
C H Wiegand Charleston S C

— B —

BALTIMORE & OHIO Baltimore Md
6,144 Miles, 1979 Steam, 9 Electric, 2 Oil, 69 Diesel, 1 Gas
C W Van Horn V Pres (Oper & Maint)
G H Dryden Signal Engineer
Comprising:
New York Terminal Region
Eastern Region
Central Region
Western Region
Also (Listed Separately)
Baltimore & Ohio Chicago Terminal
New York Terminal Region 25 B'way NYC 5 Miles
C M Shriver General Manager
A C Clarke Ch Eng Baltimore Md
C A Salverson Sig Super Staten Is N Y
Eastern Region Baltimore Md
1,975 Miles
F G Hoskins General Manager
F A Baldinger Supt Motive Power
Signal Supervisors:
C R Happ Wheeling W Va
A A Jacobs Baltimore Md
C W Lester Cumberland Md
H W Logsdon Grafton W Va
W L Nethkin Baltimore Md
R T Perrell Cumberland Md
W R Wheat Baltimore Md
Central Region Pittsburgh Pa
2,011 Miles
J D Beltz General Manager
H Rees Supt Motive Power
Signal Supervisors:
J P Buzzerd Pittsburgh Pa
W L Connors Rochester N Y
H H Gault Garrett Ind
J C Hoffman Akron O
T M Walker Connellsville Pa
Western Region Cincinnati Ohio
F B Mitchell General Manager
H J Burkley Supt Motive Power
Signal Supervisors:
G H Cannon Washington Ind
H M Dryden Dayton Ohio
H H Harding Newark Ohio
J W Kunker Cincinnati Ohio
H A Maynard Washington Ind
D W Porterfield Indianapolis Ind
BALTIMORE & OHIO CHICAGO TERMINAL Grand Central Sta Chicago Ill
67 Miles, 16 Steam, 9 Diesel
C M House Supt Motive Power & Equip
J J Clancy Signal Supervisor
BAMBERGER R R Salt Lake City Utah
64 Miles, 9 Electric, 1 Diesel-Elec
J M Bamberger General Manager
BANGOR & AROOSTOOK Bangor Me
596 Miles, 62 Steam
R H MacCready V Pres (Oper)
BARRE & CHELSEA *See Montpelier & Wells River*
BATH & HAMMONDSPORT Hammondsport N Y
8 Miles, 1 Steam
W G Aber Supt of Sig & Comm
BAUXITE & NORTHERN Box 270 E St Louis Ill
7 Miles, 5 Steam
W J Nuebling Ch Eng
BAY POINT & CLAYTON Cowell Calif
9 Miles, 1 Oil
E D Barnett Supt
BAY TERMINAL Toledo Ohio
6 Miles, 1 Steam
H O Cameron Pres & Gen Mgr
BEAUFORT & MOREHEAD Beaufort N C
33 Miles, 2 Steam
A T Leary Gen Mgr
BEAUMONT SOUR LAKE & WESTERN *See Gulf Coast Lines*
BELFAST & MOOSEHEAD LAKE Belfast Me
3 Miles, 3 Steam
W L Bowen Gen Mgr
BELLEFONTE CENTRAL Bellefonte Pa
20 Miles, 3 Steam
G E McClelland V Pres & Gen Mgr
BELT RY CO OF CHICAGO 47 W Polk Chicago
440 Miles, 59 Steam, 9 Diesel
M F Stokes Pres & Gen Mgr
F E Morrow Ch Eng
BENNETTSVILLE & CHERAW Bennettsville N C
23 Miles, 2 Steam
A T Dampier Supt
BENWOOD & WHEELING CONN Wheeling W Va
7 Miles, 4 Steam
F W Klos V Pres
BESSEMER & LAKE ERIE Greenville Pa
214 Miles, 119 Steam, 1 Diesel-Electric
F R Layng Ch Eng
G R Pflasterer Sig Eng
BEVIER & SOUTHERN Bevier Mo
10 Miles, 4 Steam
R Corbin Ch Eng
BIG CREEK & TELOCASET Pondosa Oregon
11 Miles, 1 Steam
T W Collins Pres & Gen Mgr
BIG FOUR *See C C C & St L*
BINGHAM & GARFIELD Magna Utah
33 Miles, 6 Steam, 2 Elec, 4 Diesel-Elec
N E McKinnon Supt
G C Earl Ch Eng
BIRMINGHAM & SOUTH-EASTERN Tallassee Ala
7 Miles, 2 Steam
J H Rainer Gen Mgr
BIRMINGHAM SOUTHERN Fairfield Ala
33 Miles, 16 Diesel-Elec
E W Bean Ch Eng
BLACK MOUNTAIN Erwin Tenn
13 Miles, 1 Steam
L H Phetteplace Gen Mgr
BLUE RIDGE Anderson S C
44 Miles, 3 Steam
J W Smith Supt
BOIS D'ARC & SOUTHERN Texas Bank Bldg Dallas 2 Tex
7 Miles, 2 Gas
E P Gaines Jr Pres & Gen Mgr
BONHOMIE & HATTIESBURG SOUTHERN Hattiesburg Miss
27 Miles, 3 Steam
W O Tatum Exec V Pres
BOSTON & ALBANY Boston Mass
Mileage & Equip included in N Y Central
R J Cullen Supt of Tele & Sig Eng
BOSTON & MAINE Boston Mass
1,819 Miles, 444 Steam, 9 Elec, 35 Diesel
R R Stackpole Supt Tele
J P Muller Eng Sig & Tele
W W Hartzell Field Eng Sig
Signal Supervisors:
L E Norton Dover N H
C P O'Connell Greenfield Mass
A Pennington Boston Mass
A A Wood Concord N H
BOYNE CITY Boyne City Mich
10 Miles, 2 Steam
L H White Gen Mgr
BRIMSTONE R R New River Tenn
13 Miles, 1 Steam
A A Kopp Gen Mgr
BUFFALO CREEK Buffalo N Y
34 Miles, 9 Steam, 4 Diesel-Elec
W M Sporleder Supt
BUFFALO CREEK & GAULEY Dundon Va
19 Miles, 2 Steam
J G Bradley Pres
BUFFALO UNION-CAROLINA Union S C
20 Miles, 3 Steam
L B Woodward Gen Mgr
BURLINGTON MUSCATINE & NORTHWESTERN Cedar Rapids Ia
11 Miles, 2 Steam
R F Knapp Pres & Gen Mgr
BURLINGTON-ROCK ISLAND Houston Texas
228 Miles, 2 Steam
B Bristow Eng
BURLINGTON ROUTE *See C B & Q*
BUSH TERMINAL 107 48th St. Brooklyn N Y
4 Miles, 8 Diesel-Elec
P J Roth V Pres
BUTTE ANACONDA & PACIFIC Anaconda Mont
135 Miles, 3 Steam, 29 Elec
P R Peery Supt Maint Way

— C —

CADIZ R R Cadiz Ky
10 Miles, 2 Steam
W C White Gen Mgr
CALIFORNIA WESTERN & NAVIGATION Ft Bragg Calif
49 Miles, 5 Oil
A T Nelson Gen Mgr
CAMBRIA & INDIANA Colver Pa
35 Miles, 10 Steam
J H Smith Supt
D L Rodgers Eng Maint Way
CAMINO PLACERVILLE & LAKE TAHOE Camino Calif
9 Miles, 2 Oil
S Berry Pres
CAMPBELL'S CREEK Reed W Va
18 Miles, 4 Steam
R Hatfield Gen Mgr
CANTON & CARTHAGE Canton Miss
57 Miles, 1 Steam
C L Freiler Gen Mgr
CANTON R R 300 Water Baltimore Md
35 Miles, 11 Steam
H M Diver Supt
CAPE FEAR R R Fort Bragg N C
32 Miles, 2 Steam, 2 Electric
H H Latham Supt of Sig & Comm
CARBON CO R R Columbia Utah
5 Miles, 2 Diesel-Elec
H R Malaby Gen Mgr
CAROLINA & NORTHWESTERN McPherson Sq Washington D C
113 Miles, 13 Steam
L C Walters Supt of Sig & Comm
H E Johnson Supt Hickory N C
CAROLINA CLINCHFIELD & OHIO *See Clinchfield R R*
CAROLINA CLINCHFIELD & OHIO RY OF SO CAROLINA *See Clinchfield R R*
CAROLINA SOUTHERN Windsor N C
22 Miles, 2 Steam
J H Matthews Gen Mgr
CAROLINA WESTERN Sumter S C
5 Miles, 2 Steam
T H Brice Pres
CARROLLTON R R Carrollton, Ky
9 Miles, 1 Steam
R L Booth V Pres
CASSVILLE & EXETER Cassville Mo
5 Miles, 1 Steam
R Dingler V Pres
CASTLEMAN RIVER 7006 Haze Ave Bywood Upper Darby Pa
13 Miles, 1 Steam
J Hersker Pres & Gen Mgr
CEDAR RAPIDS & IOWA CITY Cedar Rapids Ia
28 Miles, 7 Electric
A R Swem Gen Supt & Ch Eng
CENTRAL CALIFORNIA TRACTION Stockton Calif
53 Miles, 6 Electric
W L White Gen Mgr
CENTRAL INDIANA Indianapolis Ind
52 Miles, 3 Steam
J D Fuchs Supt
CENTRAL OF GEORGIA Savannah Ga
1,816 Miles, 234 Steam, 14 Diesel-Elec
R R Cummins Gen Mgr
E B DeMeritt Sig Eng Macon Ga
R M Hitchcock Super Tele Macon Ga
CENTRAL R R CO OF N J Jersey City 2 N J
657 Miles, 369 Steam, 24 Diesel
E T Moore Gen Mgr
R W Keller Elec Eng
F W Bender Sig Eng
CENTRAL VERMONT *See Canadian Nat'l Ry*
CHARLES CITY WESTERN Charles City Ia
23 Miles, 2 Elec, 1 Diesel-Elec
J F Christiansen V Pres & Gen Mgr
CHARLESTON & WESTERN CAROLINA Wilmington N C
343 Miles, 45 Steam



"In times like the present, men should utter nothing for which they would not willingly be responsible through time and in eternity."

Abraham Lincoln, 1861

a Merry Christmas and Happy New Year

Jensen

Jensen Radio Manufacturing Company
6601 S. Laramie Ave., Chicago, Ill.

F W Brown Gen Mgr
CHATTAHOOCHEE VALLEY West Point Ga
27 Miles, 3 Steam
R F Lanier Pres
CHESAPEAKE & OHIO Richmond Va
3,073 Miles 895 Steam
A T Lowmaster Exec V Pres
W N Hartman Supt Tele & Sig
D K Roll Super Sig Constr
C E Nauman Gen Super Tele & Telo Maint
H C Land Tele & Telo Eng
Supervisors of Signals:
E T Garrison Clifton Forge Va
H M Johnson Peru Ind
W H Miller Columbus O
C Persinger Covington Ky
R L Thompson Hinton W Va
S R Thompson Huntington W Va
A M Weeks Richmond Va
CHESAPEAKE WESTERN 141 W Bruce St Harrisonburg Va
52 Miles, 5 Steam
J C Black Supt
CHESTNUT RIDGE 160 Front St New York N Y
14 Miles, 3 Steam
L S Holstein Gen Mgr
CHICAGO & EASTERN ILL 332 S Mich Chicago
720 Miles, 152 Steam, 12 Diesel
F G Nicholson Gen Mgr
G P Neal Supt Sig & Tele Danville Ill
Signal Supervisors:
E Folley Danville Ill
E R Lindsey Evansville Ind
G C Seifert Salem Ill
H Duncan Danville Ill
CHICAGO & ILLINOIS MIDLAND Illinois Bldg Springfield Ill
131 Miles, 26 Steam
G W Imgrund Gen Supt
CHICAGO & ILLINOIS WESTERN 135 E 11th Pl Chicago 5 Ill
12 Miles, 4 Steam, 1 Diesel
J L Beven Pres
CHICAGO & NORTHWESTERN 400 W Madison St Chicago 6 Ill
8,077 Miles, 600 Steam, 30 Diesel
S E Noble Supt Tele & Sigs
O S Tomkins Asst Supt Tele & Sigs
M E Moyer Asst Supt Tele & Sigs
Supervisors of Telegraph & Signals:
P O Gladhill Madison Wis
C C Mansfield Boone Ia
H F Mock Chicago Ill
E V Shatwell West Chicago Ill
P A Starck Milwaukee Wis
CHICAGO & WESTERN INDIANA 47 W Polk Chicago 5 Ill
172 Miles, 19 Steam
G M Kelly Sig Super
CHICAGO ATTICA & SOUTHERN Box 169 Attica Ind
63 Miles, 5 Steam
F E Cheak Gen Supt
CHICAGO AURORA & ELGIN Wheaton Ill
112 Miles, 4 Electric
E R Ander Elec Eng
R G Kendall Comm Eng
CHICAGO BURLINGTON & QUINCY 547 W Jackson Chicago 6 Ill
9,024 Miles, 871 Steam, 80 Oil, 4 Gas-Elec, 75 Diesel-Elec
W F Zane Sig Eng Chicago
A L Essman Prin Asst Sig Eng Chicago
L Stueber Asst Sig Eng Lincoln Neb
Lines East of Missouri River 4,556 Mi
O E Ward Supt Motive Power
Signal Supervisors:
C T Bishop Aurora Ill
J H LaChance Ottumwa Ia
W W Swanson Galesburg Ill
F A Tegeler St Joseph Mo
R L Vaughn Harrison & Canal Chicago
Lines West of Missouri River 1004 Mi
Farnam Omaha 8 Neb 4,594 Miles
L Stueber Asst Sig Eng Lincoln Neb
P W Gage Sig Super Lincoln Neb
A M Horn Sig Super McCook Neb
CHICAGO GREAT WESTERN 309 W Jackson Blvd Chicago 6 Ill
1,500 Miles, 156 Steam, 6 Diesel, 2 Gas
S M Golden V Pres
T H Kearton Supt Tele & Sig
G R Holsington Asst Supt Tele
Signal Supervisors:
L D Allison Oelwein Ia
E J Klaas Oelwein Ia
W J O'Neil St Paul Minn
CHICAGO HEIGHTS TERMINAL TRANSFER
332 S Michigan Chicago 4
7 Miles, 3 Steam, 2 Diesel
F G Nicholson V Pres & Gen Mgr
CHICAGO INDIANAPOLIS & LOUISVILLE Lafayette Ind
541 Miles, 85 Steam, 4 Diesel-Elec
A Anderson Asst Ch Oper Off & Ch Eng
E G Stradling Supt Tele & Sig
E E Ireland Sig Super
CHICAGO JUNCTION *See Chicago River & Ind*
CHICAGO KALAMAZOO & SAGINAW *See Michigan Central*
CHICAGO MILWAUKEE ST PAUL & PACIFIC Union Station Chicago 6 Ill
10,411 Miles, 1008 Steam, 52 Elec, 82 Oil, 74 Diesel
J T Gillick Ch Oper Off
L B Porter Supt Tele & Sig
Eastern Lines 7,346 Miles
O N Harstad Gen Mgr Chicago Ill
J P Kaysen Asst Supt Sig Milwaukee Wis
E J Muckerheide Tele & Telo Eng Milwaukee Wis
J A Henry Super Tele & Sig Milwaukee Wis
Supervisors of Telegraph & Signals:
A F Alexander Minneapolis Minn
E D Barton Mason City Ia
R S Bentley Terre Haute Ind
F W Bornitzke Milwaukee Wis

G C Downing Milwaukee Wis
R C Dueland Ottumwa Ia
H J Dunn Minneapolis Minn
J F McConahay Milwaukee Wis
M H Schmidt Marion Ia
W H Stevens Savanna Ill
Western Lines 30,065 Miles
L W Smith Supt Tele & Sig Seattle Wash
Telegraph & Signal Supervisors:
E P Allen Tacoma Wash
R M Lloyd St Maries Idaho
C O McPherson Miles City Mont
E T McPherson Butte Mont
CHICAGO NORTH SHORE & MILWAUKEE 72 W Adams Chicago
297.8 Miles, 8 Electric
R G Kendall Comm Eng
W G Fitzgerald Sig Sup Highwood Ill
CHICAGO RIVER & INDIANA LaSalle St Sta Chicago 5 Ill
228 Miles, 35 Steam, 12 Diesel
W L Houghton Supt Equip Chicago
S L Van Akin Supt Tele Detroit Mich
CHICAGO ROCK ISLAND & PACIFIC LaSalle St Station Chicago 5 Ill
7,751 Miles, 722 Steam, 116 Diesel.
C R Swenson Sig Eng Chicago
E A Dahl Electronic Eng
C M Duffy Asst Sig Eng El Reno Okla
C E Hartvig Asst Sig Eng Chicago Ill
C O Ellis Supt Tele Chicago Ill
G E Byram Tele & Telo Super Kansas City
Signal Supervisors:
E L Bartholomew Liberal Kan
B F Beasley Des Moines Ia
C Hattery Fairbury Neb

COLORADO & WYOMING 1755 Glenarm Pl Denver Colo
114 Miles, 21 Steam
W Wire V Pres
COLORADO RAILROAD INC Pueblo Colo
33 Miles, 1 Gas-Elec
I MacDaniel Sec & Treas
COLUMBIA & COWLITZ Tacoma Wash
8 Miles, 1 Oil
C H Ingram V Pres
COLUMBIA NEWBERRY & LAURENS Columbia S C
75 Miles, 6 Steam
J P Taylor Pres & Gen Mgr
COLUMBUS & GREENVILLE Columbus Miss
168 Miles, 28 Steam
I H Atkins Supt Tele
CONDON KINZUA & SOUTHERN Kinzua Oregon
24 Miles, 1 Oil
C C Coleman Supt
CONEMAUGH & BLACK LICK Johnstown Pa
48 Miles, 27 Steam
R F Campbell V Pres & Gen Supt
COPPER RANGE 89 Broad St Boston Mass
101 Miles, 9 Steam
P F Beaudin V Pres
CORNWALL R R Bethlehem Pa
36 Miles, 9 Steam
P A Trageser V Pres
COTTON BELT ROUTE *See St Louis Southwestern*
COUDERSPORT & PORT ALLEGANY Coudersport Pa
33 Miles, 3 Steam

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

F E Kinney Cedar Rapids Ia
H B McCallum Rock Island Ill
L E Nordholm Trenton Mo
F H Rich El Reno Okla
J P Zahnen Blue Island Ill
CHICAGO ST PAUL MINNEAPOLIS & OMAHA 400 W Madison Chicago 6
1,617 Miles, 234 Steam, 8 Diesel
S E Noble Supt Tele & Sig Chicago
O S Tomkins Asst Supt Tele & Sig Chicago
F W Bleier Gen Sig Super St Paul Minn
CHICAGO SHORT LINE South Chicago Ill
29 Miles, 6 Steam, 3 Diesel-Elec
A E Feeley Gen Mgr
CHICAGO SOUTH SHORE & SOUTH BEND Michigan City Ind
77 Miles, 16 Electric
C H Jones V Pres & Gen Mgr
CHICAGO TERRE HAUTE & SOUTHEASTERN *See Chicago Milwaukee St Paul & Pacific*
CHICAGO WEST PULLMAN & SOUTHERN West Pullman Ill
31 Miles, 11 Steam
W J Wheaton Maint of Way Eng
CINCINNATI BURNSIDE & CUMBERLAND RIVER *See Southern Railway System*
CINCINNATI NEW ORLEANS & TEXAS PACIFIC *See Southern Railway System*
CITY OF PRINEVILLE Prineville Ore
18 Miles, 3 Oil
C W Woodruff Mgr
CLARENDON & PITTSFORD Proctor Vt
18 Miles, 3 Steam
H A Collin Master Mech
CLARION RIVER Ridgway Pa
11 Miles, 1 Steam
R E Cartwright V Pres
CLEVELAND CINCINNATI CHICAGO & ST LOUIS Indianapolis Ind
Mileage & Equip included in New York Central
J J Corcoran Sig Eng Cleveland Ohio
B J Schwendt Asst Sig Eng Cincinnati O
C D Cronk Asst Sig Eng Cleveland O
C E Baxter Supt Tele Detroit Mich
Signal Supervisors:
R H Burkett Bellefontain Ohio
L Clark Indianapolis Ind
C W Hummel Mattoon Ill
W V Mosk Springfield Ohio
CLINCHFIELD R R Erwin Tenn
302 Miles, 76 Steam
Comprising: Carolina Clinchfield & Ohio
Carolina Clinchfield & Ohio of S C
L H Phetteplace Gen Mgr
COLORADO & SO EASTERN Delagua Colo
18 Miles, 2 Steam
A McNew Supt
COLORADO & SOUTHERN Denver Colo
748 Miles, 64 Steam, 9 Oil, 1 Diesel
A E Parnell Supt Tele & Sig

