PRICE—TWENTY-FIVE CENTS

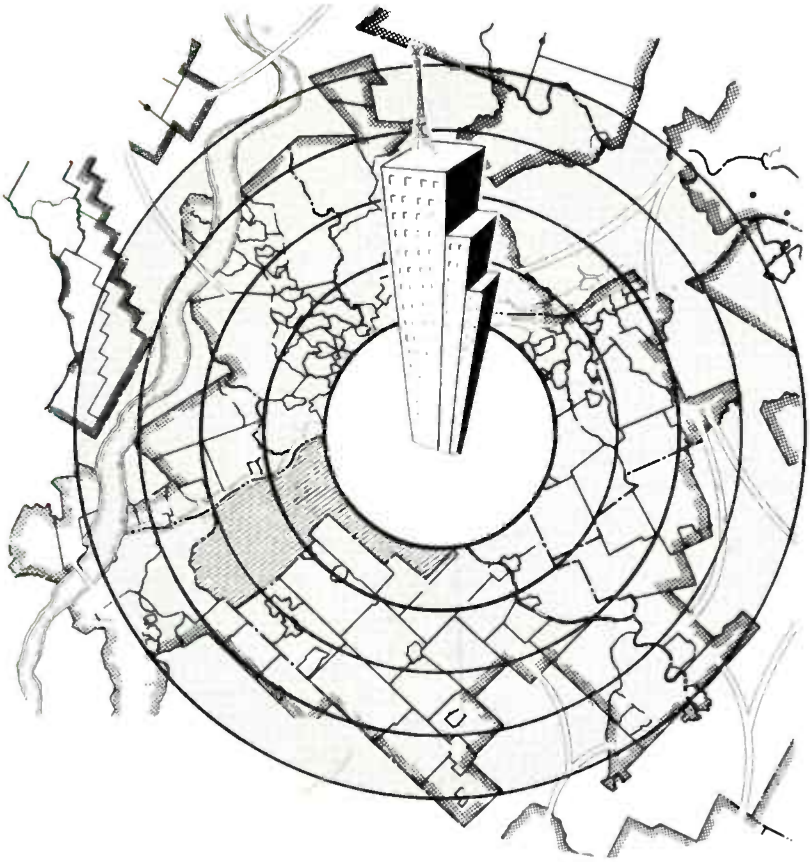
FM AND TELEVISION

APRIL 1945

FCC CHAIRMAN

Products Directory

★ ★ Edited by Milton B. Sleeper ★ ★



IS YOUR HAT IN THE TELEVISION RING?

Television promises unprecedented profit and prestige to men of vision and energy. Television will be tomorrow's highroad to local and national leadership.

If you plan to toss your hat in the Television ring, arrange *now* to assure both early postwar delivery of your telecasting equipment and the proper training of your Television station's operating personnel. Both equipment and staff training are provided for in DuMont's Equipment Reservation Plan.

DuMont-engineered telecasting equipment has rugged dependability and practical flexibility; will be designed for economical operation and is realistically priced. These facts have been spectacularly demonstrated by more than 4 years' continuous operation in 3 of the nation's 9 Television stations.

Furthermore, a pattern for profitable station design, management and programming has been set at DuMont's pioneer station, WABD New York . . . a pattern and backlog of Television "know-how" which is available to prospective station owners. Call, write or telegraph today.

DUMONT *Precision Electronics and Television*

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

NATIONAL RECEIVERS ARE THE EARS OF THE FLEET

OFFICIAL U. S. NAVY PHOTOGRAPH

3 out of 4 of the Navy's ships—landing craft and larger—are equipped with receivers designed by National

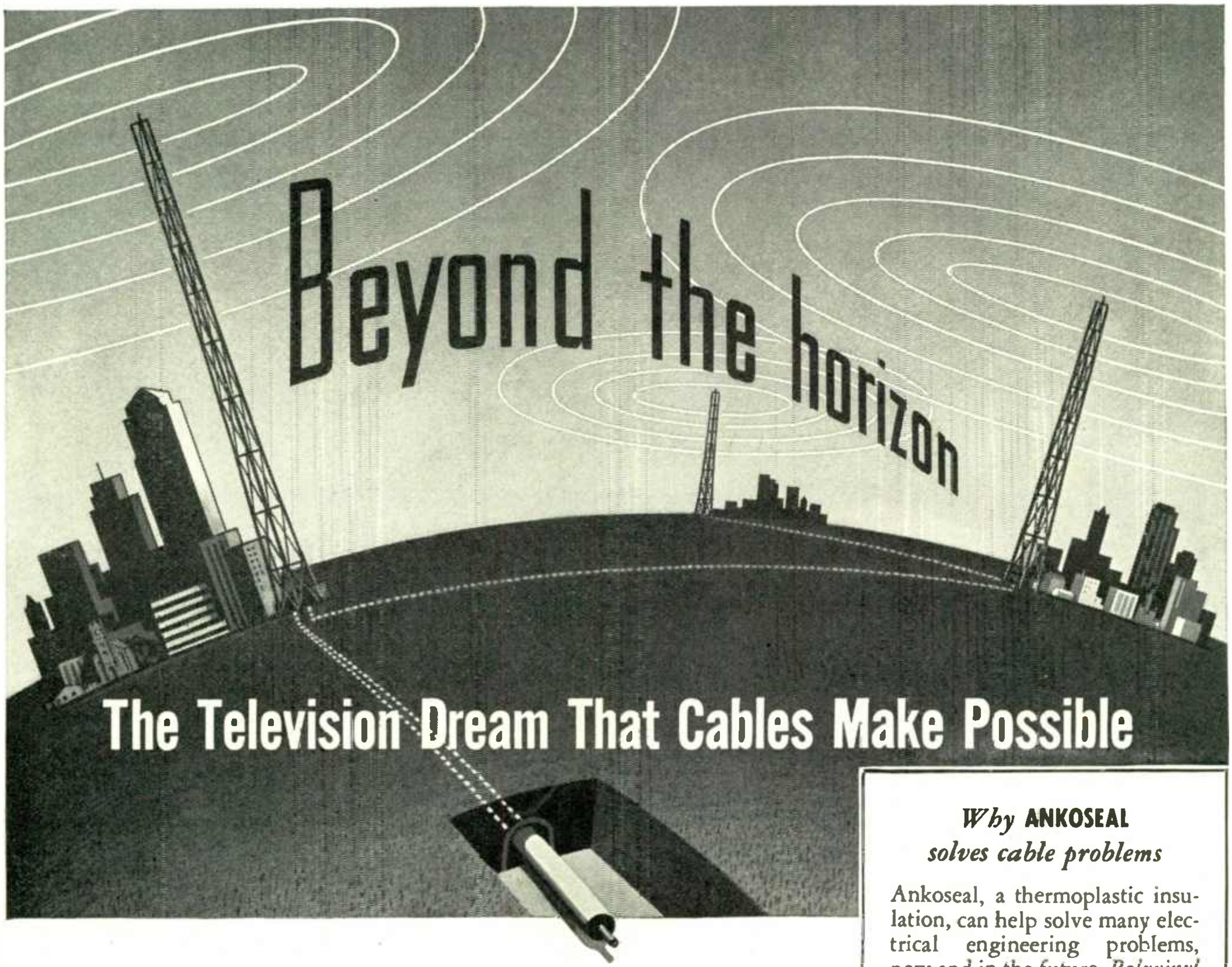
This is a small part of mighty Task Force 58. It is more than a lot of ships and a lot of men, it is an integrated striking force of terrific power. Radio communications have played a vital role in the operations for which Task Force 58 has become famous.

We are proud that National radio receivers are a part of this Force.