W F Du Bois Pres
COWLITZ CHEHALIS & CASCADE Seattle Wash
32 Miles, 3 Oil
J N Davis Pres
CRAIG MOUNTAIN Winchester Idaho
6 Miles, 1 Steam
R Hansen Gen Supt
CUMBERLAND & MANCHESTER *See Louisville & Nashville*
CUMBERLAND & PENNSYLVANIA Cumberland Md
50 Miles, 11 Steam
W Claus Gen Mgr
CUYAHOGA VALLEY 3341 Jennings Rd Cleveland Ohio
14 Miles, 9 Steam
W M Lorenz Pres & Gen Mgr

— D —

DALLAS TERMINAL R R & UNION DEPOT CO
See St Louis Southwestern
DANSVILLE & MOUNT MORRIS Dansville N. Y.
9 Miles, 2 Steam
F A Hart V Pres & Gen Mgr
DANVILLE & WESTERN Danville Va
82 Miles, 5 Steam
W J O'Pry Supt
DARDANELLE & RUSSELLVILLE Dardanelle Ark
7 Miles, 3 Steam
A P Rudowsky V Pres
DAVENPORT ROCK ISLAND & NORTHWESTERN Davenport Ia
48 Miles, 10 Steam
F S Welsbrook Gen Mgr
DE KALB & WESTERN De Kalb Miss
12 Miles, 2 Steam
E H Jones Pres
DELAWARE & HUDSON Albany N Y
848 Miles, 355 Steam, 5 Oil, 1 Diesel-Elec
S H Rice Sig Eng & Supt Tele
J A Vallee Super Sig Constr
Signal Supervisors:
C M Acker Albany N Y
B H Richards Oneonta N Y
T R Robson Carbondale Pa
DELAWARE LACKAWANNA & WESTERN 140 Cedar New York City
1604 Miles, 370 Steam, 141 Motor cars, 33 Diesel-Elec
G J Ray V Pres New York City
A Reilly Sig Eng Hoboken N J
C L Thomas Telo Eng Hoboken N J
Signal Supervisors:
G E Goeppert Buffalo N Y
J R Heisler Scranton Pa
I K Johnson Hoboken N J
DELRAY CONNECTING 7501 W Jefferson Ave Detroit 32 Mich
28 Miles, 6 Steam
G J Mobley Pres
DELTA VALLEY & SOUTHERN Wilson Ark
18 Miles, 2 Steam
E D Bryan V Pres & Gen Mgr
DENVER & INTERMOUNTAIN Denver Colo
56 Miles, 6 Electric
H Detrick Supt Equip
DENVER & RIO GRANDE WESTERN Rio Grande Bldg Denver Colo
2,405 Miles, 321 Steam, 41 Diesel-Elec
W W Pulham Supt Denver Colo
B W Molis Sig Eng Denver Colo
O H Brown Sig Constr Eng Denver Colo
J Ayer Sig Super Provo Utah
C R Homberg Sig Super Pueblo Colo
R C Eaton Sig Super Grand Jct Colo
DENVER & SALT LAKE Denver Nat'l Bldg Denver Colo
231 Miles, 39 Steam
W H Sagstetter Asst to Pres
S J Wirz Supt Tele
DEQUEEN & EASTERN DeQueen Ark
36 Miles, 1 Oil
J C Leeper V Pres
DES MOINES & CENTRAL IOWA 114 11th St Des Moines Ia
75 Miles, 7 Elec
H A Benjamin Pres & Gen Mgr
DES MOINES UNION Decatur Ill
40 Miles, 5 Steam
R J Bellsmith Supt of Tele
DETROIT & MACKINAC Tawas City Mich
242 Miles, 18 Steam, 1 Gas
C A Pinkerton Pres & Gen Mgr
DETROIT & TOLEDO SHORE LINE Monroe Mich
59 Miles, 25 Steam
O H Sessions Eng Maint of Way
DETROIT CARO & SANDUSKY Caro Mich
44 Miles, 4 Steam
J W MacLachlan Gen Mgr
DETROIT TERMINAL 14517 Woodward Ave Detroit Mich
18 Miles, 28 Steam
D G Cohan Gen Mgr
DETROIT TOLEDO & IRONTON 4921 Calhoun Ave Dearborn Mich
464 Miles, 49 Steam 2 Diesel
W G Clinton Supt Sig & Comm
P L Forbes Supt Tele & Telo
DONIPHAN KENSETT & SEARCY
See Mo Pac R R
DONORA SOUTHERN Donora Pa
16 Miles, 1 Steam
F E Van Woert V Pres & Gen Supt
DULUTH & IRON RANGE *See Duluth Missabe & Iron Range*
DULUTH & NORTHEASTERN Cloquet Minn
12 Miles, 5 Steam
G E Nichols V Pres & Gen Mgr
DULUTH MISSABE & IRON RANGE Duluth Minn
545 Miles, 139 Steam
A L Ledin Supt
DULUTH SOUTH SHORE & ATLANTIC Minneapolis Minn
535 Miles, 32 Steam
R C Wickizer Supt Tele 509 W Roosevelt Rd Chicago Ill
DURHAM & SOUTHERN Durham N C
59 Miles, 4 Steam
M D Clark Supt

— E —

EAST BROAD TOP Rockhill Furnace Pa
70 Miles, 9 Steam
C D Jones V Pres (Oper)
EAST CAROLINA Farmville N C
25 Miles, 1 Steam
W H Newell Gen Mgr
EAST ERIE COMMERCIAL Erie Pa
12 Miles, 4 Diesel-Elec
J H Huntt Pres & Gen Mgr
EAST JERSEY R R & TERM Bayonne N J
4 Miles, 4 Diesel
J A Gillespie Supt
EAST JORDAN & SOUTHERN East Jordan Mich
22 Miles, 1 Steam, 1 Gas
H P Porter Pres & Gen Mgr
EASTLAND WICHITA FALLS & GULF Eastland Texas
28 Miles, 2 Oil
C J Rhodes V Pres Gen Supt
EAST ST LOUIS JUNCTION Nat'l Stock Yards Chicago Ill
36 Miles, 8 Steam
G L Schiele Supt
EAST TENNESSEE & WESTERN NORTH CAROLINA Johnson City Tenn
34 Miles, 6 Steam
W H Blackwell V Pres & Gen Mgr
EAST WASHINGTON Seat Pleasant Md
3 Miles, 2 Steam
J M Rector Pres & Gen Mgr
EDGEMOOR & MANETTA Edgmoor S C
3 Miles, 1 Steam
R A Willis Gen Mgr
EL DORADO & WESSON El Dorado Ark
10 Miles, 3 Oil
H D Reynolds Pres
ELGIN JOLIET & EASTERN Joliet Ill
392 Miles, 174 Steam, 63 Diesel-Elec
T M Milligan Gen Supt
F C Stuart Sig Eng
F W Furnas Asst Sig Eng
ERIE R R Midland Bldg Cleveland O
2,377 Miles, 761 Steam, 12 Diesel-Elec, 1 Gas-Elec
W S Storms Sig Eng
J P Kreiter Act Supt Tele & Telo
G D Poole Tele & Telo Eng
Eastern District 1,171 Miles
R C Randall Gen Mgr Jersey City N J
Signal Supervisors:
R C Gallaher Hornell N Y
M J Menzie (Asst) Binghamton N Y
S D Richardson (Asst) Paterson N J
J H Storms Paterson N J
A C Turner Buffalo N Y
Western District 1,206 Miles
A E Kriesien Gen Mgr Youngstown O
Signal Supervisors:
O G Carey Marion O
C L Castor Youngstown O
E F Champlin Huntington Ind

A E Young Salamanca N Y
F Youngwerth (Asst) Youngstown O
ERIE & MICHIGAN RY & NAVIGATION Alabaster Mich
11 Miles, 1 Steam
A A Bigelow Gen Supt
ESCANABA & LAKE SUPERIOR Wells Mich
95 Miles, 5 Steam
G W Brown Supt
ETNA & MONTROSE Etna Pa
1 Mile, 3 Stream
M J Strueber Supt
EVANSVILLE & OHIO VALLEY Evansville Ind
14 Miles, 1 Elec
W R Hickrod Gen Mgr
EVANSVILLE SUBURBAN & NEWBURGH Evansville Ind
25 Miles, 3 Steam
C H Hendricks V Pres & Gen Mgr

— F —

FAIRPORT PAINESVILLE & EASTERN Painesville Ohio
20 Miles, 8 Steam
L L Dixon Pres & Gen Mgr
FEATHER RIVER Feather Falls Calif
30 Miles, 5 Steam
C J Everett Supt of Sig & Comm
FEDERAL VALLEY *See N Y Central*
FERNWOOD COLUMBIA & GULF Fernwood Miss
44 Miles, 3 Steam
P H Enochs Supt of Sig & Comm
FLEMINGSBURG & NORTHERN Flemingsburg Ky
7 Miles, 1 Gas-Elec
G Faulkner Gen Mgr
FLINT RIVER & NORTH EASTERN Moultrie Ga
23 Miles, 3 Steam
F R Pidcock Gen Mgr
FLORIDA EAST COAST St Augustine Fla
682 Miles, 102 Oil, 6 Diesel-Elec
W A Hoffman Supt Tele & Sig
C U Jellison Telo & Tele Insp
FONDA JOHNSTOWN & GLOVERSVILLE Gloversville N Y
20 Miles, 4 Steam
J Zimmer Pres
FORDYCE & PRINCETON Fordyce Ark
9 Miles, 2 Oil
B A Mayhew V Pres & Gen Mgr
FORE RIVER Bethlehem Pa
7 Miles, 6 Steam
P A Trageser V Pres
FT DODGE DES MOINES & SOUTHERN Boone Ia
150 Miles, 12 Elec
C H Crooks Pres & Gen Mgr
FORT MYERS SOUTHERN *See Atlantic Coast Line*
FT SMITH SUBIACO & ROCK ISLAND Paris Ark
15 Miles, 1 Steam
B A Brown Gen Mgr
FT WORTH & DENVER CITY 307 W 6th St Fort Worth Texas
804 Miles, 58 Oil, 4 Diesel-Elec
W F Zane Sig Eng Chicago Ill
H H Hasselbacher Gen Supt Tele Chicago
A E Parnell Supt Tele Denver Colo
FORTH WORTH BELT *See Texas & Pacific*
FRANKFORT & CINCINNATI Frankfort Ky
41 Miles, 5 Steam
J M Perkins Pres & Gen Mgr

— G —

GAINESVILLE MIDLAND Gainesville Ga
74 Miles, 5 Steam
F W Webb Supt
GALESBURG & GREAT EASTERN Bank Bldg Indianapolis Ind
10 Miles, 2 Steam
R H Sherwood Pres
GALVESTON HOUSTON & HENDERSON Galveston Texas
50 Miles, 7 Oil
N E Smith Supt Sig & Comm
GALVESTON WHARVES Galveston Texas
51 Miles, 7 Steam
R E Fristoe Ch Eng
GARDEN CITY WESTERN Garden City Kan
14 Miles, 1 Oil
J Stewart Pres & Gen Mgr
GENESEE & WYOMING Scranton Pa
15 Miles, 5 Steam
H C Finch V Pres & Gen Mgr
GEORGIA & FLORIDA Augusta Ga
408 Miles, 32 Steam
Chas McDiamid Supt Sig & Comm
GEORGIA NORTHERN Moultrie Ga
68 Miles, 6 Steam
C W Pidcock Pres & Gen Mgr
GEORGIA R R 4 Hunter St Atlanta Ga
329 Miles, 53 Steam
C A Wickersham Gen Mgr
GEORGIA SOUTHERN & FLORIDA *See Southern Railway System*
GRAFTON & UPTON Hopedale Mass
15 Miles, 2 Elec
A D Johnson Gen Mgr
GRAHAM COUNTY Oil City Pa
12 Miles, 1 Steam
J B Veach Pres
GRASSE RIVER Conifer N Y
16 Miles, 2 Steam
W C Sykes Pres
GRAYSONIA NASHVILLE & ASHDOWN Nashville Ark
27 Miles, 3 Steam
J W Dawson Gen Sup & Ch Eng
GREAT NORTHERN St Paul Minn
8,372 Miles, 423 Steam, 386 Oil, 12 Elec 66 Diesel-Elec, 31 Gas-Elec Motor Cars, 2 Diesel-Elec Motor Cars
H E Brashares Supt Sig
P G Seaholm Asst Supt Sig
R C Thayer Supt Tele St Paul Minn
S J Bowers Asst Supt Tele Spokane Wash
Signal Supervisors:
J P Melby Seattle Wash
H Ottoson Minneapolis Minn
GREAT WESTERN P O Box 5308 Terminal Annex Denver Colo
84 Miles, 9 Steam
D J Roach V Pres
GREENBAY & WESTERN Green Bay Wis
234 Miles, 12 Steam, 1 Diesel-Elec
H E McGee Pres
GREENVILLE & NORTHERN Greenville S C
19 Miles, 2 Steam
F G Hamblen V Pres & Gen Mgr
GULF & SHIP ISLAND *See Ill Central*
GULF COAST LINES Comprising:
Asherton & Gulf
Asphalt Belt
Beaumont Sour Lake & Western
Houston & Brazos Valley
New Iberia & Northern
New Orleans Texas & Mexico
Orange & Northwestern
Rio Grande City
St Louis Brownsville & Mexico
San Antonio Southern
San Antonio Uvalde & Gulf
San Benito & Rio Grande Valley
Sugar Land
1,734 Miles, 5 Steam, 93 Oil, 2 Elec, 7 Diesel
L S Werthmuller Sig Eng St Louis Mo
H L Robertson Asst Sig Eng Houston
W Rogers Supt Tele St Louis Mo
R H Richter Asst Supt Tele Houston Tex
GULF COLORADO & SANTA FE Galveston Texas
2,098 Miles, Equip incl in A T & S F
V O Smeltzer Sig Eng
W L Talevich Asst Sig Eng
J L L Lee Tele Mgr
Signal Supervisors:
W E Benson Temple Tex
G T Leonard Ft Worth Tex
P H Yarbrough Galveston Tex
GULF MOBILE & OHIO Mobile Ala
1,963 Miles, 160 Steam, 13 Diesel
K P Goodwin Supt Telo Tele & Sig
G D McDonald Super Telo Tele & Sig
J M Wuerpel Super Sig

— H —

HAMLIN & NORTHWESTERN Vernon Texas
11 Miles, 1 Oil
H U Jackson Pres & Gen Mgr
HAMPTON & BRANCHVILLE Hampton S C
49 Miles, 4 Steam
E O Lightsey V Pres
HANNIBAL CONNECTING Northampton Pa
4 Miles, 3 Steam
A F Tidabock Pres
HARBOR BELT LINE San Pedro Calif
118 Miles, 16 Oil
L L Laughlin Gen Mgr
HARRIMAN & NORTHEASTERN *See So Ry System*
HARTWELL R R Anderson S C
10 Miles, 1 Steam
C Quin V Pres
HELENA SOUTHWESTERN West Helena Ark
287 Miles, 4 Steam
F W Schatz Gen Mgr
HIGH POINT-THOMASVILLE & DENTON High Point N C
34 Miles, 5 Steam
O A Kirkman Exec V Pres & Gen Mgr
HILLSBORO & NORTH EASTERN Hillsboro Wis
6 Miles, 1 Gas
J A Cesnik Pres & Gen Mgr
HOBOKEN MANUFACTURERS R R Hoboken N J
11 Miles, 3 Diesel-Elec, 1 Gas
A R Macgowan Supt
HOOPPOLE YORKTOWN & TAMPICO Hooppole Ill
12 Miles, 1 Steam
A R Mathis Gen Mgr
HOOSAC TUNNEL & WILMINGTON Readsboro Vt
12 Miles, 2 Steam
J A Long Gen Supt
HOUSTON & BRAZOS VALLEY *See Gulf Coast Lines*
HOUSTON BELT & TERMINAL Union Sta Bldg Houston Texas
26 Miles, 7 Oil, 1 Diesel
G M Leach Gen Mgr
HUNTINGDON & BROAD TOP MOUNTAIN Saxton Pa
74 Miles, 9 Steam
F E Steele Supt
HUTCHINSON & NORTHERN Hutchinson Kan
6 Miles, 2 Elec
S B Horrell Gen Supt

— I —

ILLINOIS CENTRAL SYSTEM 135 E 11th Place Chicago 5 Ill
10,819 Miles, 1370 Steam, 37 Diesel, 140 Motor Cars, 140 Trailer
Comprising:
Alabama & Vicksburg
Gulf & Ship Island
Illinois Central
Vicksburg Shreveport & Pacific
Yazoo & Mississippi Valley
W M Vandersluis Gen Supt Tele & Sig
H G Morgan Sig Eng
R C Bingham Asst to Sig Eng
J M Trissal Elec Eng Fixed Property
P B Burley Electronics Eng
G K Phillis Asst Supt Tele
J C Mamage Super Telo & Tele Equip
G R Stewart Telo & Tele Eng
D C Walker Asst Supt Tele Rm 411 Grand Central Sta Memphis Tenn
C H Edney Super Telo & Tele Equip 411 Grand Central Sta Memphis Tenn
A L Stahl Telo & Tele Eng Memphis Tenn
District Foremen Telegraph:
L P Anderson Chicago Ill
L H Carlyle Memphis Tenn
D Davis Carbondale Ill
J C Doyle Champaign Ill
J A Holliday Jackson Miss
B R Peck Waterloo Ia
L R Willingham Fulton Ky
ILLINOIS NORTHERN 180 N Michigan Chicago
28 Miles, 9 Steam
W J Wheaton Maint of Way Eng
ILLINOIS TERMINAL Springfield Ill
456 Miles, 22 Steam
John Leisenring Supt of Sig & Comm
INDIANA HARBOR BELT Detroit Mich
628 Miles, 116 Steam
S L Van Akin Supt Tele
C E Rowe Sig Super Englewood Ill
W L Murphy Asst Sig Super Englewood Ill
INDIANA NORTHERN 533 S Chapin St South Bend Ind
4 Miles, 2 Steam
G R Lanphere V Pres
INDIANA SERVICE CORP 2101 Spy Run Fort Wayne Ind
18 Miles, 2 Elec
E A Luhman Gen Mgr
INDIANAPOLIS UNION Union Station Chicago
16 Miles, 11 Steam
J M Symes Pres
INTERNATIONAL-GREAT NORTHERN Houston Tex
1,155 Miles, 103 Oil, 10 Diesel
H L Robertson Act Asst Eng Sig
R H Richter Asst Supt Tele
L S Werthmuller Sig Eng St Louis Mo
W Rogers Supt Tele St Louis Mo
INTERNATIONAL R R 43 Court St Buffalo N Y
121 Miles, 3 Elec
B J Yungbluth Pres & Gen Mgr
INTERSTATE R R Andover Va
55 Miles, 13 Steam
H A Ramsey V Pres
IOWA TRANSFER Des Moines 9 Ia
3 Miles, 1 Elec
F C Hubbell Pres