NATIONAL COMPANY

MALDEN, MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD



Why ANKOSEAL *solves cable problems*

Ankoseal, a thermoplastic insulation, can help solve many electrical engineering problems, now and in the future. *Polyvinyl* Ankoseal possesses notable flame-retarding and oil resisting characteristics; is highly resistant to acids, alkalies, sunlight, moisture, and most solvents. Polyethylene Ankoseal is outstanding for its low dielectric loss in high-frequency transmission. Both have many uses, particularly in the radio and audio fields. Ankoseal cables are the result of extensive laboratory research at Ansonia—the same laboratories apply engineering technique in the solution of cable problems of all types.

TELEVISION—sign and symbol of the age to come—is one of the wonders that specially designed cable transmission makes practical. For the quality and fidelity of the transmitted image depend largely on how well the cables are engineered and manufactured, from tiny cables in the broadcasting mechanism itself to the great coaxial cables linking city with city, making possible the television networks of the future.

Thus the "wireless age" as it develops will actually need more wires—and more complicated cables—to achieve its realization! And in the solution of these problems, new and more complicated cables will be required.

Today, we will undertake to engineer and manufacture the radio and audio cable requirements of any government agency or private concern in war work. Moreover, we look forward to solving many of the most difficult cable tasks in peacetime—as we have in wartime. The same laboratories, the same Yankee ingenuity that have helped to whip many of the difficulties involved in the communications requirements of our Army and Navy are prepared to function for industry—whatever the problems of today and tomorrow.

THE ANSONIA ELECTRICAL COMPANY

Specializing in "Ankoseal" a Thermoplastic Insulation

ANSONIA • CONNECTICUT

A Wholly-Owned Subsidiary of

NOMA ELECTRIC CORPORATION

GENERAL OFFICES • NEW YORK, N. Y.

—In peacetime makers of the famous Noma Lights—the greatest name in decorative lighting. Now, manufacturers of fixed mica dielectric capacitors and other radio, radar and electronic equipment.

FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 5 APRIL, 1945 NO. 4

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THIS MONTH'S COVER

FCC Chairman Paul A. Porter will be remembered as the man under whose administration the Commission arrived at the right — or wrong — answer on FM broadcast frequencies. The wisdom or error in the final decision will eventually be known to all, and there will be no way to cover up a mistake, if one is made now. We shall have to live with that decision, for better or worse, a long, long time. And because Chairman Porter knows this, it is certain that he will search the records diligently to find the truth.

WHAT'S NEW THIS MONTH

1. FM Broadcast Frequencies
2. Philco Service

1. If any controversial subject is discussed long enough, not only is the whole truth bound to come out in the end, but also the nature of the aims and purpose which animate those who take part in the controversy. So it is seen to be in the matter of FM frequencies.

Until after the secret FCC hearing on this subject, held March 12 and 13, those who were concerned with the rapid postwar development of FM as a superior means of broadcasting and of maintaining uninterrupted employment in the industry were still confident that the Commissioners were at great pains to bring out all pertinent information and data on FM propagation, to the end that the permanent frequency assignment would make immediate and most effective use of FM's capabilities in the service of radio listeners.

If that is still the case, it is certainly not confirmed by the record at this time of writing. Here are the facts as they appear to this observer:

Before the Oral Argument, February 27 to March 1, it was announced that serious errors had been found in the Norton testimony, on which the FCC had based its proposal to move FM frequencies to 84–102 mc. Did the Commissioners plan to accept this new information as a possible reason for reconsidering their proposal to make a drastic change in the FM band? Or was Mr. Norton prepared to make a frank admission of his mistakes, and to revise his conclusions in conformity with the facts?

Apparently not. Apparently it was decided that if an admission of error should be forced upon Mr. Norton by further cross-examination, the record would be concealed for some indefinite length of time. It is hard to draw any other inference from the record because:

Prior to the Oral Argument, when new testimony was to be offered showing the errors in the method by which Mr. Norton reached his conclusions, Mr. Norton prepared a statement to be read at the Oral Argument. He said: "Unfortunately, due to security reasons, I will not be able to discuss in much more detail at this time the basis for the conclusions which I reached relative to

(CONTINUED ON PAGE 82)

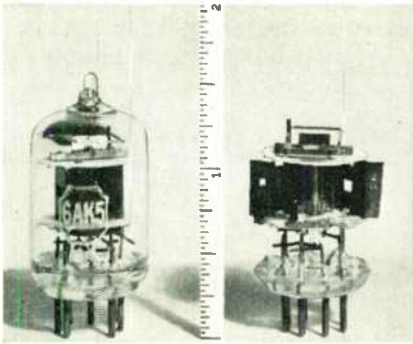
SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

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

Miniature Pentode Designed for Use In UHF Circuits

Tube Type 6AK5, a new addition to Sylvania Electric's line, is a miniature sharp cut-off pentode in the short bulb, and is especially suitable for use in ultra high



frequency equipment. Small size and high efficiency make it useful in portable equipment.

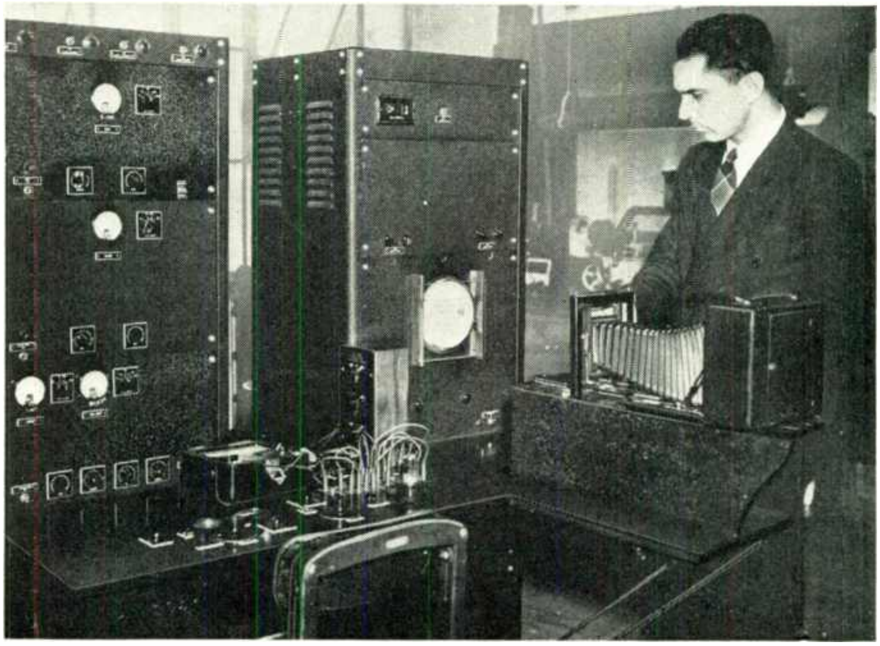
Full technical information may be obtained from Sylvania Electric.

SYLVESTER SURVEY

"Would you say your postwar radio choice would be the large console type or the smaller, table-top model?"

Oscillographic Technique Traces Tube Performance in New Regions

Method Devised by Sylvania Electric Throws New Light on Characteristics



The measurement of tube characteristics in regions where previous test methods were inapplicable has been made possible through the development, by Sylvania Electric, of a new procedure, based on photographing an oscillographic trace.

EARLIER METHODS

Formerly, tube characteristics were taken by a point-by-point method. This was extremely slow, and had the still greater disadvantage that it could be used only in those parts of the characteristics where the tube would not be damaged by continuous operation. In many recent applications, characteristics must be known in regions where a plate or grid would vaporize if left on for even a second.