— J —

JACKSONVILLE TERMINAL Jacksonville Fla
51 Miles, 11 Steam, 2 Oil
J L Wilkes Pres & Gen Mgr
JAMESTOWN WESTFIELD & NORTHWESTERN Jamestown N Y
33 Miles, 2 Elec
M P Gross V Pres & Gen Mgr
JAY STREET CONNECTING 71 Water St N Y C
5 Miles, 1 Gas
C K Woodbridge Pres
JOHNSTOWN & STONY CREEK Johnstown Pa
3 Miles, 3 Steam
C M Kimmel Pres

— K —

KANAWHA CENTRAL Charleston W Va
5 Miles, 1 Steam
H H Fletcher Gen Mgr
KANSAS & MISSOURI 1711 Minn Ave Kansas City Mo
6 Miles, 2 Elec
W H Cummins Sec
KANSAS CITY CONNECTING Livestock Exch Bldg Kansas City Mo
12 Miles, 1 Steam
J C Cash Pres
KANSAS CITY KAW VALLEY Bonner Springs Kan
42 Miles, 2 Elec
J E Hubbel Supt
KANSAS CITY PUBLIC SERVICE 728 Delaware Kansas City 13 Mo
200 Miles, 2 Elec
N Grover V Pres
KANSAS CITY SOUTHERN 114 W 11th St Kansas City Mo
1713 Miles, 189 Steam, 14 Diesel
E F Salisbury Supt Sig & Comm
C F Grundy Sig Eng
A H Ryden Supt Tele
KANSAS CITY TERMINAL Union Station Kansas City Mo
170 Miles, 13 Steam, 10 Diesel
F J Ackerman Ch Eng
KANSAS OKLAHOMA & GULF *See Midland Valley*
KELLEY'S CREEK & NORTHWESTERN Ward W Va
7 Miles, 3 Steam
L Ridenour Mgr
KELLY'S CREEK Mammouth W Va
7 Miles, 1 Steam
W F Wolfe Supt
KENTUCKY & INDIANA TERMINAL 2910 No Western Pkway Louisville 12 Ky
125 Miles, 30 Steam
C W Ashby Pres & Gen Mgr
KEWAUNEE GREEN BAY & WESTERN
35 Miles, 6 Steam, 1 Diesel-Elec
For officials see G B & W R R
KLICKITAT LOG & LUMBER Klickitat Wash
20 Miles, 2 Oil
W H Rathert Supt

— L —

LACKAWANNA & WYOMING VALLEY Scranton Pa
24 Miles, 3 Elec
P J Murphy Pres & Gen Mgr
LACKAWANNA R R *See Del Lack & West'n*
LAKE CHAMPLAIN & MORIAH Port Henry N Y
7 Miles, 1 Diesel-Elec
A K McClellan Gen Mgr
LAKE ERIE & FT WAYNE Decatur Ill
5 Miles, 1 Diesel
R J Bellsmith Supt of Tele
LAKE ERIE & EASTERN *See P & L E R R*
LAKE ERIE FRANKLIN & CLARION Clarion Pa
16 Miles, 5 Steam
L L Marshall Gen Supt
LAKELAND R R Lakeland Ga
10 Miles, 1 Steam
C Bradford Gen Mgr
LAKE PROVIDENCE TEXARKANA & WESTERN Memphis Tenn
2 Miles, 1 Steam
R W Dickinson V Pres & Supt
LAKESIDE & MARBLEHEAD Marblehead Ohio
11 Miles, 4 Steam
O F Gardner Mgr
LAKE SUPERIOR & ISPEMING Marquette Mich
156 Miles, 32 Steam
A Syverson V Pres & Gen Mgr
LAKE SUPERIOR TERMINAL & TRANSFER Superior Wis
25 Miles, 13 Steam
L M Elmslie Supt
LAKE TERMINAL Grant Bldg Pittsburgh Pa
40 Miles, 17 Steam
J M Morris Pres & Gen Mgr
LANCASTER & CHESTER Lancaster S C
29 Miles, 4 Steam
A P McLure Pres & Gen Mgr
LAONA & NORTHERN Laona Wis
14 Miles, 3 Steam
R M Connor V Pres
LARAMIE NORTH PARK & WESTERN Laramie Wyo
111 Miles, 4 Steam
F C McEntee Gen Supt
LA SALLE & BUREAU COUNTY La Salle Ill
13 Miles, 1 Steam, 1 Gas-Elec
J B McCaffrey Gen Mgr
LAURINBURG & SOUTHERN Laurinburg N C
30 Miles, 3 Steam
G Y Jones Mgr & Supt
LEHIGH & HUDSON RIVER Warwick N Y
96 Miles, 20 Steam
A Shaw Pres & Gen Mgr
LEHIGH & NEW ENGLAND Bethlehem Pa
190 Miles, 44 Steam
J E Hackman Super Tele & Sig
LEHIGH VALLEY Bethlehem Pa
1,260 Miles, 352 Steam, 51 Diesel-Elec, 5 Gas-Elec
J F Yerger Supt Tele & Sig
J A Niedeck Asst Supt Tele & Sig
Supervisors of Tele & Sig:
C L Ditchendorf Buffalo N Y
A Frank Wilkes-Barre Pa
T P Heitzman Jersey City N Y
LEWISTON & YOUNGSTOWN FRONTIER Youngstown N Y
6 Miles, 1 Diesel
J Van Kill Supt of Sig & Comm
LIGONIER VALLEY Ligonier Pa
16 Miles, 4 Steam
J P Gochnour Jr Gen Mgr
LITCHFIELD & MADISON Edwardsville Ill
51 Miles, 7 Steam, 1 Diesel-Elec
H N Huntsman Chief Engineer
LIVE OAK PERRY & GULF Foley Fla
59 Miles, 4 Steam
J H Kansinger V Pres & Gen Mgr
LONG ISLAND R R Penn Station New York N Y
374 Miles, 88 Steam, 35 Elec, 3 Diesel
J S Gensheimer Supt Tele & Sig
S B Higginbottom Asst Eng Tele & Sig
G H White Super Tele & Sig Jamaica N Y
E J Kelly Asst Super Tele & Sig Jamaica N Y
H L Rainear Asst Super Tele & Sig Jamaica N Y
LONGVIEW PORTLAND & NORTHERN Longview Wash
7 Miles, 4 Oil, 1 Diesel-Elec
R F Morse Gen Mgr
LORAIN & SOUTHERN Guildhall Bldg Cleveland Ohio
6 Miles, 1 Steam
E T Ripley Pres
LORAIN & WEST VIRGINIA *See W & L E Ry*
LOS ANGELES JUNCTION 4814 Loma Vista Los Angeles Calif
33 Miles, 1 Oil, 2 Diesels
H G Erickson Ch Eng
LOUISIANA & ARKANSAS Kansas City Mo
854 Miles, 64 Oil, 2 Diesel
F H Hooper Gen Mgr
LOUISIANA & NORTH WEST Homer La
99 Miles, 5 Steam
L S Rand Gen Supt
LOUISIANA & PINE BLUFF Shreveport La
3 Miles, 5 Oil
E A Frost Pres
LOUISIANA SOUTHERN New Orleans La
15 Miles, 2 Oil, 1 Diesel-Elec
D W McDow V Pres & Gen Mgr
LOUISVILLE & NASHVILLE 908 W B'way Louisville 1 Ky
4,745 Miles, 908 Steam, 33 Diesel-Elec
W H Stilwell Sig Eng
P P Ash Asst Sig Eng
M R Williams Sig Super Train Control
Signal Supervisors:
R C Austin Knoxville Tenn
W C Baker Mobile Ala
F Hacker Latonia Ky
G H Hume Ravenna Ky
C E Pinkston Nashville Tenn
W G Ray Birmingham Ala
E H Welsh Louisville Ky
E S Williams Evansville Ind
LOUISVILLE NEW ALBANY & CORYDON Corydon Ind
8 Miles, 2 Steam
W F Buchanan V Pres & Gen Mgr

LOWVILLE & BEAVER RIVER Lowville N Y
11 Miles, 2 Steam
F L Parker Pres

— M —

McCLOUD RIVER R R McCloud Calif
61 Miles, 14 Steam
P N Myers V Pres & Gen Mgr
McKEESPORT CONN Grant Bldg Pittsburgh Pa
15 Miles, 10 Steam
J M Morris Pres & Gen Mgr
MACON DUBLIN & SAVANNAH Macon Ga
92 Miles, 8 Steam
F C Cheney V Pres
MAGMA ARIZONA 14 Wall St New York N Y
28 Miles, 2 Oil
E G Dentzer V Pres & Gen Mgr
MAINE CENTRAL 222-242 St John Portland Me
964 Miles, 130 Steam, 5 Diesel
J P Muller Sig Eng Boston Mass
F E Avery Sig Super Portland Me
J M Scott Asst Sig Super Bangor Me
S Sullivan Asst Sig Super Portland Me
MANCHESTER & ONEIDA Manchester Ia
9 Miles, 2 Steam
C J Hockaday V Pres
MANISTEE & NORTHEASTERN Manistee Mich
112 Miles, 6 Steam
J G Johnson Gen Mgr
MANISTIQUE & LAKE SUPERIOR Decatur Ill
41 Miles, 3 Steam
R J Bellsmith Supt of Tele
MANITOU & PIKES PEAK Colorado Springs Colo
10 Miles, 4 Steam, 1 Diesel-Elec, 1 Gas
J A Carruthers V Pres & Gen Mgr
MANSFIELD RY & TRANS Shreveport La
3 Miles, 2 Oil
R G Dowell Supt
MANUFACTURERS R R 2297 S Broadway St Louis Mo
37 Miles, 8 Diesel-Elec
A E Wright Pres & Gen Mgr
MARCELLUS & OTISCO LAKE Marcellus N Y
3 Miles, 1 Steam
A V Smith Pres
MARIANNA & BLOUNTSTOWN Blountstown Fla
29 Miles, 3 Steam
O O Miller Pres & Gen Mgr
MARINETTE TOMAHAWK & WESTERN Tomahawk Wis
24 Miles, 3 Steam
J A Fremon Exec V Pres
MARION & EASTERN *See Missouri Pacific*
MARSHALL ELYSIAN FIELDS & SOUTHEASTERN 111 E Rusk St Marshall Tex
2 Miles, 1 Gas
W K Furth V Pres & Gen Mgr
MARYLAND & PENNA Mt Royal Sta Baltimore Md
81 Miles, 11 Steam
C Adler Jr Sig Eng
MASON CITY & CLEAR LAKE Mason City Ia
10 Miles, 3 Elec
C E Strickland Pres & Gen Mgr
MASSENA TERMINAL Massena N Y
2 Miles, 3 Diesel
A J Hanmer V Pres
MERIDIAN & BIGBEE RIVER Meridian Miss
51 Miles, 4 Steam
J C Floyd
MICHIGAN CENTRAL Michigan Central Term Bldg Detroit Mich
Mileage & Equip included in N Y C System
C E Baxter Supt Tele
J J Corcoran Sig Eng Cleveland O
C D Cronk Asst Sig Eng Cleveland O
Signal Supervisors:
H D Albright Jackson Mich
F M Brown St Thomas Ont
V J Humphrey Detroit Mich
T G Inwood Englewood Ill
MIDDLE CREEK 231 S LaSalle St Chicago Ill
6 Miles, 2 Steam
L S Voltz Pres
MIDDLE FORK Ellamore W Va
13 Miles, 2 Steam
H W Kelly Gen Mgr
MIDDLETOWN & UNIONVILLE Middletown N Y
15 Miles, 1 Steam
L F Zieres
MIDLAND CONTINENTAL Jamestown N D
73 Miles, 2 Steam, 1 Diesel-Elec
C W Cockrell Gen Mgr
MIDLAND VALLEY Muskogee Okla
334 Miles, 13 Steam
E M Tanner Gen Supt
MILSTEAD R R La Grange Ga
3 Miles, 1 Steam
J H Daughdrill V Pres
MINNEAPOLIS & ST LOUIS Northwestern Bank Bldg Minneapolis Minn
1,409 Miles, 89 Steam, 11 Gas-Elec, 12 Diesels
C S Weatherill Chief Engineer
G S Lovering Asst Ch Eng & Supt T & S
MINNEAPOLIS ANOKA & CUYUNA RANGE Fridley Minn
5 Miles, 2 Elec
J B Hawley Pres
MINNEAPOLIS EASTERN Minneapolis Minn
4 Miles, 1 Steam
P J Tomlinson Supt
MINNEAPOLIS NORTHFIELD & SOUTHERN Pence Bldg Minneapolis Minn
77 Miles, 10 Steam, 1 Diesel-Elec
J R Branley Gen Mgr

MINNEAPOLIS ST PAUL & SAULT STE MARIE Soo Line Bldg Minneapolis Minn
4,277 Miles, 275 Steam, 9 Diesel-Elec
J R Smith Supt Tele & Sig
B F McGowan Asst Sig Eng
R C Wickizer Supt Tele (Chicago Dist)
MINNESOTA DAKOTA & WESTERN International Falls Minn
22 Miles, 6 Steam
W La Du Gen Supt
MINNESOTA TRANSFER 2071 Univ Ave St Paul Minn
140 Miles, 13 Steam, 6 Diesel
H McCarthy Gen Supt
MINNESOTA WESTERN Minneapolis Minn
115 Miles, 1 Diesel
J R Branley Gen Mgr
MISSISSIPPI & ALABAMA Leakesville Miss
17 Miles, 2 Steam
O T Brown Supt of Sig & Comm
MISSISSIPPI & SKUNA VALLEY Box 391 Memphis Tenn
21 Miles, 1 Steam
R Y Duquesnay V Pres & Gen Mgr
MISSISSIPPI CENTRAL Hattiesburg Miss
158 Miles, 12 Steam
L F Faulkner V Pres & Gen Mgr
MISSISSIPPI EXPORT Moss Point Miss
44 Miles, 2 Diesel-Elec
W M Dutton V Pres & Gen Mgr
MISSISSIPPIAN R R Amory Miss
24 Miles, 2 Steam
F L Puckett Pres & Mgr
MISSOURI & ARKANSAS Harrison Ark
365 Miles, 20 Steam
J R Tucker Gen Mgr
MISSOURI & ILLINOIS BRIDGE & BELT Alton Ill
3 Miles, 1 Steam
A A Lampert Supt
MISSOURI-ILLINOIS *See Mo Pac R R*
MISSOURI-KANSAS-TEXAS Dallas Texas
1,798 Miles, 29 Steam, 244 Oil
J A Johnson Supt Tele & Sig Denison Tex
R R Wood Sr Sig Super Denison Tex
R O Johnson Tele & Sig Super Denison Tex
R A Mosse Sig Super Parsons Kan
W G Pluto Sig Super Parsons Kan
MISSOURI-KANSAS-TEXAS R R CO of TEXAS Katy Bldg
1,350 Miles, 37 Oil
J A Johnson Supt Tele & Sig Denison Tex
R R Wood Sr Sig Super Denison Tex
W H Dutton Sig Super Denison Tex
R O Johnson Tele & Sig Super Denison Tex
L F Garrison Sig Super Waco Tex
MISSOURI PACIFIC LINES *Officials & mileage below. Comprising:*
Doniphan Kensett & Searcy
Gulf Coast Lines
International-Great Northern
Marion & Eastern
Missouri-Illinois
Missouri Pacific
Natchez & Louisiana Ry Transfer Co
Natchez & Southern
St Joseph Belt
Union Ry Co (Memphis)
Union Terminal Ry (St Joseph Mo)
MISSOURI PACIFIC R R Mo Pac Bldg St Louis Mo
7,139 Miles, 714 Steam, 213 Oil, 47 Diesel-Elec
L S Werthmuller Sig Eng
A T Hunot Asst Sig Eng
W Rogers Supt Tele
R A Hendrie Asst Supt Tele
C H Dietrich Gen Super Tele
F K Garlock Tele Eng
W Chunn Tele Eng
O J Surron Super Tele Kansas City Mo
P F McKinney Super Tele Little Rock Ark
Signal Supervisors:
W N Barnes Atchison Kan
C Brady Coffeyville Kan
J W Chowning Monroe La
E M Kempe Dodson Mo
N S Lynch Kansas City Mo
R R Ragland De Soto Mo
Spillman Nevada Mo
O R Thurston Little Rock Ark
L D Woods (Asst) Little Rock Ark
J L Marcum 3001 Chouteau Ave St Louis Mo
MOBILE & GULF Fayette Ala
34 Miles, 2 Steam
R E Loper Gen Mgr
MODESTO & EMPIRE TRACTION Modesto Calif
5 Miles, 4 Oil
G K Beard V Pres & Mgr
MONONGAHELA CONNECTING 311 Ross St Pittsburgh Pa
38 Miles, 22 Steam, 10 Diesel
W E Cox V Pres & Supt
MONONGAHELA RY CO Penn Sta Pittsburgh Pa
171 Miles, 53 Steam
C M Yohe V Pres
MONONGAHELA WEST PENN PUBLIC SERVICE Parkersburg W Va
97 Miles, 3 Elec
J R Robinson Supt Maint of Way
MONSON R R Monson Me
8 Miles, 2 Gas, 2 Steam
P A Jackson Supt
MONTANA WESTERN Valier Mont
20 Miles, 1 Steam
C E Atwood Supt of Sig & Comm
MONTANA WYOMING & SOUTHERN Belfry Mont
34 Miles, 3 Steam
W H Bunney Pres & Gen Mgr
MONTOUR R R Coraopolis Pa
51 Miles, 22 Steam
W H Hamilton Gen Supt
MONTPELIER & WELLS RIVER Montpelier Vt
20 Miles, 8 Steam

H L Skeels Pres
MOORE CENTRAL Asheboro N C
10 Miles, 1 Steam, 2 Gas
A Ross Sec
MOREHEAD & NORTH FORK Clearfield Ky
4 Miles, 2 Steam
M C Crosley Pres & Gen Mgr
MORRISTOWN & ERIE Whippany N J
11 Miles, 3 Steam
M Jensen V Pres
MOSCOW CAMDEN & SAN AUGUSTINE Camden Tex
7 Miles, 2 Oil
S F Adams Gen Supt
MOSHASSUCK VALLEY Saylesville R I
5 Miles, 2 Steam
D C Paton Gen Supt
MOUNT HOOD Hood River Ore
22 Miles, 1 Steam
L Kostol Gen Supt
MUNCIE & WESTERN 1410 E 12th St Muncie Ind
5 Miles, 1 Gas, 1 Gas-Elec
V G Krauskopf Supt
MURFREESBORO — NASHVILLE Murfreesboro Ark
15 Miles, 1 Steam, 1 Oil
J L Ledbetter