PHOTOGRAPHIC RECORDING

The new technique permits taking of characteristics in these regions. The oscillographic trace of the characteristics is shown on a special Sylvania 7-inch cathode ray tube, and may be photographed.

Improved tubes and circuits are expected to result from the use of the new method, equipment for which was built in Sylvania Electric's Commercial Engineering Laboratory.

SYLVANIA ELECTRIC

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.

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

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108 SERIES *Amplifiers*

WITH MOUNTING ACCESSORIES

TYPE 108-B two-stage Amplifier provides transformer input impedances for either 30 or 250 ohms with nominal output impedance 500 or 8 ohms. Variable gain 65/105 db. with electronic volume control. Frequency response better than ±1 db. 30/16,000 c.p.s. Power output +43 V.U. (20 watts) with less than 5% RMS harmonic content. Noise level full gain 56 db. below full output.

THE 108 SERIES consist of four different amplifiers available simply by changing one or two small input panels on the master chassis. Except for these input panels all amplifiers have the same transmission characteristics. Input impedance, gain and noise level depending on types listed below.

These units are designed for the highest type audio service having gain-frequency characteristics better than ±1 db. 30/16,000 c.p.s. Power output +43 V.U. (20 watts) with less than 5% RMS harmonic content.

TYPE 108-A two-stage Amplifier provides transformer input for either 600 ohm or bridging. 600 ohm input fixed gain 61 db. Bridging input variable gain 6/46 db. Noise level 68 db. below full output.

TYPE 108-B as illustrated and described above.

TYPE 108-C combines the input channels of the 108-A and 108-B Amplifiers. Channel 1—600 ohm input variable gain 20/60 db. Bridging input variable gain 2/42 db. Channel 2—high gain 30/250 ohm input variable gain 62/102 db. with electronic volume control. Noise level 56 db. below full output.

TYPE 108-D two-channel each 30/250 ohm input. Either channel variable gain 62/102 db. with electronic volume control. Noise level 56 db. below full output.

MOUNTING ACCESSORIES

TYPE 202-A Wall Mounting Cabinet permits universal installation of 108 Series Amplifiers to any flat surface. Well ventilated and designed for maximum accessibility, servicing and convenience of installation. Standard aluminum gray finish.

TYPE 9-A Modification Group permits 108 Series Amplifiers to mount on standard 19" telephone relay racks. Occupies 7" rack space. Allows servicing from front of rack. Standard aluminum gray finish.

The Langevin Company
INCORPORATED
SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

NEW YORK
37 W. 65 St., 23

SAN FRANCISCO
1050 Howard St. 3

LOS ANGELES
1000 N. Seward St., 38

ENGINEERING SALES

Hoffman: Will be represented in Honolulu by Tommy Kearns, radio and appliance distributor in the Islands for the last 20 years. Arizona Wholesale Supply Company will handle Hoffman sets in Arizona and in the Las Vegas, Nev., and Needles, Calif. areas.

Benwood Linze: Has opened a New York office in the Graybar Building, 420 Lexington Avenue. H. S. Dahl, for the past 10 years a specialist in metallic rectifiers, will be in charge.

Westinghouse: Times Appliance Company, Inc., which introduced Westinghouse sets in New York nearly 24 years ago, has been appointed exclusive distributors for the postwar line in the 5 boroughs of New York, and Nassau, Suffolk, and Westchester counties.

Utah: Robert M. Karet, sales manager of Utah's wholesale and sound divisions, has completed a trip from Spokane to St. Louis, giving demonstrations of a new wire recorder at jobber's and servicemen's meetings.

Motorola: York Automotive Distributing Company, Inc., 33 W. 60 Street, New York City, has changed its name to Motorola-New York, Inc. A branch at 177 Central Avenue, New Jersey, will be known as Motorola-New Jersey, Inc. There will be no change in officers or management. Motorola sets will be distributed by this organization in New York counties of New York, Kings, Queens, Richmond, Suffolk, Nassau, and Westchester, and in the Jersey Counties of Monmouth, Mercer, Middlesex, Somerset, Hunterdon, Union, Morris, Sussex, Passaic, Essex, Hudson, Warren, and Bergen.

For Arkansas, Motorola has appointed Home Appliance Distributors, 600 W. 7th Street, Little Rock.

Stromberg-Carlson: Has appointed Midwest-Timmerman Company, Davenport, Ia., as distributor for Iowa, and parts of Nebraska, Illinois, and South Dakota.

In the Hawaiian Islands, the line will be handled by Electrical Distributors, Inc., of Honolulu.

Bendix: The following additional distributors have been appointed for the Bendix radio line: Alford's Wholesale, Albuquerque, New Mexico, for all the state except ten southern border counties; Gunn Dis-

(CONTINUED ON PAGE 78)

Using Strength, Lightness, Wearing Quality

STRENGTH, light weight and wear-resistance make Synthane laminated highly desirable for retainers in high speed ball bearings . . . and an excellent example of putting plastics where plastics belong.

If you haven't used plastics at all or to the fullest extent, if you are not certain *which* of the many plastics fits into your plans . . . or where . . . or why . . . or what the cost will be . . . ask us to help you, preferably *before* you design.

This way, if Synthane is the answer to your needs, you can be sure of design and material not only right for the application but right for fabrication. Should you, in addition, want us to take over fabrication, you can be sure your parts will be produced by men who know machining of plastics, working on machines fitted especially for plastics. For your whole job or any part of it—design, materials or fabrication —remember Synthane. It will give you a real sense of satisfaction to know whether the job can be done, how it can be done, how long it will take to produce and how much it will cost. Synthane Corporation, Oaks, Pa.

SYNTHANE TECHNICAL PLASTICS · **DESIGN · MATERIALS · FABRICATION**

SHEETS · RODS · TUBES · FABRICATED PARTS · MOLDED MACERATED · MOLDED LAMINATED

SYNTHANE

AND NOW... the General Electric

INTRA-TEL SYSTEM

Television by wire for business, education and industry

The G-E Intra-Tel system can make a store the show place of a community. With it, it will be possible to televise and transmit living pictures throughout the store and in display windows. It is a new sales power that will increase customer traffic on every floor and in every department.

From the television laboratories of General Electric has come a powerful new selling aid for business, a dynamic medium for education, an effective tool for industry. It is G-E Intra-Tel—a television-by-wire system that can carry high-quality pictures and sound and reproduce them anywhere within the range of the system.

● Intra-Tel has great potentialities. In merchandising it can increase store traffic. With an Intra-Tel system dynamic demonstrations can be displayed simultaneously on every floor and in show windows. In education, the Intra-Tel system can bring special demonstrations, lectures, and motion pictures to every classroom. In industry the Intra-Tel system can provide the means for coordinating activities throughout a plant, observe production progress, to peer into inaccessible places or to observe extremely hazardous operations. The Intra-Tel system uses no transmitter and its installation thus requires neither FCC license nor government approval.