— N —

NACOGDOCHES & SOUTHEASTERN Nacogdoches Tex
42 Miles, 1 Oil
H W Whited V Pres & Gen Mgr
NACOZARI R R El Paso Texas
77 Miles, 1 Oil
H S Fairbank V Pres
NARRAGANSETT PIER Peace Dale R I
8 Miles, 2 Gas
J A Monahan Sec
NASHVILLE CHATTANOOGA & ST LOUIS 930 B'dway Nashville 3 Tenn
1,072 Miles, 205 Steam, 16 Diesel-Elec
E W Anderson Sig & Tele Eng
L W Oliphant Super Sig Constr
C R Stuart Super Tele Maint & Constr
NATCHEZ & SOUTHERN Natchez Miss *See Mo Pac R R*
3 Miles, 1 Steam
NATCHEZ URANIA & RUSTON Urania La
7 Miles, 1 Oil
Q T Hardtner Pres & Gen Mgr
NELSON & ALBEMARLE Schuyler Va
14 Miles, 2 Steam
C C Rothwell V Pres & Gen Mgr
NEVADA COPPER BELT Mason Nevada
29 Miles, 2 Oil
L G Ellis Supt
NEVADA NORTHERN East Ely Nevada
165 Miles, 7 Steam
H J Beem Gen Mgr
NEWBURGH & SO SHORE 8143 B'dway Cleveland 5 Ohio
5 Miles, 9 Steam, 12 Diesel
F A Gideon Pres & Gen Mgr
NEW HAVEN & DUNBAR Dunbar Pa
6 Miles, 1 Steam
P Friedley Pres
NEW IBERIA & NORTHERN *See Gulf Coast Lines*
NEW JERSEY INDIANA & ILLINOIS Ry Exch Bldg St Louis Mo
12 Miles, 1 Steam
N B Pitcairn Pres
NEW ORLEANS & LOWER COAST New Orleans La
60 Miles, 5 Steam
G C Stohlman V Pres
NEW ORLEANS & NORTHEASTERN *See Southern Railway System*
NEW ORLEANS PUBLIC BELT Municipal Bldg New Orleans La
128 Miles, 3 Steam, 10 Oil, 6 Diesel-Elec
E J Garland Gen Mgr
NEW ORLEANS TERMINAL *See Southern Ry System*
NEW ORLEANS TEXAS & MEXICO *See Gulf Coast Lines*
NEW YORK CENTRAL SYSTEM 466 Lexington Av New York N Y
10,534 Miles, 3,190 Steam, 144 Elec, 168 Diesel-Elec
W A Jackson Gen Supt Tele & Telo
J L Niesse Asst to Gen Supt Tele & Telo
Comprising:
Boston & Albany
Chicago Junction
Chicago River & Indiana
Cleve Cin Chic & St Louis
Indiana Harbor Belt
Michigan Central
New York Central
Peoria & Eastern
Pittsburgh & Lake Erie
Buffalo & East
C E Baxter Supt of Tele Detroit Mich
R B Elsworth Sig Eng Albany N Y
West of Buffalo
C E Baxter Supt of Tele Detroit Mich
J J Corcoran Sig Eng Cleveland O
NEW YORK CHICAGO & ST LOUIS Term Tower Cleveland 1 Ohio
1,688 Miles, 351 Steam
S G Raber Supt Tele & Sig
F H Schultize Asst Supt Tele
H G Stiebeling Asst Sig Supt
A L Shepard Sig Office Eng
Nickel Plate District
Signal Supervisors:
J Saunders (Asst) Ft Wayne Ind
E Schroff Ft Wayne Ind
H M Van Osinski Conneaut Ohio
C R Myers (Asst) Conneaut Ohio
Lake Erie & Western District
C Mettlin Sig Super Frankfort Ind
H V Gillette Asst Sig Super Frankfort Ind
Clover Leaf District
C Mettlen Sig Super Frankfort Ind
H V Gillette Asst Sig Super Frankfort Ind
NEW YORK DOCK 44 Whitehall St New York N Y
11 Miles, 2 Steam, 4 Oil
G E Fenniman V Pres

NEW YORK NEW HAVEN & HARTFORD New Haven Conn
1,838 Miles, 496 Steam, 127 Elec, 113 Diesel, 1 Gas
R E Taylor Sig Eng
W A Ford Gen Sig Super
C R Somers Off Eng
T P Flavell Asst Off Eng
Signal Supervisors:
O F Dorward New Haven Conn
O Frantzen Boston Mass
A Schwartz Hartford Conn
E W Shea Providence R I
NEW YORK ONTARIO & WESTERN 330 W 42nd St New York N Y
546 Miles, 87 Steam, 5 Diesel
H H Shannon Sig Eng Middletown N Y
NEW YORK SUSQUEHANNA & WESTERN North Hawthorne N J
129 Miles, 20 Steam, 2 Gas, 8 Diesel
W I McAlpine Sig Super
NEZPERCE & IDAHO Nezperce Idaho
14 Miles, 1 Steam
H C Kendall Pres & Gen Mgr
NIAGARA JUNCTION Niagara Falls N Y
33 Miles, 9 Elec
T P Redding Gen Supt
NICKEL PLATE ROAD *See N Y C System*
NORFOLK & PORTSMOUTH BELT LINE Norfolk Va
27 Miles, 23 Steam
H L White V Pres & Gen Mgr
NORFOLK & WESTERN Roanoke Va
2,127 Miles, 562 Steam, 16 Elec
J A Beoddy Supt Tele & Sig
J L George Asst Supt Tele
A B Armistead Asst Supt Sig
A R Clark Super Telo & Tele
J O Trump Gen For Tele & Sig
I H East Asst Gen For Tele & Sig
NORFOLK SOUTHERN Norfolk Va
728 Miles, 51 Steam
C A Riggan Super Tele Telo & Sig
NORTHAMPTON & BATH Northampton Pa
12 Miles, 3 Oil-Elec
A F Tidabock Pres
NORTHEAST OKLAHOMA Miami Okla
41 Miles, 6 Diesel
E C Mackey Supt Sig & Comm
NORTHERN OHIO *See Akron Canton & Youngst'n*
NORTHERN PACIFIC St Paul Minn
10,249 Miles, 834 Steam, 43 Diesel
S W Law Sig Eng
F L Steinbright Supt Tele
R B Johnson Asst Supt Tele
C W Harding Asst Supt Tele Seattle Wash
Supervisors of Signals:
F L Eukes Livingston Mont
T C Hanson Tacoma Wash
A G Nutting St Paul Minn
NORTHERN PACIFIC TERMINAL CO OF OREGON Union Sta Portland Oregon
79 Miles, 14 Oil, 8 Diesel
H D Mudgett Mgr
NORTH LA & GULF Hodge La
25 Miles, 3 Oil
J S Hunt Pres
NORTHWESTERN PACIFIC 65 Market St San Francisco Calif
331 Miles, 36 Oil
D J Russell Pres
NORWOOD & ST LAWRENCE Norfolk N Y
18 Miles, 3 Steam
E W Beaty Supt

— O —

OAKLAND TERMINAL 114 Sansome St San Francisco Calif
14 Miles, 2 Elec, 2 Diesel
G E Duffy V Pres
OHIO & MORENCI Springfield Ohio
22 Miles, 4 Steam
W G Bell V Pres & Gen Mgr
OHIO CENTRAL LINES *See New York Central*
OHIO PUBLIC SERVICE Hanna Bldg Cleveland Ohio
45 Miles, 2 Elec
T O Kennedy Pres & Gen Mgr
OKLAHOMA R R 1206 Exch Ave Oklahoma City
142 Miles, 7 Elec
N Barrett V Pres
OKMULGEE NORTHERN Okmulgee Okla
10 Miles, 2 Oil
D H Corbell Mgr
OMAHA LINCOLN & BEATRICE 895 North St Lincoln Nebraska
10 Miles, 2 Elec
M Freshman V Pres & Gen Mgr
ONEIDA & WESTERN Hinsdale Ill
38 Miles, 3 Steam
M S Healy Pres
ORANGE & NO WESTERN *See Gulf Coast Lines*
OREGON & NORTHWESTERN Hines Oregon
51 Miles, 2 Oil
E T F Wohlenberg V Pres & Gen Mgr
OREGON ELECTRIC R R *See SP & S*
OREGON PACIFIC & EASTERN Cottage Grove Oregon
20 Miles, 2 Steam
R P Boyce Gen Mgr
OREGON TRUNK R R *See SP & S*
OSAGE R R Lep Okla P. O. Webb City
18 Miles, 1 Steam
L P Groves Mgr
OUACHITA & NORTH-WESTERN Clarks La
10 Miles, 1 Oil
W L McDermott Supt

— P —

PACIFIC COAST R R 811 S Alaska Way Seattle Wash
43 Miles, 5 Steam
G W Mertens Pres & Gen Mgr

A Leader in the Communication and Electronic Fields

FEDERAL · FTR · TELEPHONE & RADIO ·

MANUFACTURERS OF

INTELIN CABLE AND INSULATED WIRE

Federal's Intelin Divison is the largest producer of the largest variety of high-frequency cables. Special developments in these fields have resulted in superior cables for all types of wiring . . . power . . . communications . . . high-frequency transmission.

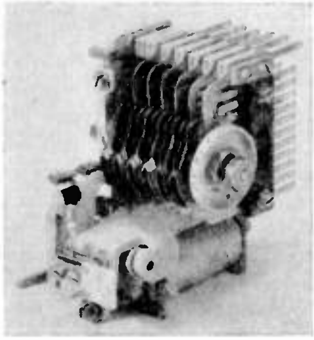
RADIO COMMUNICATIONS EQUIPMENT

Receivers and transmitters for two-way communication, for FM operation, and for AM operation at low, medium, and high frequencies; with a range of transmitter power outputs from 5 watts to 200,000 watts.

FEDERAL SELENIUM RECTIFIERS

Dependable, long life, direct current power supplies for open and closed loop signal circuits . . . and for use wherever direct-current is required from an alternating current source over a wide range of voltage and current needs.

FTR-800 High-Speed Automatic Selector



for local and remote circuit control or selection . . . push-button or dial . . . flexible and highly adaptable for signal and alarm circuit uses. 6 wiper-11 points, or 3 wiper-22 points.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

NEWARK 1, NEW JERSEY

PACIFIC ELECTRIC 208 E 6th St Los Angeles Calif
891 Miles, 50 Elec, 6 Oil
E C Johnson Chief Engineer

PANAMA R R Balboa Heights, C Z
98½Miles, 25 Steam, 5 Diesel
A C Garlington Electrical Engineer

PANHANDLE & SANTA FE Amarillo Tex
1,888 Miles *See A T & S F R R*

PARIS & MT PLEASANT Paris Texas
51½Miles, 4 Oil
R W Wortham Pres

PATAPSCO & BACK RIVERS Bethlehem Pa
67 Miles, 15 Steam, 19 Diesel
P A Trageser V Pres

PEARL RIVER VALLEY Picayune Miss
5 Miles, 2 Steam
A H Knight Sec

PECOS VALLEY SOUTHERN
40 Miles, 1 Oil
See T & P R R

PENINSULA TERMINAL Union Stock Yds North Portland Ore
4 Miles, 2 Oil
H H Burdick Pres

PENNSYLVANIA & ATLANTIC New Egypt N J
25 Miles, 1 Steam
F Johnson Gen Mgr

PENNSYLVANIA R R Broad St Sta Bldg 1617 Penn Blvd Phila Pa
9,767 Miles, 4,369 Steam, 256 Elec, 3 Gas, 18 Diesel
W R Triem Gen Supt Tele
W M Post Sig Eng
New York Zone
698 Mi (inc L I R R)
J S Gensheimer Supt Tele & Sig
Supervisors of Tele & Sig:
S F Schmidhamer Jersey City N J
G H White Jamaica N Y
Eastern Region Penn Sta 30th St Phila
3,011 Miles
J I Kirsch Supt Tele & Sig
J C Patterson Asst Supt Tele & Sig
Supervisors of Tele & Sig:
T R Adams Williamsport Pa
F L Chatten Harrisburg Pa
E T Hammer Sunbury Pa
P J Irvin Baltimore Md
F G Mayer Harrington Del
W C Miller Baltimore Md
W D Stewart Altoona Pa
W G Trost Philadelphia Pa
D R Vought Camden N J
Central Region Penn Sta Pittsburgh Pa
3,354 Miles
A M Crawford Supt Tele & Sig
B F Dickinson Eng Tele & Sig
T E Binyon Eng Tele & Tele
Supervisors of Tele & Sig:
E G Baumann Pittsburgh Pa
G L Black Cleveland Ohio
C Darrah Pittsburgh Pa
C W Henricks Pittsburgh Pa
W A Jones Erie Pa
C Myers Pittsburgh Pa
G W Spangler Pittsburgh Pa
C M Weaver New Castle Pa
O M Willard Buffalo N Y
Western Region Union Sta Chicago Ill
R F Raughley Supt Tele & Sig
W G Salmonson Eng Tele & Sig
Supervisors of Telegraph & Signals:
H T Fleisher Ft Wayne Ind
G C Godshall Toledo O
R E Harlow Terre Haute Ind
C P Huth Cincinnati O
P W Iba Indianapolis, Ind
S J King Columbus O
G H Leford Chicago Ill
D L Moore Logansport Ind
C P Woodson Grand Rapids Mich

PENNSYLVANIA-READING SEASHORE LINES Camden N J
405 Miles, 23 Steam
S F Schmidhamer Super Tele & Sig

PEORIA & EASTERN Indianapolis Ind
202 Miles, 42 Steam
W Davis Gen Mgr

PEORIA & PEKIN UNION Springfield Ill
158 Miles, 16 Steam, 4 Diesel
W C Hurst V Pres

PERE MARQUETTE Gen Motors Bldg Detroit 2
1949 Miles, 286 Steam, 6 Diesel
H C Lorenzen Supt Tele & Sig
M F Anderson Asst Sig Eng

PETALUMA & SANTA ROSA Petaluma Calif
38 Miles, 6 Elec
W B Isaacs Eng Maint of Way

PHILADELPHIA BETHLEHEM & NEW ENGLAND Bethleham Pa
55 Miles, 8 Steam, 20 Diesel
D M Petty Pres

PICKENS R R Pickens S C
9 Miles, 1 Steam
T J Mitchell Gen Mgr

PIEDMONT & NORTHERN Charlotte N C
130 Miles, 17 Elec
F H Cothran Pres

PIONEER & FAYETTE Pioneer O
5 Miles, 1 Steam
E S Snyder Pres

PITTSBURGH & LAKE ERIE P & L E Term Bldg Pittsburgh Pa
233 Miles, 266 Steam
E F Brown Sig-Elec Eng
Signal Supervisors:
W A Dean Pittsburgh Pa
H P McKenery McKeesport Pa
F K Mitchell Beaver Pa

PITTSBURGH & OHIO VALLEY Neville Island Pa
8 Miles, 4 Steam
C G Gibson Supt

PITTSBURG & SHAWMUT Kittanning Pa
97 Miles, 16 Steam
W W Morrison V Pres & Gen Mgr

PITTSBURGH & WEST VIRGINIA Wabash Bldg Pittsburgh Pa
136 Miles, 33 Steam
A I Derr V Pres

PITTSBURGH CHARTIERS & YOUGHIOGHENY Penn Station Pittsburgh Pa
19 Miles, 10 Steam
N W McCallum Chief Engineer

PITTSBURG COUNTY McAlester Okla
25 Miles, 2 Elec
M M Scheme V Pres & Gen Mgr

PITTSBURGH LISBON & WESTERN Youngstown O
22 Miles, 5 Steam
G C Harper Pres

PITTSBURG SHAWMUT & NORTHERN St Marys Pa
190 Miles, 15 Steam
P B McBride Gen Mgr

PORT ANGELES WESTERN Port Angeles Wash
62 Miles, 3 Oil
H LeGear Supt & Mgr

PORT EVERGLADES BELTLINE Ft Lauderdale Fla
12 Miles, 4 Diesel-Elec
F J Stewart Chief Engineer

PORT HURON & DETROIT Port Huron Mich
20 Miles, 4 Steam
W N Boyd Supt

PORTLAND ELECTRIC POWER 1605 S E Water Av Portland Ore
37 Miles, 12 Elec
B Rossiter Chief Engineer

PORTLAND TERMINAL *See Maine Central R R*

PRATTSBURGH R R Prattsburgh N Y
12 Miles, 2 Steam
S B Merritt Mgr

PRESCOTT & NO WESTERN Prescott Ark
33 Miles, 3 Oil
J R Bemis Pres

PRESTON R R Crellin Md
12 Miles, 3 Steam
J W Kendall V Pres

PULLMAN R R 707 E 111th St Chicago Ill
31 Miles, 3 Steam, 2 Diesel
N Kunst Pres

— Q —

QUANAH ACME & PACIFIC Quanah Tex
122 Miles, 7 Oil
A F Sommer V Pres & Gen Mgr

QUINCY R R Quincy Calif
6 Miles, 2 Oil
L H Thayer Supt

— R —

RAHWAY VALLEY Kenilworth N J
15 Miles, 3 Steam
G A Clark President

RAPID CITY BLACK HILLS & WESTERN Rapid City S D
34 Miles, 5 Oil
J P Nye Gen Mgr

RARITAN RIVER R R South Amboy N J
21 Miles, 8 Steam
H Fliskov Mgr

READER R R Shreveport La
23 Miles, 3 Oil
B McCullough Gen Mgr

READING COMPANY Reading Term Phila 7 Pa
1,374 Miles, 631 Steam, 58 Diesel
S R Negley Elec Eng
J W Moorehouse Elec Super
E W Reich Sig Eng Reading Pa
Supervisors of Signals:
T G Phillips Philadelphia Pa
E L Rogers Reading Pa
L B Sinclair Tamaqua Pa

RED RIVER & GULF Long Leaf La
62 Miles, 2 Oil
H A White Gen Mgr

RICHMOND FREDERICKSBURG & POTOMAC Fredericksburg Va
118 Miles, 110 Steam
W K Saunders Super Sig

RIO GRANDE & EAGLE PASS Laredo Texas
21 Miles, 2 Steam, 1 Gas
R W Davis Pres

RIO GRANDE CITY *See Gulf Coast Lines*

RIO GRANDE SOUTHERN Durango Colo
174 Miles, 6 Steam
C W Graebing Gen Mgr

RIVER TERMINAL R R 3100 E 45th St Cleveland Ohio
22 Miles, 16 Steam, 3 Diesel
B Ladley Gen Mgr

ROARING FORK Blackwood Va
15 Miles, 1 Steam
L J Huettle Chief Engineer

ROCKDALE SANDOW & SOUTHERN Rockdale Tex
6 Miles, 2 Steam
J M Weed Gen Mgr

ROCKINGHAM R R Rockingham N C
22 Miles, 2 Steam
W H Newell Gen Mgr

ROCK ISLAND SOUTHERN Rock Island Ill
58 Miles, 2 Steam, 2 Elec
L R Walsh Pres

ROCK PORT LANGDON & NORTHERN Rock Port Mo
6 Miles, 2 Steam
P Hedgpeth Supt Sig & Comm

ROSCOE, SNYDER & PACIFIC Roscoe Tex
32 Miles, 3 Oil
R O Dobbins Vice President

RUTLAND R R Rutland Vt
408 Miles, 60 Steam
A T Danver Ch Eng
W O Cutler Supt Tele

— S —

ST JOHNSBURY & LAKE CHAMPLAIN Montpelier Vt
96 Miles, 9 Steam
A G Emery Gen Supt

ST JOHNS RIVER TERMINAL *See Southern R R*

ST JOSEPH BELT Mo Pac Bldg St Joseph Mo
19 Miles, 1 Diesel
R E Hastings V Pres & Gen Mgr

ST JOSEPH TERMINAL 803 S 4th St St Joseph Mo
11 Miles, 3 Steam
C H Drew Supt

ST LOUIS & BELLEVILLE ELECTRIC 7 Collinsville Ave E St Louis Mo
18 Miles, 2 Elec
T G Dyer Supt

ST LOUIS & O'FALLON 2927 S B'dway St Louis Mo
19 Miles 2 Steam
H Marsh Chief Engineer