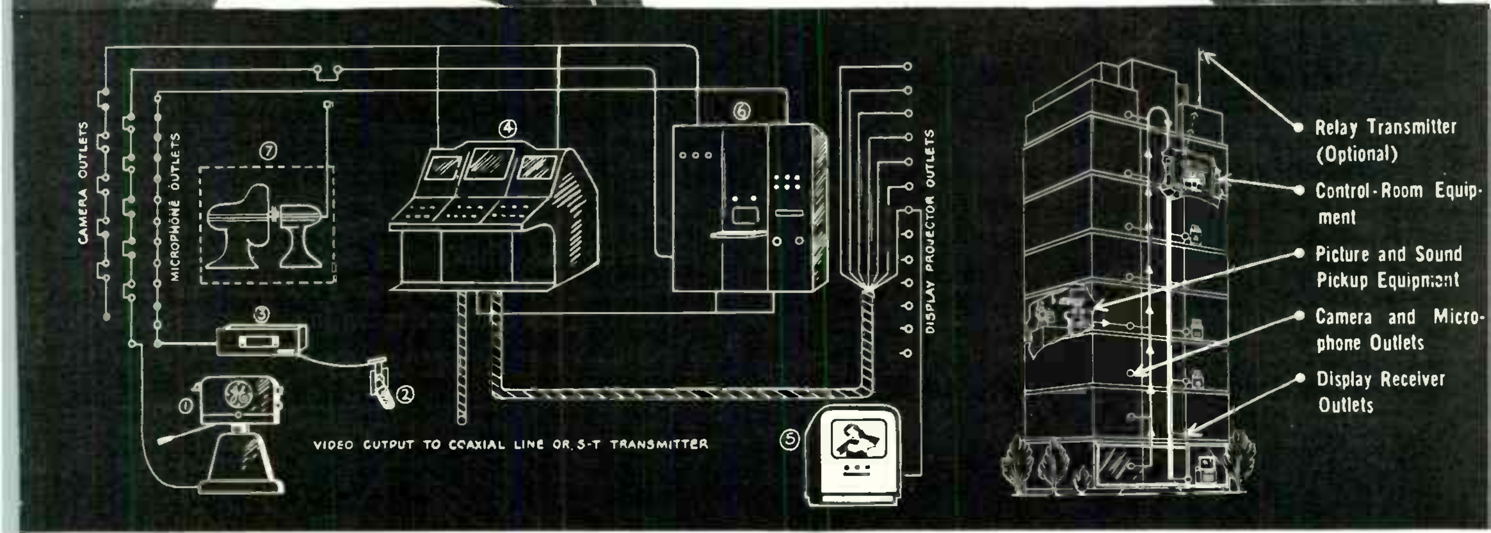
● A G-E Intra-Tel system includes one or more portable pickup cameras, one or more sound microphones, and a control and monitoring console. The entire system is designed so that both picture and sound are fed by cable to any number of home-type or display receivers. If desired, a motion picture projector and film pickup camera can easily be added to the system. Provision can also be made to link the system to any outside local television broadcast station by means of coaxial line or by radio relay.

● For details on G-E Intra-Tel systems and television broadcast systems, see your G-E broadcast equipment representative, or write for the booklet "Television Broadcasting Post-War," *Electronics Department, General Electric, Schenectady 5, N. Y.*

STUDIO AND STATION EQUIPMENT • TRANSMITTERS

GENERAL ELECTRIC

156-D1-6012



A typical G-E Intra-Tel system. With the Intra-Tel system, portable television cameras and sound microphones can be operated from any place in store or plant. Pictures and sound picked up by cameras (1) and microphone with microphone amplifier (2) and (3) are fed by cable to the control and monitoring console (4). Outlets at the console make it possible to feed picture and sound signals by cable to any number of display receivers (5). Amplifiers and pulse generator (6) maintain signal levels and synchronize scanning, respectively. Film projector (7) is used for motion pictures.

Plan to visit General Electric's great television proving ground — WRGB at Schenectady. Every Wednesday and Friday are "open house" days. Write for the folder, "How to get to Schenectady," or see your local G-E broadcast equipment representative.

Establish a delivery priority now on your future television equipment. General Electric offers you the "G-E Television Equipment-Reservation Plan." Write for your copy. It explains how you can assure yourself early delivery of your television equipment.

Hear the G-E radio programs: "The World Today" news, Monday through Friday, 6:45 p.m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p.m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p.m., EWT, CBS.

ANTENNAS • ELECTRONIC TUBES • HOME RECEIVERS

FM • TELEVISION • AM

See G.E. for all three!

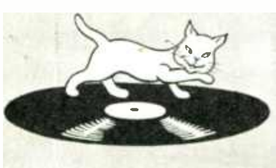
"The following is electrically transcribed..."

on PRESTO discs!

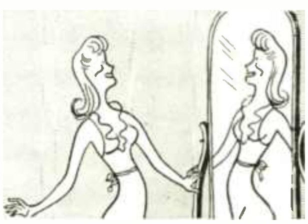
To any modern youngster or her Mommy, the Super Suds jingle is as familiar as the works of Mother Goose. In two years, this merry snatch of song has proved itself a commercial with "super-do"—lilting its way into the musical memory of America, and, incidentally, selling a whacking big heap of suds.

Super Suds "spots" are cut on PRESTO discs. *Most important transcriptions are.* For recording engineers know that PRESTO discs give finer results with less margin for error—*actually perform better than most of the recording equipment on which they are used.* That's why you'll find, in most large broadcasting stations, recording studios and research laboratories, the standard recording disc is a PRESTO.

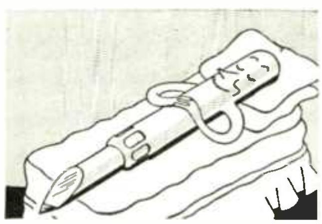
WHY BROADCASTING STUDIOS USE MORE PRESTO DISCS THAN ANY OTHER BRAND



Less Surface Noise



No Distortion



Easier on Cutting Needle

No Fussy Needle Adjustments

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

PRESTO

RECORDING CORPORATION

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

Walter P. Downs Ltd., in Canada

FROM COMPONENT...TO COMPLETE STATION

A vital link in a long chain of equipment . . . from microphone to antenna . . . the lead-in cable plays an important part in dependability of operation.

Federal's Intelin Cables *are* dependable. They've proved that in broadcast and military installations all over the world . . . standing up under severe operating conditions . . . in all kinds of climate.

And that's typical of *all* Federal broadcast equipment. From lead-in cable to complete station, it has earned a reputation for *performance* because it's *built to stay on the air*.

Amplitude Modulation, Frequency Modulation, and Television . . . for quality, efficiency, dependability . . . look to Federal for the finest in broadcast equipment.

FEDERAL FTR TELEPHONE & RADIO

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE, Newark 1, N. J.

Unfailing Dependability

TURNER 99 DYNAMIC

The most rugged microphone in the entire Turner line. Engineered and built for the discriminating user who wants utmost efficiency and dependability. Available as No. 999 with Balanced Line features for critical applications. Write for complete specifications and details.

Built to stand up and deliver under the most difficult acoustic and climatic conditions, Turner Microphones are "sound" instruments of rugged dependability. For indoor or outdoor use in arctic cold, desert heat or tropic humidity, they're precision engineered to give crisp, clear transmission of any sound, with all gradations of tone and volume faithfully reproduced without distortion or blasting.

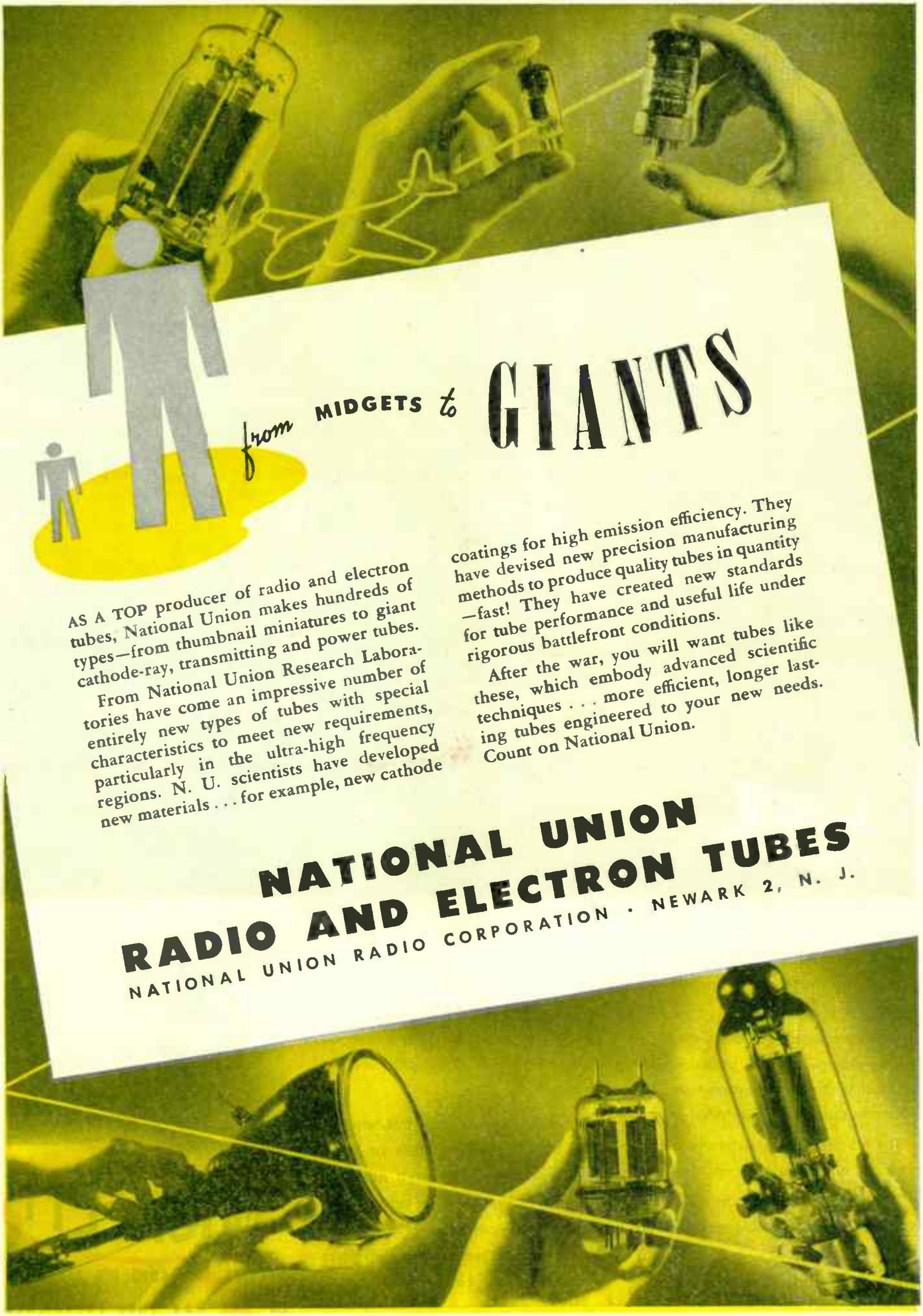
In every theater of military operations—on land, on sea, and in the air—in critical P.A., recording or broadcast work—wherever accurate transmission of voice, music or any sound is vital, Turner Microphones set the standard for unfailing performance.

The TURNER Company
Cedar Rapids, Iowa

There is a Turner Microphone for every electronic communications application. Get the complete Turner story from Turner engineers. Write for Free Illustrated Catalog giving details and specifications on all Turner Microphones for recording, P. A., amateur or commercial broadcast work. Write today.

Turner Microphones

TURNER—Pioneers in the communications field


from MIDGETS to GIANTS
AS A TOP producer of radio and electron tubes, National Union makes hundreds of types—from thumbnail miniatures to giant cathode-ray, transmitting and power tubes.
From National Union Research Laboratories have come an impressive number of entirely new types of tubes with special characteristics to meet new requirements, particularly in the ultra-high frequency regions. N. U. scientists have developed new materials . . . for example, new cathode coatings for high emission efficiency. They have devised new precision manufacturing methods to produce quality tubes in quantity —fast! They have created new standards for tube performance and useful life under rigorous battlefront conditions.
After the war, you will want tubes like these, which embody advanced scientific techniques . . . more efficient, longer lasting tubes engineered to your new needs. Count on National Union.
NATIONAL UNION
RADIO AND ELECTRON TUBES
NATIONAL UNION RADIO CORPORATION · NEWARK 2, N. J.

BLAW-KNOX and the voice of radio

Blaw-Knox Towers have played an important part in radio since the early days of Marconi. Most Radio Towers*, here and abroad, are of Blaw-Knox design or manufacture. Blaw-Knox's importance in military electronic development cannot now be disclosed.

What Blaw-Knox means to radio, it means to many other industries. If you are concerned with modern methods for converting raw materials to usable products by chemical or mechanical means, or solvent recovery . . . or any ramification of industrial processing, Blaw-Knox can carry on from pilot plant to full scale production.

Blaw-Knox can serve in other ways: with prefabricated piping, equipment for the steel industry and a broad line of construction equipment, to name a few. Let us discuss your problems with you—at your convenience.

*The Tower is an essential part of the voice of radio. Blaw-Knox Towers (some over 1000' high) are used for broadcasting, communications, navigation, television, facsimile, police work . . . as well as for undisclosed electronic purposes.

BLAW-KNOX COMPANY

A Pacemaker for American Initiative and Ingenuity

2046 Farmers Bank Bldg., Pittsburgh, Pa.

LEWIS FOUNDRY & MACHINE DIVISION, Rolls and Rolling Mill Machinery

POWER PIPING DIVISION, Prefabricated Piping Systems

COLUMBUS DIVISION, Ordnance Matériel

SPECIAL ORDNANCE DIVISION, Bofors Anti-Aircraft Gun Mounts and Mechanisms

BLAW-KNOX DIVISION, Chemical & Process Plants & Equipment, Construction Equipment, Steel Plant Equipment, Radio & Transmission Towers . . . General Industrial Products

PITTSBURGH ROLLS DIVISION, Rolls for Steel and Non-Ferrous Rolling Mills

UNION STEEL CASTINGS DIVISION, Steel and Alloy Castings

NATIONAL ALLOY STEEL DIVISION Heat and Corrosion-Resistant Alloy Castings

MARTINS FERRY DIVISION Bofors Anti-Aircraft Gun Mounts

BLAW-KNOX SPRINKLER DIVISION Automatic Sprinklers and Deluge Systems

A FEW VICTORY PRODUCTS

ANTI-AIRCRAFT GUN MOUNTS · GUN SLIDES · LANDING BARGES · SYNTHETIC RUBBER PLANTS · PIPING FOR NAVAL VESSELS · POWDER PLANTS · ROCKETS · 16" PROJECTILES · CAST ARMOR FOR TANKS & NAVAL CONSTRUCTION · CHEMICAL PLANTS

A BASICALLY NEW IDEA IN FM TRANSMITTERS...

PLUS ALL THE EXTRAS OF SPECIAL WESTINGHOUSE RESEARCH FOR FM

Here in a smartly-styled package is a basically new approach to FM transmitter design . . . combined with all the performance extras of special Westinghouse research for frequency modulation.