ST LOUIS & OHIO RIVER *See Alton & So R R*
16 Miles, 1 Steam

ST LOUIS & TROY Hannibal Mo
5 Miles, 1 Steam
W C Ramsay Pres & Gen Mgr

ST LOUIS BROWNSVILLE & MEXICO *See Gulf Coast Lines*

ST LOUIS-SAN FRANCISCO Springfield Mo
4,647 Miles, 601 Steam, 28 Diesel
R W Troth Sig Eng
R E Testerman Asst Sig Eng
S L Uhr Tulsa Okla
G F Linster Supt Tele
C I Garton Supvr C T C
Signal Supervisors:
H Barron Springfield Mo
G J Drummon Springfield Mo
P W Davis Jasper Ala
F C Harper Cape Girardeau Mo
E Shannon Memphis Tenn

ST LOUIS SAN FRANCISCO & TEXAS Springfield Mo
154 Miles
F G Jonah Chief Engineer

ST LOUIS SOUTHWESTERN Cotton Belt Bldg St Louis Mo
1,617 Miles, 32 Steam, 178 Oil, 7 Diesel
Comprising:
St Louis South Western
St Louis South Western R R Co of Texas
F W Green Ch Oper Off
R M Stone Supt Tele Tyler Texas

ST MARYS R R St Marys Ga
11 Miles, 4 Steam
W T Scarboro Gen Agt

SABINE & NECHES VALLEY Deweyville Tex
14 Miles, 1 Oil
C C Cary Pres

SACRAMENTO NORTHERN Sacramento 14 Calif
275 Miles, 23 Elec
C B Bruner Chief Engineer

SALT LAKE & UTAH 107 W South Temple Salt Lake City Utah
76 Miles, 6 Elec
W J Browne Supt of Sig & Comm

SALT LAKE GARFIELD & WESTERN 22 E 1st So Salt Lake City Utah
17 Miles, 6 Elec
H A Snow Pres

SAN ANTONIO UVALDE & GULF *See Gulf Coast Lines*

SAN BENITO & RIO GRANDE VALLEY *See Gulf Coast Lines*

SAN DIEGO & ARIZONA EASTERN 65 Market San Francisco Calif
140 Miles, 13 Oil
A W Flanagan Supt Tele

SAND SPRINGS Sand Springs Okla
32 Miles, 4 Elec
C O Nuckolls Chief Engineer

SAN FRANCISCO & NAPA VALLEY Napa Calif
7 Miles, 3 Diesel
C E Brown V Pres & Gen Mgr

SAN LUIS VALLEY SOUTHERN Denver Nat Bldg Denver 2 Colo
32 Miles, 2 Steam
G T Kearns V Pres & Mgr

SANTA FE SYSTEM *Comprising:*
Atchison Topeka & Santa Fe
Gulf Colorado & Santa Fe
Panhandle & Santa Fe

SANTA MARIA VALLEY 6381 Hollywood Blvd Los Angeles Calif
23 Miles 6 Oil
J M Davis Mgr

SAVANNAH & ATLANTA Savannah Ga
145 Miles, 13 Steam
J A MacLeod Chief Engineer

SEABOARD AIR LINE Norfolk Va
4,179 Miles 552 Steam, 1 Oil, 44 Diesel
J R DePriest Supt Tele & Sig

SIERRA R R Jamestown Calif
57 Miles, 5 Oil
J E Taylor V Pres & Gen Mgr

SIOUX CITY TERMINAL Sioux City Ia
18 Miles, 4 Steam
J T Flynn Supt

SKANEATELES SHORT LINE Skaneateles N Y
5 Miles, 2 Steam
A H Holder Gen Mgr

SMOKY MOUNTAIN R R Sevierville Tenn
30 Miles, 3 Steam
M Kesselman Gen Mgr

SOUTH BROOKLYN R R 250 Hudson New York N Y
9 Miles, 3 Elec
P E Pfeifer Gen Supt

SOUTH BUFFALO Bethlehem Pa
87 Miles, 21 Steam, 18 Diesel
H M Dalziel Chief Engineer

SOUTH GEORGIA Quitman Ga
77 Miles 3 Steam
S S Rountree Pres

SOUTH OMAHA TERMINAL So Omaha Neb
32 Miles, 8 Steam
J V Erixon Chief Engineer

SOUTH SHORE R R Jackson La
28 Miles, 3 Steam
H H Holloway Gen Supt

SOUTHERN R R SYSTEM McPherson Sq Washington D C
7,735 Miles, 1,558 Steam, 54 Diesel
Comprising:
Alabama Gt Southern
Cincinnati Burnside & Cumberland River
Cincinnati New Orleans & Texas Pacific
Georgia Southern & Florida
Harriman & Northeastern
New Orleans & Northeastern
New Orleans Terminal
St Johns River Terminal
Southern R R
L C Walters Asst to V Pres (Sig)
P E Snead Asst Eng Sig & Elec
J A Jones Asst to V Pres (Comm)
D Ruff Tele & Telo Eng
A H Johnson Supt T & T Cincinnati O
J R Smith Supt T & T Charlotte N C
Eastern Lines Charlotte N C
2,989 Miles
T N Charles Sig & Elec Supt
J R Smith Supt Tele & Telo
J W Sutton Super Tele & Telo
Signal Supervisors:
W O Junker Spartanburg S C
P S Scharf Greensboro N C
R T Sewell Greenville S C
L E Walke Orange Va
W H Wiley Columbia S C
Central Lines Knoxville Tenn
2,463 Miles
T N Charles Sig & Elec Supt Charlotte N C
H A Hudson Sig & Elec Supt Cincinnati O
Signal Supervisors:
J W Cole Macon Ga
C E Colvin Knoxville Tenn
C A Hinds Rome Ga
R T Hinds Atlanta Ga
C L Kale Asheville N C
F W Long Sheffield Ala
Western Lines Cincinnati O
2,283 Miles
H A Hudson Sig & Elec Supt
A H Johnson Supt Tele & Telo
N O Keller Super Tele & Telo
Signal Supervisors:
C B Behnke Slidell La
M Brock Lexington Ky
W C Brown Birmingham Ala
A N Goodson Tuscaloosa Ala
J L Linn Birmingham Ala
J Waller Chattanooga Tenn
A W Wilson Somerset Ky

SOUTHERN INDIANA R R Speed Ind
5 Miles, 3 Elec
G L Harmon Gen Supt

SOUTHERN IOWA R R Centerville Ia
32 Miles, 3 Elec
E L Shutts Pres

SOUTHERN NEW YORK 225 B'dway New York City
3 Miles, 3 Steam
M P Gross V Pres & Gen Mgr

SOUTHERN PACIFIC SYSTEM *Comprising:*
Southern Pacific Co — Pacific Lines
Southern Pacific Lines — Tex & La
Texas & New Orleans R R

SOUTHERN PACIFIC CO — Pacific Lines
65 Market St San Francisco Calif
8,263 Miles, 39 Steam, 1,486 Oil, 104 Diesel
R D Moore Sig Eng
A W Flanagan Supt Tele
W R Birt Asst Supt Tele
A E DeMattei Asst Supt Tele
R E Steere Asst Supt Tele
Signal Supervisors:
T Armstrong San Francisco Calif
S L Baxter Sacramento Calif
P A Bliss Los Angeles Calif
O A Burton Bakersfield Calif
L V Cutsforth Portland Ore
T L Gordon West Oakland Calif
J H Hickey Dunsmuir Calif
W J Jenne El Paso Tex
A C Krout Tucson Ariz
D C Miller Ogden Utah

SOUTHERN PACIFIC LINES (Texas & New Orleans R R) So Pac Bldg Houston Tex
4,340 Miles, 467 Oil, 8 Diesel, 1 Gas
R W Meek Sig Eng
M O Scobee Supt Tele
Signal Supervisors:
D W Rosenzweig Lafayette La
W R Smylie Houston Tex
N C Tubbs Ennis Tex
P V Wright San Antonio Tex

SOUTHERN PACIFIC OF MEXICO 65 Market San Francisco Calif
1,331 Miles, 88 Oil
W B Barker Chief Engineer Guadalajara Mexico D F Mex

SPOKANE COEUR D'ALENE & PALOUSE *See Great Northern*

SPOKANE INTERNATIONAL Spokane 1 Wash
150 Miles, 14 Steam
D R Waite Gen Supt
J B Williams Div Eng
C J Sinnitt Asst Supt

SPOKANE PORTLAND & SEATTLE Portland Ore
962 Miles, 85 Oil, 16 Elec, 14 Diesel
Comprising:
Oregon Elec
Oregon Trunk
United Rys
A J Witchel Ch Eng
D I Clough Elec Supt

SPRINGFIELD & SOUTHWESTERN Springfield Ill
8 Miles, 2 Steam
T A Cahee Supt

SPRINGFIELD TERMINAL Springfield Vt
7 Miles, 3 Elec
W G Bell Gen Mgr

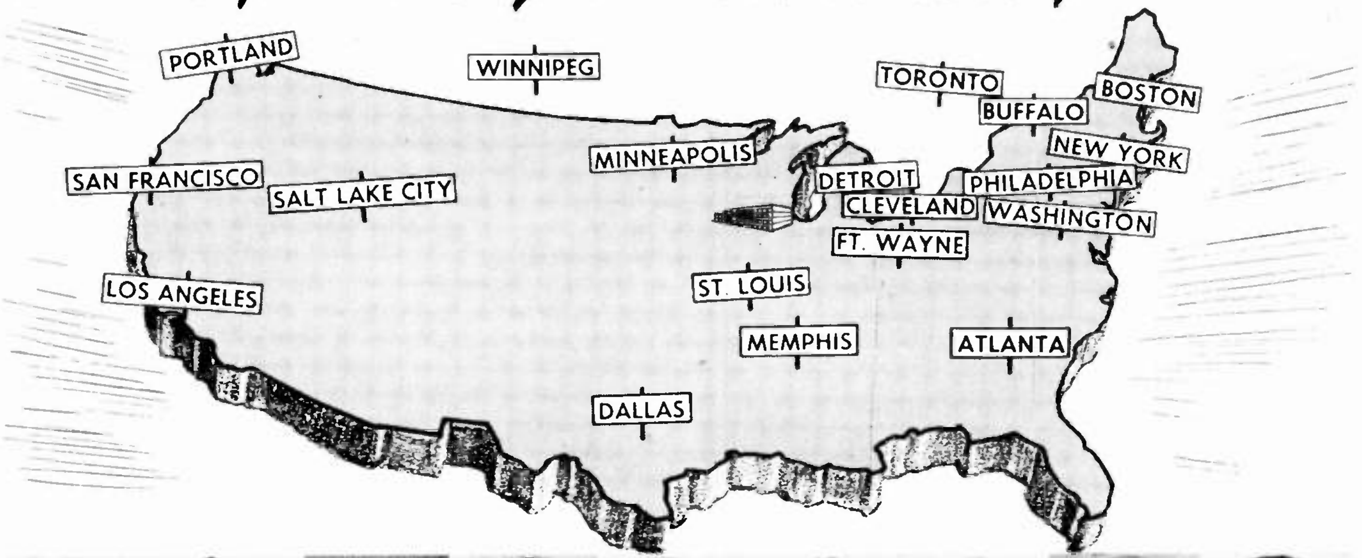
SPRINGFIELD TERMINAL (of Illinois) Springfield Ill
5 Miles, 2 Steam
G Willis Chief Engineer

STATE BELT R R Foot of Battery St San Francisco Calif
58 Miles, 7 Steam, 4 Diesel
F G White

STATEN ISLAND RAPID TRANSIT St George S I N Y
23 Miles, 4 Steam
C A Salverson Super Sig Tele & Telo

STEELTON & HIGHSPIRE Bethlehem Pa

. . . . your SIMPSON representative can help solve your instrument problems



Brower Murphy — John J. Cota
ATLANTA—Murphy & Cota
5 Ivy St.
N. C., S. C., Ga., Ala., & Fla.

P. R. Sturgeon
BOSTON
25 Huntington Ave.
Maine, N. H., Vt., Mass., Conn., R. I.

J. V. Costello
BUFFALO
547 Ellicot Sq. Bldg.
New York state except New York City

J. L. Vergilio — L. H. Waldrip — J. C. Lehner
CLEVELAND—J. L. Vergilio Co.
504 Erie Bldg.
State of Ohio

J. A. Basiger

M. C. Larkin

J. Y. Schoonmaker
DALLAS
2320 Griffin St.
Texas, & Oklahoma

R. C. Merchant
DETROIT
4829 Woodward Ave.
State of Michigan

B. L. MacPherson
FORT WAYNE
1724 Alabama Ave.
Indiana & Kentucky

C. R. Lynch
LOS ANGELES
210 W. Seventh St.
Calif., below Fresno, and Arizona

J. M. Cartwright — W. C. Cartwright
MEMPHIS
1276 Peabody Ave.
Tenn., Miss., La., & Ark.

M. E. Foster
MINNEAPOLIS
Andrews Hotel
Minn., N. Dak., S. Dak., Ia., Neb., Western Wis.

John M. Forshay
NEW YORK
27 Park Place
New York City and New Jersey north of Trenton

Don H. Burcham
PORTLAND
917 S. W. Oak St.
Wash., Ore., Idaho, Mont., Br. Col. and Alaska

S. K. MacDonald — J. C. Muggleworth — John J. Mahoney
PHILADELPHIA—S. K. MacDonald
1343 Arch St.
Southern N. J. including Trenton, Del., Md., Va., & W. Va.

R. G. Bowen
SALT LAKE CITY
83 E. First St., Logan, Utah
Utah, Nev., Colo., Wyo. & N. Mex.

W. J. Purdy
SAN FRANCISCO
420 Market St.
Northern Calif., including Fresno

N. W. Kothrinus
ST. LOUIS
1218 Olive St.
Mo., Kan., & Ill. south of Peoria

Noble C. Shilt
WASHINGTON
S. K. MacDonald
Riggs Bank Bldg.
Regional office of S. K. MacDonald Phila.

L. D. Cahoon
TORONTO
2271 Danforth Ave.
Ontario, Quebec, & New Brunswick

H. F. DREW
WINNIPEG
Sparling Sales Ltd.
270 Fort St.
Alberta, Saskatchewan, & Manitoba

SIMPSON ELECTRIC COMPANY
5200-5218 Kinzie Street
Chicago 44, Illinois

John C. Hill, Mgr.
EXPORT DEPT
308 W. Washington St.
Chicago, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory

35 Miles, 9 Steam, 5 Diesel
H M Dalziel Chief Engineer

STOCKTON TERM & EASTERN Stockton Calif
22 Miles, 1 Oil
F E Odell Supt

STRASBURG R R Strasburg Pa
4 Miles, 1 Gas
J E Homsher Pres

SUGAR LAND R R *See Gulf Coast Lines*

SUMPTER VALLEY R R Baker Oregon
62 Miles, 3 Steam, 1 Diesel
J F Carpenter Asst Gen Mgr

SUMPTER & CHOCTAW Bellamy Ala
23 Miles, 2 Steam
W T Haynie V Pres & Gen Mgr

SUNCOOK VALLEY Concord N H
29 Miles, 1 Steam
E J Stapleton Gen Mgr

SUNSET R R *See A T & S F R R*

SYLVANIA CENTRAL Savannah Ga
15 Miles, 1 Steam
R R Cummins Pres

— T —

TALLULAH FALLS Cornelia Ga
58 Miles, 4 Steam
H L Brewer Gen Mgr

TAMA & TOLEDO Toledo Ia
4 Miles, 1 Diesel
D V Wells Supt

TAMPA SOUTHERN *See Atlantic Coast Line*

TAVERES & GULF Taveres Fla
38 Miles, 1 Steam
W H Edmunds Supt

TENNESSEE & NORTH CAROLINA Hayesville N C
25 Miles, 3 Steam
R E Crawford

TENNESSEE ALABAMA & GEORGIA Chattanooga Tenn
95 Miles, 7 Steam
W A Forrester Chief Engineer

TENNESSEE CENTRAL Amer Trust Bldg Nashville Tenn
287 Miles, 34 Steam, 2 Diesel
H R Manby Chief Engineer

TENNESSEE R R Oneida Tenn
65 Miles, 6 Steam
S A Blair Gen Mgr

TERMINAL R R ASSOC OF ST LOUIS Union Sta St Louis Mo
367 Miles, 101 Steam, 48 Diesel
A P Hix Sig Eng
E A Wunder Supt Tele & Telo
H Austill Ch Eng

TERMINAL RAILWAY ALABAMA STATE DOCKS Mobile Ala
41 Miles, 5 Steam
C U Irvine Supt

TEXAS & NEW ORLEANS *See S P Lines*

TEXAS & PACIFIC Tex & Pac Bldg Dallas Tex
1,884 Miles, 289 Oil
E P Weatherby Sig Eng
F W Burkholder Sig Super Ft Worth Tex
C C Whitehead Sig Super Ft Worth Tex
G E Thompson Sig Super Alexandria La

TEXAS CITY TERMINAL Texas City Tex
42 Miles, 1 Gas, 4 Oil
H J Mikeska Pres & Gen Mgr

TEXAS ELECTRIC R R CO 216 Inter-urban Bldg Dallas Tex
174 Miles
G H Peters Supt of Power

TEXAS-MEXICAN R R Laredo Tex
161 Miles, 6 Oil, 6 Diesel
R R Fenner Gen Mgr

TEXAS OKLAHOMA & EASTERN Dierks Bldg Kansas City Mo
40 Miles, 1 Oil
J C Leeper V Pres & Ch Eng

TEXAS PACIFIC-MISSOURI PACIFIC TERMINAL R R OF NEW ORLEANS St Louis Mo
94 Miles 2 Oil, 2 Diesel
L W Baldwin Pres

TEXAS SOUTH-EASTERN Diboll Tex
21 Miles, 1 Oil
H G Temple Pres & Gen Mgr

TIDEWATER SOUTHERN Modesto Calif
65 Miles, 2 Oil, 2 Elec
R T Kearney Supt

TOLEDO ANGOLA & WESTERN Lock Box 858 Toledo Ohio
10 Miles, 1 Steam
R E Minogue Supt

TOLEDO PEORIA & WESTERN Peoria Ill
239 Miles, 16 Steam
I H Hultgren Supt Tele & Sig

TOLEDO TERMINAL Toledo Ohio
88 Miles, 20 Steam
A B Newell Pres & Gen Mgr

TONOPAH & GOLDFIELD Tonopah Nev
100 Miles, 6 Oil
E Peterson Super Tele

TOOELE VALLEY Tooele Utah
9 Miles, 4 Steam
T E Tate Supt

TORONTO HAMILTON & BUFFALO 230 Pk Ave New York City
111 Miles, 23 Steam, 1 Gas
J G Stonehouse Sig Super Hamilton Ont

TREMONT & GULF Winnfield La
97 Miles, 1 Steam, 5 Oil
T W Fatherson Gen Supt

TRONA R R Trona Calif
31 Miles, 3 Oil
J L Robinson Gen Mgr

TUCKASEEGEE & SOUTH EASTERN E La Porte N C
12 Miles, 1 Steam
Mrs J Keys Pres & Gen Mgr