Built in 1, 3, 10 and 50 kw ratings, this new design provides direct generation of the modulated carrier by a simple and straightforward circuit. Frequency corrections are independent of critical tuning. Distortion is low.*

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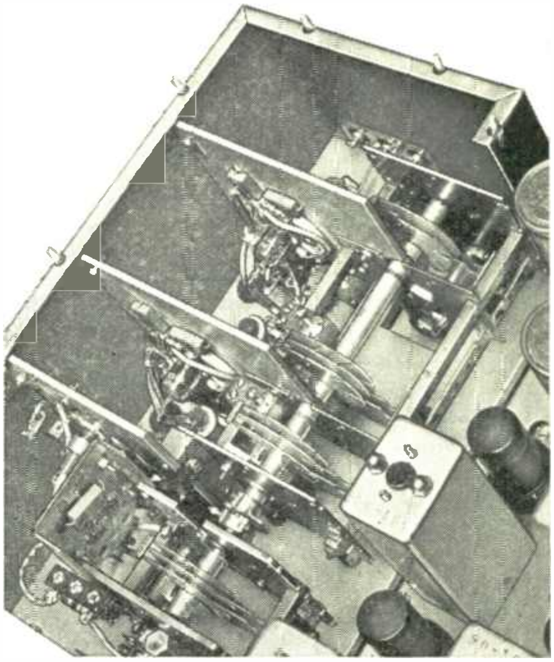

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OPPOSING VIEWS ON LOWER TELEVISION CHANNELS

Question of Permanence of "Temporary" Channels Raised at Oral Argument before FCC

DU MONT BRIEF

FOLLOWING is the text of the brief presented at the Oral Argument on frequency allocations by Thomas T. Goldsmith, Jr., Director of Research for Allan B. Du Mont Laboratories, Inc. Only the introductory remarks have been omitted:

Thirteenth Channel ★ We request that the channel from 102–108 mc. be definitely assigned to television at the present time. While 12 channels will provide for a limited competitive commercial service, the addition of the 13th channel will be of further assistance. Furthermore, it will be developed along lines probably capable of including all of these 13 channels, and assure ready adaptation to include other channels between 84 mc. and 180 mc.

Future Expansion ★ The Federal Communications Commission should take such steps as are practical to earmark additional 6-mc. channels in the region between 84 mc. and 180 mc., to be released by other services when no longer required, and to be then assigned to television service as the commercial television service demands further expansion.

Adequate 6-mc. television broadcast allocations will be provided if eventually television occupies the entire spectrum between 44 and 216 mc., but this entire spectrum can be assigned as needed by normal expansion of the service having begun with the present 12 proposed channels.

VHF Broadcasting ★ As to Frequency Modulation broadcasting, the range from 84 to 102 mc. can probably be incorporated in television receiver designs to provide both television reception and frequency modulation sound broadcast reception. Then as television commercial operation expands it can, if necessary, absorb these Frequency Modulation sound broadcast channels if that service no longer receives public demand in view of the superior television service providing both sight and sound.

There has been some discussion that the region of the spectrum from 84 to 102 mc. may not prove sufficient to accommodate all the channels which may be requested for very high frequency broadcast service. If this inadequacy of spectrum is seriously anticipated, we recommend that the very high frequency broadcast people change at once from the wide band frequency modulation specifications requiring 200 kilocycles per station (and in practice possibly requiring even 400 kc. per station in a given area) to a system requiring narrower channels per station in the manner proposed in the following paragraph.

For very high frequency broadcasting, employ amplitude modulation with an assigned channel width per station of 40 kc. Make these frequency assignments in the region of the spectrum from 84 to 102 mc. as presently proposed in the Federal Communications Commission allocation plan. Allow each station for VHF broadcasting to use as much power as it wishes. With this plan of assignment it should then be possible to provide each applicant for a broadcast station with a substantially clear channel. In this way, 450 clear channels will be provided, and with characteristics of propagation in this region of the spectrum it is very probable that duplicate assignments might still be made in widely separated portions of the United States, still allowing unlimited power. From our experience with operation of amplitude modulation transmission and Frequency-Modulation transmission for the sound channel on a carrier frequency of 83.75 mc., we are thoroughly convinced that the narrower band amplitude modulation can provide an excellent broadcasting service.

We are recommending that the Federal Communications Commission allocation with regard to very high frequency broadcasting stay where it is in the proposed allocation plan, but suggest that consideration may be given to a respecification of the type of service if the proponents of wide band FM broadcasting do not feel that the proposed Federal Communications Commission allocation plan provides sufficient channels.

If the available spectrum for very high frequency broadcasting proposed in the Federal Communications Commission allocation plan should prove inadequate to accommodate all qualified applicants, then it would be wise to plan a division of the channels so as to accommodate both FM and AM in this region of the spectrum between 84 mc. and 102 mc. Applicants desiring to carry on broadcasting using amplitude modulation could be assigned a portion of this spectrum, say 6 mc. wide. Each station could be allocated 40 kc. and thus provide for a total 150 channels for very high frequency amplitude modulation broadcasting. There would yet remain of the total of 18 mc. an amount of 12 mc. allocated to Frequency Modulation broadcasting providing 60 FM channels. Thus, those persons desiring to broadcast by Frequency Modulation may continue that type of broadcasting. However, those persons desiring to broadcast amplitude modulation may be permitted to do so, and a total of 210 broadcast channels could thus be provided.

Television At 50 Mc. Rather Than FM ★ Television service in the region from 44 to 48 mc. is more sound technically than Frequency Modulation sound broadcast service in this same region of the spectrum. Television operates fundamentally with a higher signal level at the receiver due to the much broader band characteristics of its signals. Although a higher ratio of 100 to 1 for received signal to interference signal is specified as protection for television than the ratio of 10 to 1 protection for Frequency Modulation sound broadcasting, it is nevertheless true that television can tolerate occasional long distance sporadic signals more readily than Frequency Modulation sound broadcasting. For example, a television receiver may operate on the 500-microvolt contour of a

TELEVISION, as well as FM, has its upstairs vs downstairs problems, though they are of a different nature. Television has been assigned twelve 6-mc. channels between 44 and 216 mc., and twenty-two 20-mc. channels in a solid block from 480 to 920 mc. One school of thought believes that an adequate, national service, of acceptable picture quality, can be established downstairs in the immediate postwar period. Another holds that 6-mc. picture quality will not satisfy the public, and that any use of downstairs frequencies, during the time required to put 20-mc. pictures on the air, should be announced as being only an interim effort. These two schools of thought are represented in the Du Mont and CBS briefs filed for the FCC's Oral Argument on the proposed frequency allocations.

broadcast station. An interfering station on the same channel located at such a distance that occasional sporadic interference is possible, may put in a signal strength of 100 microvolts. The television receiver would be disturbed for that short interval of interference but the desired station would still come through with some degradation. On the other hand, if an FM receiver was operating on the fringe of its service contour with a field strength of 50 microvolts, then a distant interfering station with a sporadic signal strength of 100 microvolts would make it impossible for the FM receiver to receive any intelligible signal from the desired station.

Furthermore, FM stations, with their relatively narrow band width, can be designed to radiate effective powers of hundreds of kilowatts while television stations with their broad band characteristics probably would be limited to the order of tens of kilowatts. Thus, there is much greater likelihood of the FM stations providing long distance high level occasional interfering signals. Also, if any FM stations are assigned in the region near 50 mc. then *all* would probably be assigned in this region, making all FM stations susceptible to this sporadic interference. Television would have only a few of its channels in this region and susceptible to this sporadic interference.

Consideration should be given to the effects of multipath and shadow. Past experience with television picture transmission and associated FM or AM sound transmission has shown that multipath effects are more serious on the picture channel than on the sound channel. This would be expected theoretically, since the picture channel cannot resolve relatively short intervals of time of a few microseconds which are characteristic of multipath. Since picture channels are susceptible to this multipath transmission, it would seem wisest to keep the television channel assignments in the lower part of the frequency spectrum. Operating experience has been had on broadcasting between 44 mc. and 84 mc. for picture transmission, and the multipath problems have not been too serious although they are present in some receiving allocations. We do not anticipate any serious conditions because of multipath in the commercial broadcast use of the spectrum for television up to 216 mc. Nevertheless where there is a choice between sound broadcasting and television broadcasting for use of the frequencies between 44 and 84 mc., then television should be assigned this region in preference to assigning it to sound broadcasting, since the sound broadcasting can as readily use a higher frequency without probable extensive difficulties from multipath phenomena. Certainly, if sound broadcasting utilizes narrow band amplitude modulation, very little difficulty will be experienced for multipath conditions on frequencies around 100 mc.

Therefore, if it is a choice in the spectrum between 44 and 84 mc. whether FM or television should be assigned in this region, it is obvious that television should get the assignment.

Shared Channels ★ It is proposed by the Commission in the allocation plan that certain of the services may be able to use television frequencies on a secondary basis by a space-sharing plan, wherein the other services occupy television channels adjacent to those used for television in given areas. There is a chance that this plan of sharing may have some merit. However, I would urge strongly that the Commission make it perfectly clear in the channel allocation that television is to have the primary use of the 12 channels. With only 12 channels available for this commercial service, it is imperative that the fullest use be made of these channels in accordance with a carefully drawn up national plan for television. Other services should be allowed to use these adjacent channels only on the basis of non-interference with currently installed existing television stations and with probable future television stations for the area in question.

Television Experimentation ★ We feel that the present proposed allocation for television experimentation between 480 and 920 mc. is adequate for such experimentation and should be retained on an *experimental* basis.

Television Relay ★ The provisions made for television relay services are adequate for presently anticipated requirements and we feel that should further requirements prove necessary, they can be adjusted in view of the relative merit of such relay services as compared with other services at such a time when they should be necessary.

Permanence of Channels ★ We urge that the Federal Communications Commission more strongly clarify the permanence of the 12 commercial 6-mc. television channels. We feel that these channels are going to be used on a permanent commercial basis and that official statement from the Federal Communications Commission to the effect that they will remain assigned for this purpose over a period of at least 10 years is necessary to safeguard both manufacturers and the public with regard to their investment in such a commercial service.

CBS BRIEF

THE CBS brief discussed FM and subscription broadcasting, as well as television. The following text presents the part concerning television and is complete except for the introductory analysis of opinions as to the technical advantages of television transmission in the 480- to 920-mc. band:

"Good-Enough" Television ★ We may confidently expect after the war somewhat better television, even on the low-definition standards, than was available to the public before the war. Tube and receiver improvements, as well as improvements in studio design and operation, will produce pictures in the home which will have more brilliance and contrast and be less subject to distortion, and pictures which are consequently more easily projected and enlarged.[1]

After giving full weight to these considerations, however, it is submitted that a television service on prewar standards, which confine the television picture in the straitjacket of low-definition, will not attract and hold an audience large enough to "put television across". The need for radical and fundamental improvement is obvious from the following significant facts:

(a) Only 7,000 television sets were sold in an area containing 3,000,000 homes during nearly two years of prewar broadcasting.

(b) Less than 40,000 sets were sold in England during the three-year period of daily television broadcasting.

(c) Present television pictures are, by direct mathematical and optical comparison, less detailed than a crude home movie.

(d) The majority of independent stations affiliated with the CBS network do not believe present television pictures are good enough to be viewed for more than one hour without eyestrain, or good enough to sell sets in large quantities.

Further, there has been evidence that, before the war, families who bought television sets used them less and less after the first novelty wore off.

Good programming is an essential prerequisite to wide popular acceptance of television. But, broadcasters — and the public — have a prime interest in seeing that the technical standards of television are set high, because good programs cannot win popular acceptance if the programs sharply deteriorate between the studio and the receiving set. Technical advancement, making possible more flexibility and creativeness in the operations

[1] These collateral improvements will, of course, be as equally applicable to high-definition television as to low-definition television.

of program producers, will free the art from many of its present limitations.[2]

Better Television Can Be Realized ★ Columbia proposed the better television in April, 1944. Today, less than a year later, there appears to be unanimous agreement that the better television will be proved. The Commission has said in its Report:

"The Commission is fully convinced that by virtue of the recent developments in the electronic art, a wide channel television broadcasting system, utilizing frequencies above 400 mc., can be developed, and the transmission of higher definition monochrome pictures and high-definition color pictures achieved."

The only question still debated is, "When can the new television be demonstrated and proved?"

Opponents of the better television say — not before a minimum of five years. Columbia says — within one year after manpower and materials are fully available, and possibly before the end of 1945.

The better television will be brought to the public at an early date if a substantial part of the television industry co-operates competitively in the development of the new system and in the field-testing and the fixing of new standards.

Fords and Frigidaires ★ The opponents of "better television now" have said, in effect, "Where would the automobile industry be if the Model T had been held off the market because a better car was in the offing, or the modern mechanical refrigerator if millions of its cruder counterparts had not first been sold?"

This type of argument is based on two fundamental misrepresentations:

(a) Columbia has not said and does not say that present television should be stopped or that sets manufactured to receive the prewar standards should be withheld from the public.

(b) The comparison with Fords and Frigidaires completely ignores the lock-and-key relationship which is the essence of television broadcasting.

Today, nearly twenty years after the last Model T was built, some of them are still on the road and providing their owners with transportation. Likewise, some of the earliest mechanical refrigerators are still giving service. In television, however, as soon as the postwar, high-definition television is proved and the broadcasters change their transmitters so as to provide the new and better service, every low-definition set which has been bought by the public will become completely obsolete and useless. Each low-definition television receiving set will then be a lock without a key, because the necessary complement to the receiver — the signal from the low-definition transmitter — will be missing.

Dual Operation No Solution ★ This lock-and-key relationship presents the dilemma of a public which may have bought television sets made on the old standards in the expectation that such sets will provide them with years of television service. No one could lightly contemplate the overnight destruction of the public's investment at a time when, say, 1,000,000 old-standard sets had been sold.

In order to protect this possible public investment, it has been suggested that television broadcasters who are licensees of low-definition stations at the time new standards are adopted, continue for a number of years their operation of the low-standard transmitters in simultaneous service with their high-definition transmitters. It is possible that, from the standpoint of the public, dual operation may be a satisfactory solution if there should be very substantial public investment in low-definition television, such as might be represented by the purchase of 1,000,000 low-definition sets. It is submitted, however, that such a solution will lead to the following results:

(a) It will tend toward the doubling of costs of broadcasters charged with the dual operation.

(b) To the extent that broadcasters attempt savings by utilizing the same programs for both services, dual operation will either limit the program potentialities of the new standards or result in unsatisfactory old standards of transmission.

(c) The prospect of a requirement of dual operation will cause those interested solely in broadcasting to hesitate before entering into television until the new standards are adopted and the threat of the burden of dual operation has been removed.

The above predicament may be avoided if (a) broadcasters and manufacturers concentrate their efforts now to bringing the better television to the public as quickly as possible, a course which Columbia has consistently urged, and (b) the public be kept fully informed as to the nature of their investment in low-definition sets.

Public Should Be Informed ★ Columbia interprets the Commission's proposed allocation of frequencies for television as assigning the narrow-band, low-definition channels in the lower frequencies to television on a temporary basis — and we believe that the substantial and expanding needs of other services for frequencies in this portion of the spectrum will sooner or later require the use of the frequencies presently proposed for the low-definition television.

The Commission has found that:

(a) No more than 12 channels below 300 mc. can be assigned to television if the minimum needs of other services are to be met.

(b) Sky-wave interference may be a problem with television on the lower frequencies.

(c) High-definition television, both in black and white and in color, can be achieved on frequencies above 400 mc.

(d) The development of the upper portion of the spectrum is necessary for a truly nation-wide and competitive television system.