TUCSON CORNELIA & GILA BEND Ajo Ariz
44 Miles, 1 Oil
LM Barker Gen Mrg

TUSKEGEE R R Tuskegee Ala
6 Miles, 2 Steam
W Runnette Gen Mgr

TWIN BRANCH R R Mishawaka Ind
3 Miles, 2 Elec
O K Fay Gen Supt

TWIN CITY R R Chehalis Wash
2 Miles, 1 Elec
G M Brown Gen Mgr

— U —

UNADILLA VALLEY New Berlin N Y
49 Miles, 4 Steam
L L Schomo Supt Motive Power

UNION ELECTRIC Coffeyville Kan
86 Miles, 6 Elec
L L Francis Pres & Gen Mgr

UNION FREIGHT R R New Haven Conn
2 Miles, 4 Steam
J F Doolan Oper Asst

UNION PACIFIC R R 1416 Dodge Omaha Neb
9,782 Miles, 974 Steam, 534 Oil, 73 Diesel
L D Dickinson Gen Sig Eng
T W Hays Asst Gen Sig Eng
Eastern District Omaha Neb
3,827 Miles
D C Bettison Sig Eng
Signal Supervisors:
E H Bullock Omaha Nebr
M P Dalbey Cheyenne Wyo
E C Grant Denver Colo
G A Ziehlke Kansas City Mo
South-Central District Union Pac Bldg Salt Lake City Utah
3,743 Miles
R B McArdle Sig Eng
Signal Supervisors:
B P Manear Las Vegas Nev
R V Moisbee Salt Lake City Utah
F A Purdy Pocatello Idaho
A R White Los Angeles Calif
Northwestern District Pittock Block Portland Ore
2,212 Miles
R C Charlton Sig Super Albina Ore
C A Larson Sig Super Spokane Wash

UNION R R East Pittsburgh Pa
45 Miles, 124 Steam, 18 Diesel
E Bouchet Supt Sig

UNION RAILROAD OF OREGON P O Box 1202 Portland Ore
5 Miles, 1 Gas
R Woodbury Pres & Gen Mgr

UNION RY CO (Memphis) Memphis Tenn
104 Miles, 13 Steam
W E Lamb Pres

UNION TERMINAL Dallas Tex
16 Miles, 1 Oil
M L Buckner V Pres & Gen Mgr

UNION TERMINAL RY (St Joseph Mo) Mo Pac Bldg St Joseph Mo
25 Miles, 3 Steam, 1 Diesel
R E Hastings Pres & Gen Mgr

UNITED RAILWAYS *See S P & S*

UPPER MERION & PLYMOUTH Conshohocken Pa
12 Miles, 10 Steam, 3 Diesel
H P Ross V Pres

UTAH IDAHO CENTRAL Ogden Utah
94 Miles, 7 Elec
W J Browne Supt Power & Equip

UTAH R R Newhouse Bldg Salt Lake City Utah
111 Miles, 13 Steam
G S Anderson Pres & Gen Mgr

— V —

VALLEY & SILETZ Hoskins Ore
41 Miles, 4 Oil
F W A Cox Supt

VENTURA CO R R Oxnard Calif
11 Miles, 3 Oil
J W Rooney V Pres & Gen Mgr

VERDE TUNNEL & SMELTER Clarkdale Ariz
11 Miles, 2 Oil
J B Pullen V Pres

VICKSBURG SHREVEPORT & PACIFIC *See Illinois Central System*

VIRGINIA & CAROLINA SOUTHERN Lumberton N C
53 Miles, 6 Steam
J Q Beckwith V Pres

VIRGINIA & TRUCKEE Carson City Nev
46 Miles, 5 Oil
G T Salzman Ch Eng

VIRGINIA BLUE RIDGE Massies Mill Va
16 Miles, 4 Steam
T A Fry V Pres

VIRGINIAN R R Princeton W Va
657 Miles, 106 Steam, 12 Diesel
A R Kyle Supt Tele & Sig
E Lockhart Asst Supt Tele & Sig

VISALIA ELECTRIC Exeter Calif
39 Miles, 1 Elec, 1 Gas
R T Jackson Mgr

— W —

WABASH R R Decatur Ill
2394 Miles, 384 Steam, 17 Diesel
G A Rodger Signal Eng
R J Bellsmith Supt Tele

WACO BEAUMONT TRINITY & SABINE Trinity Tex
41 Miles, 2 Oil
T B Legett Gen Mgr

WALLA WALLA VALLEY Walla Walla Wash
24 Miles, 5 Elec
J E Martin Gen Mgr

WARE SHOALS Ware Shoals S C
5 Miles, 1 Steam
C P Gordon Sec

WARREN & OUACHITA VALLEY Warren Ark
16 Miles, 1 Steam
W R Warner Gen Mgr

WARRENTON & SALINE RIVER Warren Ark
16 Miles, 3 Steam
J C Anthoni V Pres & Gen Mgr

WARRENTON R R Warrenton N C
3 Miles, 1 Steam
J Rodgers Supt

WEST COAST VIEW OF TELEVISION

(CONTINUED FROM PAGE 44)

I am not talking about the novelty period, or those people who rush in and always want to be first on whatever it is. I am talking about the thing when it settles down to the long pull, when an advertising dollar invested in television is going to be scrutinized in comparison with that same dollar spent in visual media or in sound broadcasting.

That is when the test is coming, and it is at that point of development that the amount and the measure of the premium the advertiser is willing to pay is going to be determined on some actual, and factual, and practical ground.

I am not going to bore you with any reiteration of some of the other problems of production that were so adequately and eloquently covered by the other speakers this morning.

I would like to conclude on an optimistic note. I am an optimist by nature. I voted for Mr. Dewey and really thought he was going to be elected.

I sincerely believe in our engineers and scientists. That belief is predicated on some of the things I have been privileged to witness. I have seen engineers and scientists who have diverted their energies during the past two and a half years to help the war effort reach into the atmosphere and harness forces and make them work in exact areas efficiently, under the most trying conditions, and I feel sincerely, from what I have seen, that they will take more out of that blue sky and harness it into standards of useful and practical electronic developments that will have peacetime applications. Already they have done more in two and one-half years than they normally would have done in twenty-five years.

I have an abiding faith in the genius of American business men, an abiding faith in their standards and ideals. And because the public wants it and is ready for it, and because we are ready to give it to them, I am sure that television has a very definite, a very broad, constructive, and serviceable future.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

After a day filled with addresses and panel discussions of all phases of the art television made a personal appearance to speak for itself at the evening demonstration.

It was a wise and constructive decision to give those attending the Conference a chance to see television, despite the fact that the transmitters and receivers represented the 1939 state of apparatus development. Thus a common basis was provided for future discussions of picture quality. Now we can compare any im-

(CONCLUDED ON PAGE 59)

U. S. RAILROADS, Continued

WASHINGTON & OLD DOMINION Arlington Va
52 Miles, 3 Diesel
G C Baggett V Pres & Gen Mgr
WASHINGTON & VANDEMERE *See Atlantic Coast Line*
WASHINGTON IDAHO & MONTANA Potlatch Idaho
50 Miles, 4 Oil
W J Gamble Asst Gen Mgr
WATERLOO CEDAR FALLS & NORTHERN Waterloo Ia
128 Miles, 10 Elec
T E Rust Chief Engineer
WATERVILLE R R Waterville Wash
5 Miles, 1 Steam
W V Friel Gen Mgr
WEATHERFORD MINERAL WELLS & NORTH WESTERN Weatherford Tex
31 Miles, 1 Oil
M Y Anderson V Pres
WESTERN ALLEGHENY Kaylor Pa
21 Miles, 4 Steam
C L Correy Gen Mgr
WESTERN MARYLAND RAILWAY Hagerstown Md
720 Miles, 212 Steam, 18 Diesel
K L Muse Sig & Telo Eng
E C Shreve Eng Maint of Way Hillen Sta Baltimore Md
J A Abbott Supt Hagerstown Md
J M Miller Supt Cumberland Md
WESTERN PACIFIC 526 Mission St San Francisco 5 Calif
1,195 Miles, 152 Oil, 25 Diesel-Elec, 17 Steam
H W Dunn Signal Engineer
J P Quigley Supt Tele
WEST PITTSTON-EXETER Scranton Pa
3 Miles, 3 Steam
C H McKnight Supt & Ch Eng
WEST VIRGINIA NORTHERN Kingwood W Va
11 Miles, 4 Steam
G Reith Gen Mgr
WHEELING & LAKE ERIE Brewster Ohio
999 Miles, 154 Steam, 4 Diesel
E A Hamilton Elec Eng
WHITE SULPHUR SPGS & YELLOWSTONE PARK White Sulphur Spgs Mont
23 Miles, 1 Steam
G A Wetherell Supt
WICHITA FALLS & SOUTHERN Wichita Falls Tex
169 Miles, 9 Oil
J D Sullivan Gen Mgr
WILLAMINA & GRAND RONDE Longview Wash
8 Miles, 2 Steam
H B Robertson V Pres
WINCHESTER & WESTERN Winchester Va
18 Miles, 1 Steam
D H Sencindiver Pres
WINFIELD R R Butler Pa
13 Miles, 2 Steam
F C McKee Pres
WINIFREDE R R Charleston W VA
10 Miles, 1 Steam
A R Yarborough Traf Mgr
WINONA R R Warsaw Ind
58 Miles, 1 Propane, 1 Propane-Elec
B R Ritter Gen Supt
WINSTON-SALEM SOUTHBOUND Wilmington N C
89 Miles, 8 Steam
Lowell White Gen Supt Tele
WOOD RIVER BRANCH Hope Valley R I
6 Miles, 1 Gas
R R Rawlings Eng
WRIGHTSVILLE & TENNVILLE Dublin Ga
36 Miles, 3 Steam
B H Lord Pres & Gen Mgr
WYANDOTTE SOUTHERN Wyandotte Mich
6 Miles, 3 Steam
W D LeBar Gen Supt
WYANDOTTE TERMINAL Wyandotte Mich
9 Miles, 5 Steam, 1 Diesel
E Edson Pres
WYOMING R R Buffalo Wyoming
28 Miles, 3 Steam
C C Palmer Supt Tele & Comm

— Y —

YAKIMA VALLEY TRANSPORTATION Yakima Wash
34 Miles, 3 Elec
LeGrand Young V Pres & Supt
YAKUTAT & SOUTHERN Hamlin St & Fairview Av Seattle Wash
15 Miles, 1 Diesel
G V Graham Pres & Gen Mgr
YAZOO & MISSISSIPPI VALLEY *See Illinois Central System*
YORK UTILITIES Sanford Me
2 Miles, 2 Elec
W M B Lord V Pres & Gen Mgr
YOSEMITE VALLEY Merced Calif
78 Miles, 8 Steam
L A Foster Gen Mgr
YOUNGSTOWN & NORTHERN Youngstown Ohio
5 Miles, 7 Steam, 7 Diesel
F H Pilgrim Gen Supt
YOUNGSTOWN & SUBURBAN Youngstown Ohio
19 Miles, 3 Elec
G C Harper Pres
YREKA WESTERN Yreka Calif
8 Miles, 2 Oil
O F Guerin Supt
YUMA VALLEY Yuma Ariz
43 Miles, 1 Oil
C B Elliott Supt

CANADIAN RAILROADS

ALGOMA CENTRAL & HUDSON BAY Sault Ste Marie Ont
332 Miles, 27 Steam
R S McCormich Gen Supt & Ch Eng
ALMA & JONQUIERES Lake St John Que
11 Miles, 3 Steam
T J Butler Mgr
BRITISH COLUMBIA ELEC Vancouver B C
213 Miles, 11 Elec
J B Mouat Supt
BRITISH COLUMBIA YUKON
BRITISH YUKON NAVIGATION
BRITISH YUKON R R
See White Pass & Yukon
CANADA & GULF TERMINAL Mont Joli Que
38 Miles, 5 Steam
T J Fouhy Gen Supt
CANADIAN NATIONAL Montreal Que
23,198 Miles, 2,380 Stm, 84 Oil, 33 Elec, 35 Diesel *Comprising:*
Canadian Government
Canadian Northern
Central Vt (*Mileage shown separately*)
Duluth Winnipeg & Pacific
Duluth Rainy Lake & Winnipeg
Grand Trunk Pacific
Grand Trunk R R
Gr Trunk Western (*Mileage also shown separately*)
Niagara St Catharines & Toronto (*Mileage also shown separately*)
N B Walton Exec V Pres (Oper)
Atlantic Region 3,076 Miles
H L Black Sig Eng Moncton N B
Central Region 7,506 Miles
C H Tillett Sig Eng Toronto Ont
Western Region 11,533 Miles
L A Guthrie Sig Eng Winnipeg Man
CENTRAL VERMONT
422 Miles, 62 Steam
R D Garner Gen Mgr St Albans Vt
DULUTH WINNIPEG & PACIFIC — DULUTH RAINY LAKE & WINNIPEG
173 Miles
W C Owens Gen Mgr Winnipeg Man
GRAND TRUNK WESTERN
1,026 Miles
W L Dayton Sig Eng Detroit Mich
J B McGregor Supt Tele Battle Creek Mich
NIAGARA ST CATHARINES & TORONTO Toronto Ont
57 Miles
J F Pringle V Pres & Gen Mgr
CANADIAN NORTHERN *See Canadian National*
CANADIAN PACIFIC 204 Hospital St Montreal
17,038 Miles, 1,700 Steam, 15 Diesel
W D Neil Gen Mgr Comm
E S Taylor Sig Eng Rm 337 Union Sta Toronto Ont
L A W East Ch Eng Comm 204 Hospital Montreal Que
C R Hodgdon Sig Eng Winnipeg Man
New Brunswick Dist 842 Miles
C H Cameron Sig Super St John N B
Quebec Dist 1,658 Miles
E S Becksted Sig Super Montreal Que
Ontario Dist 1,423 Miles
R I Becksted Sig Super Toronto Ont
Algoma Dist 1,223 Miles
E S McCracken Gen Mgr North Bay Ont
Manitoba Dist 2,516 Miles
J I MacKay Gen Supt Winnipeg Man
Saskatchewan Dist 3,626 Miles
H C Taylor Gen Supt Moose Jaw Sask
Alberta Dist 3,103 Miles
A Davies Sig Super Calgary Alta
British Columbia Dist 1,987 Miles
A Davies Sig Super Calgary Alta
CENTRAL VERMONT R R *See Canadian Nat'l*
CUMBERLAND R R Springhill N S
32 Miles, 6 Steam
D A McMillan Supt
DOMINION ATLANTIC R R Kentville N S
304 Miles, 23 Steam
J J Richardson Eng
ESQUIMALT & NANAIMO R R Victoria B C
209 Miles, 25 Oil
C D Mackintosh Asst Supt & Div Eng
GREATER WINNIPEG WATER DIST St Boniface Man
97 Miles, 4 Steam, 1 Diesel, 1 Elec
H Shand Eng 185 King St Winnipeg
H DeCuyper Gen Foreman 202 Notre Dame St Boniface
G McFadden Gen Supt Greater Winnipeg Water Dist St Boniface Man
LAKE ERIE & NORTHERN Preston Ont
51 Miles, 6 Steam
D A McMillan Supt
LONDON & PORT STANLEY London Ont
55 Miles, 3 Elec, 10 Motor Cars
E V Buchanan Mgr
MARITIME COAL R R & POWER Amherst N S
15 Miles, 4 Steam
N T Avard Gen Mgr
MIDLAND R R CO OF MANITOBA 175 E 4th St Paul 1 Minn
6 Miles, 2 Steam
C M Nye Ch Eng
MONTREAL & SOUTHERN COUNTIES Toronto Ont
54 Miles, 2 Elec
E B Walker Gen Supt
MORISSEY FERNIE & MICHEL Fernie B C
5 Miles, 2 Steam
H P Wilson Pres & Gen Mgr
NAPIERVILLE JUNCTION 1010 St Catherine W Montreal Que
28 Miles, 2 Steam
J H Nuelle Pres
NEWFOUNDLAND R R St Johns N F
738 Miles, 45 Steam
D G Ross Ch Eng Maint of Way
NIAGARA ST CATHARINES & TORONTO *See Canadian Nat R R*
NORTHERN ALBERTA Edmonton Alta
923 Miles, 16 Steam
J M MacArthur Gen Mgr

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 57)

provements with what we saw at the first TBA demonstration.

There is no denying that much improvement is needed. Most striking was the fact that, after the initial part of the program, when a boxing bout was televised, the reception did not hold the attention of the audience.

It reminded this writer of the World's Fair period when, at Andrea Radio, so many jobbers, dealers, and department store buyers came over to see the noontime programs. They watched the television images for five minutes, exclaimed that it was wonderful and marvelous, and then said, "Well, let's go to lunch," just as if the show was over, instead of just starting!

It was the same way at the TBA demonstration, when the boxing bout ended. Some people left, others sat around talking, but few sat still and watched the entire program. It just didn't hold their attention.

This is comment rather than complaint, however, for it is reasonable to assume that postwar television will show as much of an improvement over that demonstration as is represented by military development during the last four years.

While the television images were far below motion picture standards, it was amazing to hear how inferior the sound-on-film quality was, compared to live talent sound, when motion pictures were televised. Movie people have always been very smug about their sound quality, but there is no denying that, compared to the FM transmission of live talent, it is awful.

The principal complaint about the images was the lack of shading. Light spots tended to be white, and dark spots tended to be black. In the case of one singer who was shown close up, it was necessary to look away from the televisor in order to enjoy her very pleasing voice.

The same thing was true of a black-faced tap dancer, though for a different reason. Either he did not have a telegenic personality or television did him an injustice. In either case, the video reception only detracted from the sound of his tap dancing.

On the other hand, the boxing bout was good — equal, for purposes of comparison, to a seat in the popular-price section of the arena. If there was less detail than could have been seen by the ticket-holders, that was made up by the fact that the camera was located at a spot where the action could be followed at all times.

Altogether, TBA performed a real service in organizing their first conference. Now, if we are favored by the fortunes of war, we can expect to see a great measure of improvement demonstrated at the next annual meeting.

CANADIAN RAILROADS
Continued

OSHAWA R R Toronto Ont
22 Miles, 6 Elec
J F Pringle V Pres & Gen Mgr
PACIFIC & ARCTIC R R & NAVIGATION *See White Pass & Yukon Route*
PACIFIC GREAT EASTERN R R Squamish B C
347 Miles, 10 Steam
J A Quick Supt
QUEBEC RAILWAY LIGHT & POWER Quebec Que
33 Miles, 7 Steam
E D Gray-Donald Ch Eng
QUEBEC CENTRAL R R Sherbrooke Que
362 Miles, 18 Steam
F H Hibbard Ch Eng
ROBERVAL & SAGUENAY Sun Life Bldg Montreal Que
38 Miles, 6 Stm, 3 Elec
W C Duncan Mng Director
SYDNEY & LOUISBURG Sydney N S
120 Miles, 26 Steam
W S Wilson Ch Eng
TEMISCOUATA R R Riviere du Loup Que
113 Miles, 7 Steam
T N Walsh Supt Sig & Comm
TEMISKAMING & NORTHERN ONTARIO R R COMMISSION North Bay Ont
574 Miles, 51 Stm, 1 Diesel
G M Simpson Supt Tele & Telo
THOUSAND ISLANDS R R Toronto Ont
5 Miles, 1 Gas-Elec
J F Pringle V Pres & Gen Mgr
TORONTO HAMILTON & BUFFALO Hamilton Ont
111 Miles, 23 Steam, 1 Gas-Elec
J G Stonehouse Sig Super
WHITE PASS & YUKON Skagway Alaska
110 Miles, 9 Steam
Comprising: British Columbia Yukon
British Yukon
British Yukon Navigation
Pac & Arctic R R & Navigation
V I Hahn Supt

MEXICAN RAILROADS

CAMARGO & WESTERN Calle Bolivar No 21 Mexico City Mex
20 Miles, 1 Gas
G S McLaughlin Ch Eng
CANANEA CONSOLIDATED COPPER Cananea Sonora Mex
32 Miles, 9 Oil
A Mendelsohn Gen Mgr
CHIHUAHUA MINERAL Chihuahua Chih Mex
9 Miles, 1 Steam, 3 Oil
M O'Reilly Gen Mgr
COAHUILA & ZACATECAS Coahuila Mex
103 Miles, 11 Steam
J Morales Supt
EL ORO MINING & R R CO E Oro Mex
9 Miles, 3 Steam
G M Wasteneys Gen Mgr
FERROCARRIL INDUSTRIAL EL POTOSI Y CHIH Chihuahua Mex
14 Miles, 7 Elec
L Obregon Ch Elec
FERROCARRILES NACIONALES DE MEXICO
See National Rys of Mexico
FERROCARRILES UNIDOS DE YUCATAN S A
See United R R's of Yucatan
FERROCARRIL MEXICANO DEL NORTH *See Mexican Northern*
FERROCARRIL SUD PACIFICO DE MEXICO
See Southern Pacific R R Co of Mex
MEXICAN NORTHERN Ave 16 Sept 26 Mexico City Mex
88 Miles, 8 Steam
J M Delgado Mgr
MEXICAN PACIFIC Sinaloa Mex
25 Miles, 3 Steam
W P Griggs Gen Mgr
MEXICAN R R Co Ltd Plazuela Buena Vista Mexico City Mex
434 Miles, 60 Oil, 12 Diesel
L P Castro Res Eng
MEXICO NORTH-WESTERN R R Ciudad Juarez, Chih., Mex
476 Miles, 2 Steam, 24 Oil
F J Clark V Pres (Oper)
MINATITLAN AL CARMEN Minatitlan Ver., Mex
9 Miles, 5 Oil
J J Nettel Flores Ch Eng
NATIONAL R R OF MEXICO Mexico City Mex
8,384 Miles, 1019 Steam *Comprising:*
National Rys of Mexico
Interoceanic Ry of Mexico
Tehuantepec National Ry
Veracruz to Alvarado Ry
A Ortiz Gen Mgr Mexico City
B E Arias Supt Tele & Elec Mexico City
POTOSI & RIO VERDE San Luis Potosi S L Potosi Mexico
41 Miles, 3 Oil
R M Leech Supt
SOUTHERN PACIFIC OF MEXICO Guadalajara Mexico
1,331 Miles, 88 Oil
A M Fernandez Gen Mgr
TOLUCA & ZITACUARO Mexico City Mex
40 Miles, 3 Steam
J Zermeno Pres & Gen Mgr
UNITED R R's OF YUCATAN Merida Yucatan Mex
564 Miles, 58 Steam
M Mier y Teran Mgr
VERACRUZ TO ALVARADO *See National Rys of Mexico*
VERACRUZ TERMINAL Mexico D F Mex
32 Miles, 10 Oil
J D W Holmes Gen Mgr
WESTERN RY OF MEXICO Culiacan Sinaloa Mex
38 Miles, 4 Steam
L V Valdes Mgr

FM CHANNEL WIDTH

(CONTINUED FROM PAGE 43)

the same assigned carrier frequency if the frequency deviation of the transmitter is reduced.

Bursts ★ A corollary of the conclusion with respect to common channel operation is that bursts of interference from distant transmitters would be more serious if the frequency deviation were reduced.

Transmitter Signal-to-Noise Ratio ★ The desired figure of −70 db transmitter noise level can be obtained more easily with wide frequency deviation, since transmitter circuit noise has a smaller effect on the transmitter frequency deviation.

Transmitter Monitoring ★ As a practical matter, it has been noticed that Frequency Modulation transmitter operators have a tendency not to operate so as to obtain the maximum permissible frequency deviation. In a low frequency deviation system this would result in a greater impairment to the service rendered by the transmitter than in a wide deviation system.

Spectrum Utilization ★ Due to theoretical considerations, the frequency spectrum is somewhat less efficiently utilized with low transmitter frequency deviation than with high deviation. The reason for this lies in the distribution of energy in the sidebands associated with Frequency Modulation transmission.

An analysis of the Bessel functions involved in the calculation of these sidebands indicates that if, giving due consideration to guard band, a 200-kc. channel is required for a transmitter frequency deviation of ±75 kc., a 100-kc. channel would permit a frequency deviation of only approximately ±30 kc.

Allocations ★ The strongest argument for reducing the transmitter frequency deviation has been that a greater number of channels would be available in a given frequency band. Thus eighty 100-kc. channels would be assigned in the region between 42 and 50 mc. rather than forty 200-kc. channels.

The assumption that this would result in providing twice the number of transmitters in a given area is open to serious question, since there is no assurance that assignments could be made on every other channel in the same area. This problem probably could not be answered definitely until after field tests had been made.

The problem is concerned not only with the matter of receiver selectivity, but also with the question of the relative values of signal strength from undesired and desired stations operating only 2 channels or 200 kc. apart in the same area.

Multiplex Operation ★ If the frequency deviation of the FM broadcast transmitter is halved, multiplex operation would become more difficult, if not impossible. Although such operation is not a factor at the present time, it would be unwise to set standards which would mitigate against multiplex operation in the future.

Multipath Distortion ★ It has been claimed that the distortion of Frequency Modulation signals due to multipath transmission would be reduced if the transmitter deviation were decreased. This is doubtless true. However, halving the frequency deviation would not eliminate such distortion but would only reduce the number of localities in which distortion might occur.

Multipath distortion is not believed to be an important factor in Frequency Modulation broadcasting, since the number of listener complaints regarding such distortion have been negligible. Moreover, this situation is bound to improve when high powered transmitters and more adequate transmitter antennas are available after the war.

In this connection it should be noted that some FM broadcast transmitters in the New York area are operating with horizontal polarization and others with vertical polarization. This makes it difficult to obtain satisfactory reception from all New York City FM stations on one stationary antenna in some locations.

Cooperation with Television ★ It may be argued that the choice of the proper deviation for Frequency Modulation broadcast transmitters should be decided on its own merits without regard to the problems involved in the television sound channel. However, it should be pointed out that the advantages resulting from the use of a 40-kc. deviation in the television FM sound channel will be obtained only if a wide deviation is employed in Frequency Modulation broadcasting.

The principal argument for the use of a 40-kc. deviation on the television sound channel is that greater drift tolerances will be permitted. This is obviously an important factor in the higher-frequency television channels. However, the advantage of greater permissible drift will result only if the television sound channel circuits have wide frequency bands.

It has been assumed that the television sound channel would also be used for FM broadcast transmission. If the frequency deviation in FM broadcast transmitters is reduced to 40 or 30 kc., the sound channel circuits must be correspondingly reduced in width in combination television and FM broadcast receivers. Thus the drift problem becomes worse rather than better. On the other hand, if 200-kc. channels are employed in FM broadcasting, the combination receivers will of necessity employ broad-band circuits and the desirable increased tolerances with respect to drift in the television sound channel using a 40-kc. deviation will be realized.


The Best Show On the Air Saturday Night!
"MEET YOUR NAVY"
Now Carries the RAYTHEON Name into 3,500,000 Radio Homes Each Week!
Every Saturday Night
ENTIRE BLUE NETWORK
Coast to Coast 181 Stations
RAYTHEON MANUFACTURING COMPANY
Waltham and Newton, Massachusetts
All Four Raytheon Divisions Have Been Awarded Army-Navy "E" with Three Stars
Free!
Ask your Raytheon distributor for colorful, attention-getting "Meet Your Navy" display to tie in with this great program. Easel-mounted, 17½ x 20½".
RAYTHEON
High Fidelity
ELECTRONIC AND RADIO TUBES
DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS

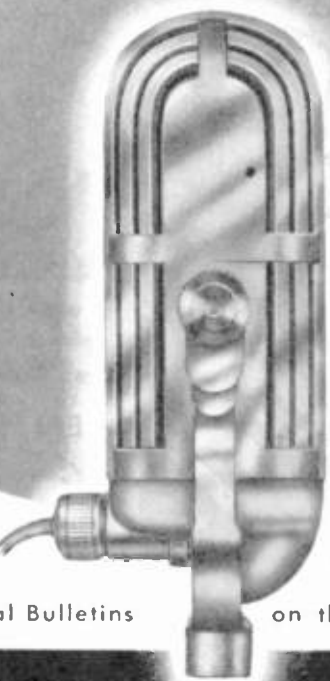
American OUT IN FRONT!

Whether it's the philharmonic, oratory, news, public address, sportscast or commercial, the quality of the program that goes through depends **first** on the microphone **OUT IN FRONT!**

There it stands, unattended, with the whole show going on. It just **has** to be dependable. It just **has** to have full range for the job.

D5

D9A



D3

D5 DYNAMIC—An ideal microphone for general use, due to its versatility and dependability. Microphone contour and diaphragm protective grille designed to minimize wind noise and sound field distortion. Recommended for close talking as well as distant sound source pick-up.

D9A UNIDIRECTIONAL DYNAMIC—A pressure-velocity combination microphone, will pick-up from front only, broad frequency response and high output, should fill the majority of requirements. Especially recommended for indoor use due to feed-back reduction and elimination of extraneous pick-up.

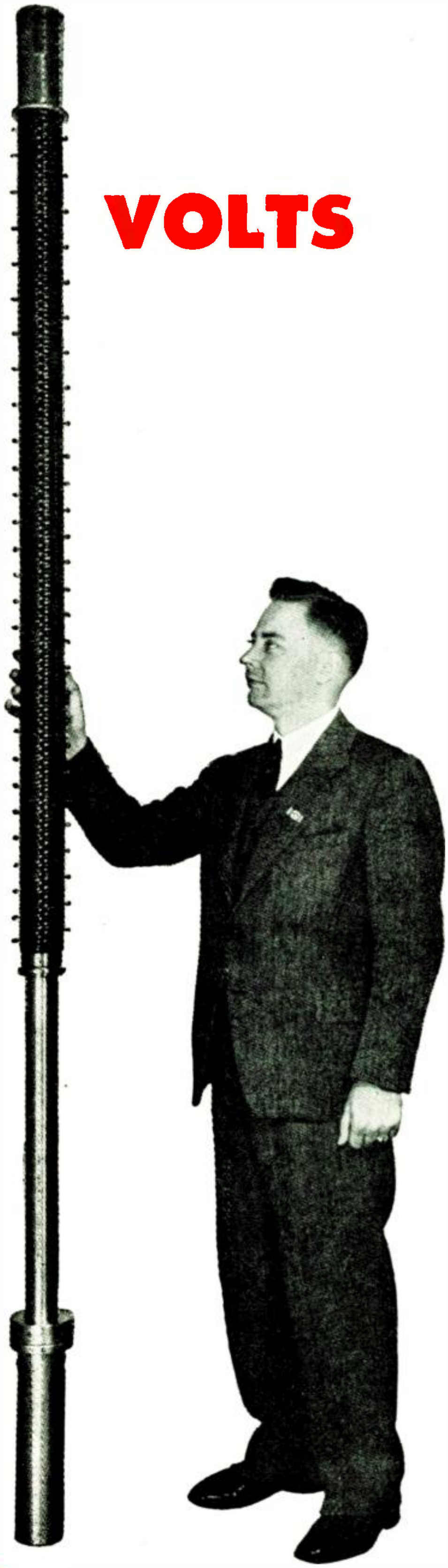
D3 DYNAMIC—Recommended for those microphone applications where high fidelity (uniform response from 50 to 10,000 cps) is of prime importance. Attention to detail in design and construction of each microphone insures stable operation and optimum performance for all types of audio pick-up.

Write for Comprehensive Technical Bulletins on these and other American Microphones.

American MICROPHONE CO.

1915 So. Western Avenue, Los Angeles 7, California

PRECISION AT 2,000,000 VOLTS



ANOTHER MACHLETT TECHNIQUE

WE ARE not going to tell you here why this tube was made, what it does, or what it is for. The important thing about it to you as a user of radio oscillator, amplifier and rectifier tubes for communications or induction heating is that it represents the toughest assignment ever handed the electronic tube industry, and that of all tube makers only Machlett perfected the techniques that made the tube possible.

The tube is sealed-off, vacuum-tight, and operates at 2,000,000 volts, direct current. These and other difficult conditions were essential to assure high and constant power, reduction of heat, and precise focusing of the electron beam.

Electrical and mechanical problems presented by the tube were so severe that some scientists doubted they could be solved, but Machlett, drawing upon its long experience, met every requirement in a little over two years.

This is significant to you because every electronic tube, whether it produces X-rays, or radio waves, or is a rectifier, depends for its success in your service upon correct design, proper vacuum, adequate insulation, and precision-made parts, to assure precise control of the electrons that make any such tube function.

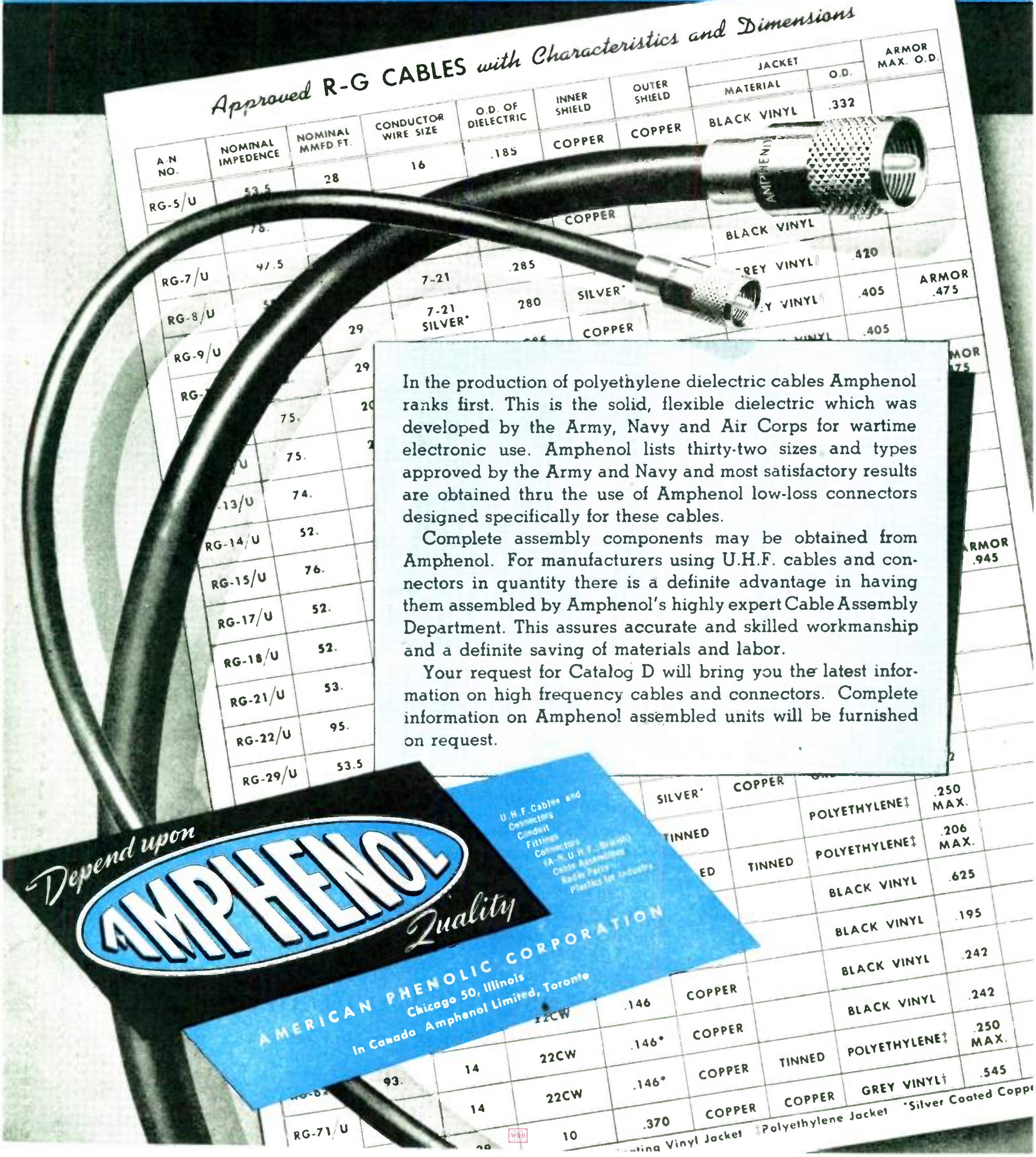
The perfection of this 2,000,000-volt direct-current tube is the best proof we can offer of the value of the Machlett skills that go into the design and manufacture of every tube bearing our name . . . Machlett Laboratories, Inc., Springdale, Connecticut.

MACHLETT

APPLIES TO RADIO ITS 46 YEARS OF X-RAY TUBE EXPERIENCE

AMPHENOL *Offers*

The Most Complete Line of U. H. F. Cables and Connectors . . .



In the production of polyethylene dielectric cables Amphenol ranks first. This is the solid, flexible dielectric which was developed by the Army, Navy and Air Corps for wartime electronic use. Amphenol lists thirty-two sizes and types approved by the Army and Navy and most satisfactory results are obtained thru the use of Amphenol low-loss connectors designed specifically for these cables.

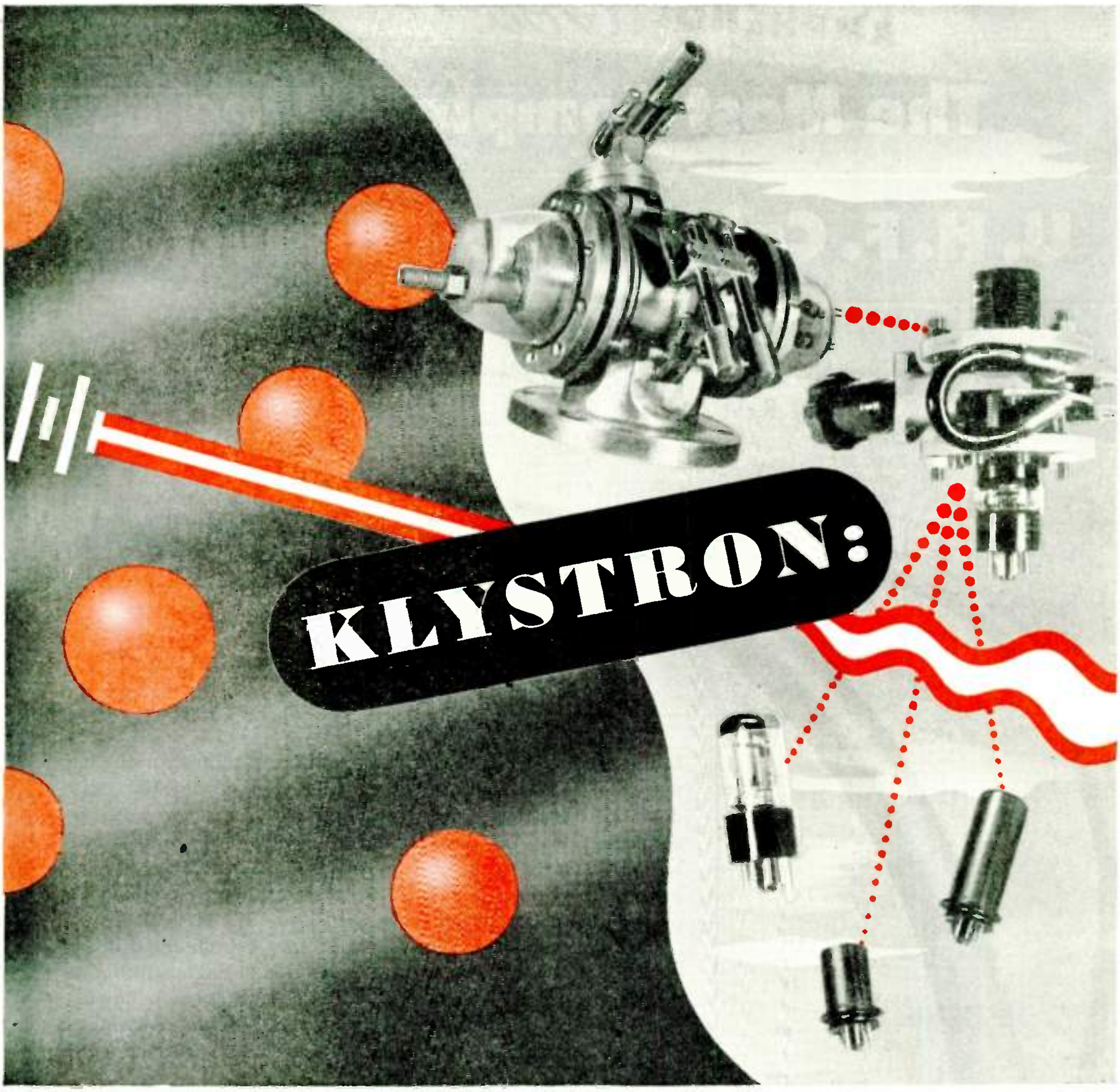
Complete assembly components may be obtained from Amphenol. For manufacturers using U.H.F. cables and connectors in quantity there is a definite advantage in having them assembled by Amphenol's highly expert Cable Assembly Department. This assures accurate and skilled workmanship and a definite saving of materials and labor.

Your request for Catalog D will bring you the latest information on high frequency cables and connectors. Complete information on Amphenol assembled units will be furnished on request.

Depend upon AMPHENOL *Quality*

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

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


KLYSTRON:

POSTWAR STANDARDS

(CONTINUED FROM PAGE 33)

cult to control than the frequency range."

It costs money to build receivers that have wide-range response and freedom from distortion. They can't be bought for $60. But the pleasure of listening with a fine receiver to an FM station operating at full fidelity is certain to confirm Mr. Ready's conclusion that: "You will hardly believe how good such reproduction can be until you try it."

"As for noise-free reception," the author of the pamphlet continues, "in actual field tests in downtown districts of New York City, it can be demonstrated that reception on an average price FM set (about $60), operating on a self-contained antenna, is noisier than a $16.50 AM receiver requiring no antenna. In order to have the FM receiver equal the performance of the low-priced AM receiver with respect to noise elimination, it is necessary to install a doublet antenna system on the roof and to carry the signal down to the receiver by special wires. The installation of an antenna plus a good average FM receiver will therefore total over $75. Thus it is seen that in order to obtain the performance now possible on a $16.50 AM receiver, one must spend about $50 more to secure comparable FM reception, since in even a very cheap AM set a special antenna is not needed."

(CONTINUED ON PAGE 70)

IMPORTANT ARTICLES

For January and February Issues

FM HANDBOOK

BY RENÉ HEMMES

A series of articles to be published later in book form, under the title "FM Handbook," will start in the January issue. It will cover both the elementary and advanced aspects of FM theory, the design of FM transmitters and receivers, measurements, tests and servicing, antennas, and special installations and applications.

FUNCTIONAL DESIGNS FOR HOME RADIO INSTALLATIONS

BY MILTON B. SLEEPER

This series, starting in February, will present the first fundamental improvements in home radio since sets were first admitted to American living rooms. Walter Buehr, whose work appears in House & Garden and other foremost publications, has been engaged to provide the drawings of floor plans and design details. Under preparation for many months, this series of articles, combining the best engineering, architectural, and decorative thought, will unquestionably have a profound influence of postwar radio set design—particularly because it points the way to the elimination of the furniture problem.

POSTWAR STANDARDS

(CONTINUED FROM PAGE 69)

This is interesting, not because it is even related to facts, but because it shows how much misinformation has been accepted by engineers.

In the first place, no "good average FM-AM receiver" has ever been offered at a retail price of $60. Pilot Radio and Freed-Eisemann table models were priced at about $125. While public preference strongly favored the more expensive console phonograph combinations, either of these sets, using a foot of wire for an antenna, could deliver noise-free FM reception of such superior tone quality as to make a $16.50 AM set sound like the squawking of a back-fence string telephone.

The only prewar set offered at $60 capable of FM-AM reception employed an FM circuit without a limiter and was, therefore, incapable of suppressing noise. Its performance was, in fact, only comparable to a cheap AM model. It was not a good FM receiver, nor an average one, and, in the opinion of engineers familiar with FM circuits, it was not a real FM set at all.

The next statement, presented as a fact, concerns multi-path distortion. Here it is: "In addition to the fact that the points of so-called superiority have no practical value to the general public, FM has one serious defect for which there is no solution at the present time. In the March, 1944 issue of *QST*, an article was published called "FM Distortion in Mountainous Terrain." The sad experience of an FM receiver owner is outlined. It shows that there are areas around Asheville N. C., where it is not possible to get satisfactory FM reception. Distortion of the FM signals in these locations is impossible to eliminate, even with special antenna systems. It should be noted that the skyscrapers of New York City simulate, on a small scale, the mountainous conditions of Asheville. This same distortion will be experienced in all large cities where tall buildings exist. AM broadcasting in the standard band does not suffer from this serious defect."

Let's look into this conclusion, offered as a fact. The *QST* article concerned reception from Gordon Gray's station WMIT, on Clingman's Peak. This transmitter was under construction at the time of Pearl Harbor, and work was stopped before the 50-kw. equipment could be installed. Consequently, it has been operated with about 1 kw. fed into a temporary antenna. How, then, could satisfactory reception be expected in Asheville? To anyone knowing the circumstances, the tests reported in *QST* merely confirm the classic statement that if signals can't reach a certain point, it's no use to try to build a receiver to pick them up there!

As for distortion "in all large cities

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POSTWAR STANDARDS

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where tall buildings exist," one might ask: "When will it begin?" The only reports of multi-path distortion ever reported to this office have come from New Jersey and Long Island. In each case, because the reports were too vague to be conclusive evidence, we wrote for specific information, but no replies were ever received. Experience we have gathered during the past four years shows definitely that FM reception in both urban and rural areas, even where reception comes from stations not yet operating at their full authorized power, is far more dependable and consistent night and day the year around than AM. Even in New York City, the distribution of FM signals is more complete than that of AM signals. This is not an expression of opinion, but of experience which anyone can confirm who wants to find out for himself. It is true in Chicago, also, and in other cities such as Philadelphia and Boston. And it holds good in the Green Mountains, the White Mountains, and the Berkshires of New England where Yankee Network's Paxton and Mount Washington stations, operating at their rated power, are giving noise-free, high quality FM reception to listeners who cannot get decent signals on any type of receiver from any AM station.

But to return to the pamphlet. It continues: "It might be instructive to note that several years ago the British turned down FM. They stated that FM is not suitable for their Country. This decision by Great Britain is doubly significant because they have been pioneers in high frequency broadcasting and television."

That statement is both false and misleading. Neither radio listeners nor the radio industry of Great Britain "turned down FM" several years ago. It is true that several British engineers made inquiries about FM in the United States, and attended a demonstration of reception from Alpine, but England was at war then. It would have been as impossible to erect FM broadcast stations or to produce receivers then, or since that time, in England, as in the United States after we entered the war.

Certainly the radio engineers in the British Army are getting first hand knowledge of our military FM equipment, both at the front lines and at communications headquarters in England. It is unlikely that they do not know that a large part of our message traffic between England and the Continent is being handled by FM networks.

Further evidence of their lively interest in Frequency Modulation comes to light in the subscription files of *FM* AND TELEVISION. The list is headed by the War Office, the Ministry of Supply, the Royal Aircraft Establishment, the Patent Office Library, and on down through the list of

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radio manufacturers. South Africa, India, Australia, and New Zealand are also well represented. Dr. Augustin Frigon, general manager of the Canadian Broadcasting Corporation, announced last October that over 60 applications for FM stations had been filed there, and that public demonstrations of FM have started already.

The final paragraphs of the pamphlet in question present this conclusion: "By this promotion, it is hoped that FM's so-called super qualities can be promoted to such an extent that the public will pay $60 for an FM receiver instead of $10 for an AM receiver. But the sad part of this situation, as far as the general public is concerned, is that for $60 its entertainment at its possible best will be no different than what it could buy with an AM receiver at one-sixth the price. . . .

"To the promoters of FM, the challenge is to produce radio receivers which will receive FM and AM broadcasting in places like New York City and in suburban areas a distance of 50 miles from large centers of population without the use of extra antenna systems. These sets must sell at a profit at $29.95 (about the average price of AM sets) and give a service performance at least equal to AM sets selling for $16.50 which do not require auxiliary antenna systems. At the present state of development of the radio engineering art, this is not possible."

Right there, our pamphleteer has come upon a matter of policy which will determine the future radio broadcasting and manufacturing industry, for better or for worse. That is the question as to whether the trend in the quality of postwar transmission and reception should be toward higher or lower standards.

To see this problem clearly, let us consider first another, parallel industry — the business of manufacturing and selling automobiles.

Over a period of years, Ford, Chevrolet, and Plymouth have established the prices and designs of cars in the lowest, and most popular, price bracket. In planning their yearly models, these companies had the choice of maintaining the price level and adding new features of comfort and performance, or of seeking ways to lower prices again and again while maintaining the basic function of providing transportation.

We know that hundreds of thousands of people cannot, and do not, pay more than $300, or less, for their automobiles. Furthermore, a chassis, equipped with wheels, steering gear, an engine, and some kind of a body could be produced to sell new at $300. Why, then, do we not have these really cheap cars?

The reason is simple. The manufacturers know that there is more value in a second-hand car originally built to sell for $750

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POSTWAR STANDARDS

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than in a new car priced at $300. To make this greater value available to families of limited means, they have set up their sales plan to move second-hand cars in order to stimulate the buying of new models on a trade-in basis. A major by-product of this setup is the large and profitable second-hand business of the automobile dealers.

What course did radio manufacturers pursue to meet the new conditions which prevailed after the record-volume year of 1929? Their thinking is generally represented by the acceptance, expressed in the quotation above, of $16.50 as a reasonable price for an AM radio set. And it may be that $29.95 will be established as the level to which FM-AM sets should be brought down.

Certainly there was no evidence of conviction to the contrary in the radio industry, prior to 1941. But in that year, there was enough FM broadcasting to support FM-AM set sales in several large trading centers. Most of those new models were priced at $350. Others ranged up to $1,000. All of them sold faster than the manufacturers could turn them out from that time until the war stopped all production in 1942. Why? Because really fine sets combining FM and AM reception gave the purchasers a chance to compare the best, but very limited, quality of AM reception with the realism of program reproduction made possible by the fidelity of FM broadcasting *plus* receivers of corresponding characteristics.

That was a new, fresh start for those manufacturers who had the foresight and aggressiveness to go into FM-AM set production, and they, their jobbers, and their dealers profited by giving the public such value in radio entertainment as was never heard in American homes before!

What will the manufacturers do next? Will they apply to postwar radio the philosophy of inadequacy, reducing profits all down the line by making a still larger number of even cheaper sets, to the further detriment of service to radio listeners?

Or will a new philosophy of improvement be established, so that the performance of any set will be compared not to models priced at $16.50, but to those which are designed to give the full realism of reproduction which can be obtained from FM broadcasting?

The difference in the sales and promotion planning between these two philosophies can be summed up in this way. The former is summarized by the sales approach: "It's time to buy a new radio because they are still cheaper now." The latter, by the line of attack: "It's time to trade in your old radio because you can get a better one now."

One is as limited as the thinking of the

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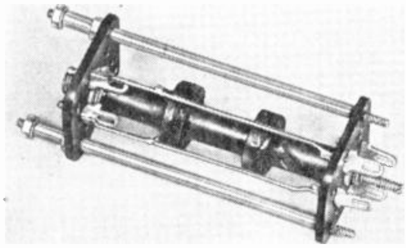

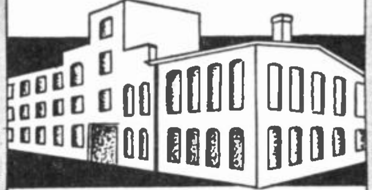

POSTWAR STANDARDS

(CONTINUED FROM PAGE 73)

man who wrote the pamphlet quoted here. The other is geared to thinking in terms of public service by which industry, labor, and distribution can contribute most effectively to the postwar recovery in our United States. In such an effort, product development and design calls for forward-looking engineering that is honest and sincere. There is no place for small-minded men who seek to impose their own intellectual limitations upon others.

PLANS FOR RAILROAD RADIO

(CONTINUED FROM PAGE 23)

travels on the railroad. Men and women and now even children have come to know that radio is an absolute essential of safety on airplanes. No one would think of boarding an airliner that lacked radio equipment.

When the time comes that radio equipment is available, public demand for this added factor of safety will quickly break down all barriers against its use by the railroads. In fact, to meet the pressure of competition from air lines, busses, and automobiles, the roads will find it necessary to feature the use of radio both as a new measure of safety and of speed by which running time will be reduced and delays will be avoided.

Summary of Services ★ Plans formulated by the Railroad Radio Communications Services Committee of RTPB Panel 13, and submitted to the FCC have been divided into 8 classes. These are:

1. End-to-End Train Communication (two-way)
   A. Train communication from end-to-end whether in motion, standing, or parted.
   B. Communication between train and the conductor, flagman, or other employee on the ground.
   C. Communication from one train to another train approaching, passing, or departing from another.
2. Fixed Point and Train Communication (two-way)
   A. Yard operations.
   B. Terminal operations.
   C. Communications to trains en route, and to dispatchers.
   D. Radio on work equipment used for emergencies. This includes derricks, snowplows, and fire fighting equipment.
3. Emergency Service (two-way)
   A. Bridging gaps during wire-line failures.
4. Remote Control (two-way)
   A. Supervision and control of train operation from a fixed point.

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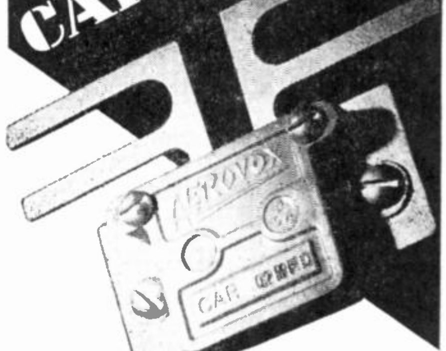

PLANS FOR RAILROAD RADIO

(CONTINUED FROM PAGE 74)

5. Radar
   A. For craft on inland waters employed for railroad service, particularly under fog conditions.
6. Ship-to-Shore (two-way)
   A. Harbor craft service (short range).
   B. Inland waterways and Great Lakes service (long range).
   C. Direction finding.
7. Miscellaneous
   A. Device for warning wayside employees of approach of trains.
   B. Communication between installation and maintenance forces.
8. Research
   A. Micro-wave development for various railroad communications purposes.

Analysis of Service Requirements ★ Experiments and test operations have been carried out during 1945 to an extent that definite data as to frequencies, apparatus requirements, and methods of use have been worked out for each type of railroad service. Complete details will be presented in Part 2 of this paper.

Editor's Note: *Part 2 will appear in an early issue of FM* and Television.

SYNCHRONOUS FM SATELLITE

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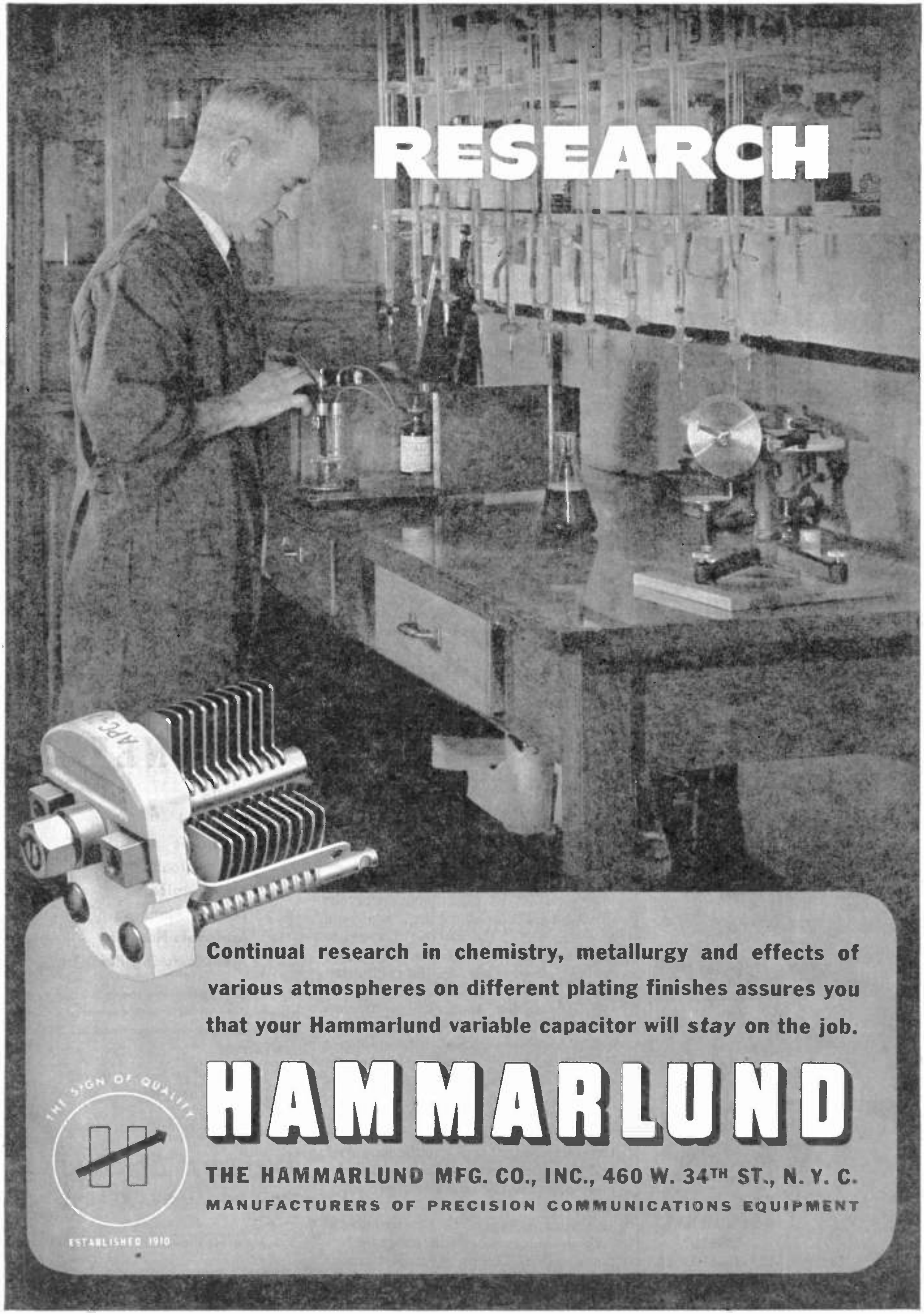
Proper placement of the boosters in a pattern relative to the less densely populated areas should result in fewer potential cases of interference. For example, the area served by the booster just described was estimated at 16 square miles. In an area of this size, it is conceivable that thirty-five to fifty thousand people could reside. If such a city happened to be situated in a valley surrounded by hills, and with, let us say, 1,000 microvolts average outside or above the shadow and 50 microvolts in the shadow, it would be comparatively easy to locate the pick-up on one side of a hill and the transmitter 600 to 1,000 ft. on the other side. The signal from the transmitting antenna would be beamed over the city below. In this instance the degraded service area in relation to the coverage would be very small, and therein lies one of the most important advantages of this system.

There is no reason why the technique of suppressing the satellite carrier from the receiver input could not be improved, and this would result directly in utilizing more power in the satellite, if necessary. This could be accomplished by greater separation between the booster and the pick-up antenna or with improved antenna design. The proper adjustment of power could be made to fit the service to each specific need.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TO LOOK AHEAD!

As the New Year begins to unfold, we borrow one moment from our unceasing wartime exertions to lift our eyes to the future.

All of R. E. L. pioneering efforts—the accumulation of years of invaluable, hard-earned experience—have been pointed toward a goal, which can only be attained when the combined energies of the armed forces and industry have achieved the final peace.

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