(e) Even as to the 12 low-definition channels proposed, 11 are to be shared with other services and one channel (No. 5) will not be available to television for a number of years.

At the press conference held on January 15, 1945, Commissioner Jett, in discussing the problem of interference in the lower frequencies proposed for television service, and comparing the problems of interference between FM and television in this portion of the spectrum, stated: "FM is to be started and developed as a permanent broadcasting service for the future . . . we are encouraging the development of television above 480 mc. We fully expect after a number of years that the truly competitive operations in this country will be in the bands above 480 mc. Therefore, of the two services, when you consider that we must select between one and the other, the 6-mc. television service will be of a temporary character. . . . Therefore, the service that is temporary in character should take the interference, not the one that will be with the public throughout the entire future."

Notwithstanding the findings of the Commission and the clarification provided by Commissioner Jett, the proponents of low-definition television have publicly interpreted the Commission's Report as giving the "green light" to this prewar system.

If we are to avoid:

(a) a sudden destruction of future large public investment in low-definition television sets, made in good faith with the expectation of long-term usefulness, when television broadcasters change over to high-definition transmission under new standards, and

(b) the risk that the better television may be indefinitely, or permanently, postponed because of the weight of this public investment,

the public should be kept clearly, fully and frankly informed. This does not mean, and Columbia has never proposed, that

(CONTINUED ON PAGE 85)

[2] The present low-definition standards require close-ups or waist-shots to convey facial expression on the receiver screen. The televising of group activities, whether dramatic, musical or in discussion groups, must now be interrupted by frequent individual close-ups, with consequent loss of pace and sense of unity.

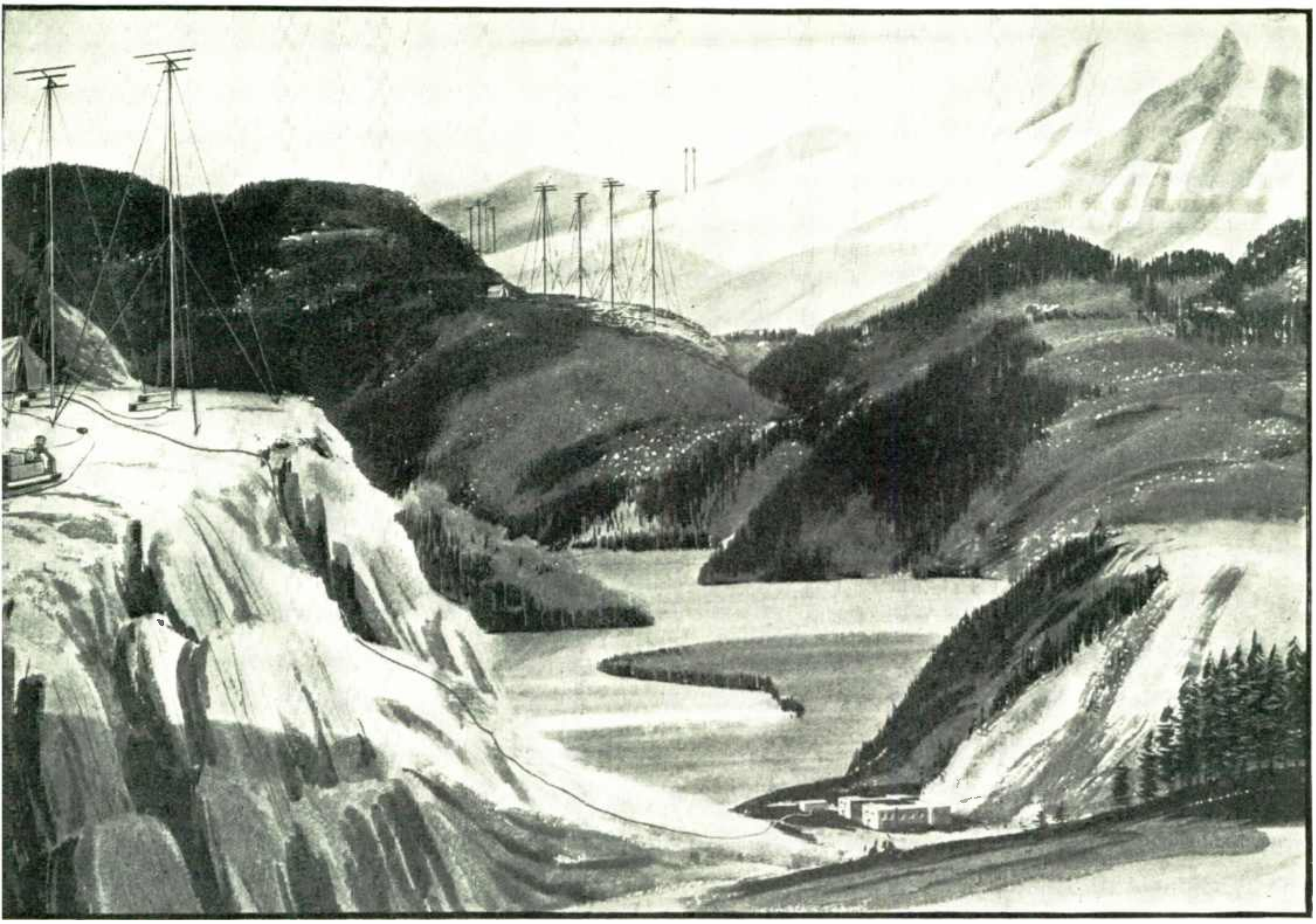


FIG. 1. EXAMPLE OF AN FM LINK INSTALLATION IN THE EUROPEAN THEATRE, SHOWING TERMINALS AND TWO RELAYS

HOW FM LINKS ARMY WIRE SYSTEMS

Description of Equipment Which Has Played an Outstanding Part in the European Campaign

BY LIEUT. ROBERT W. EHRLICH*

BEHIND the lines of our advancing armies, it is the job of the Signal Corps to install, operate, and maintain a vast system of communications networks, over which flow the messages that keep the armies functioning. These circuits must handle an extremely heavy load of traffic over long distances yet they must be installed with a minimum of time and personnel. One answer to this problem has been the development of spiral-four cable, a 4-wire cable that can handle 4 two-way telephone conversations simultaneously and can be installed at the rate of 3 to 5 miles per hour by a few men in a truck. However, there are certain areas such as swamps, jungles, and water barriers over which it is extremely dangerous if not impossible to install cable or pole lines. Here, FM radio links are called upon to complete the military communications system.

*FMSCPA Building 779, Fort Monmouth, N.J.

A feature of the FM radio link is the speed with which it can be installed. Radio equipment can be carried to advanced positions as fast as vehicles can transport it and, in a matter of minutes, reliable telephone communication can be established with the rear. Through its speed of installation, the FM radio link has helped to make it possible for large army units to be coördinated in their rapid forward sweeps.

The Army's radio link equipment is just what its name implies: radio equipment specifically designed to be used as a link in wire systems. The wire lines are connected directly to the link equipment, and the signals relayed by radio, up to approximately 25 miles. In order to have two-way communication, a receiver and a transmitter are required at each terminal, with a separate carrier frequency for each direction. Where longer distances are involved, relay stations may be used, as shown in Fig. 1. At each relay station, two sets of receivers and transmitters are required, and a new pair of frequencies is assigned to each leg of the relay.

Requirements of Link Circuits ★ The development of radio link equipment has called for a great deal of ingenuity on the part of the designers in order to meet the specialized requirements of this type of service. It is the purpose of this article to discuss the many design factors involved, and to show how the problems were met.

One of the foremost requirements of any communications system is that it transmit the incoming signal with sufficient fidelity, so it is of interest to investigate the type of signal that the equipment

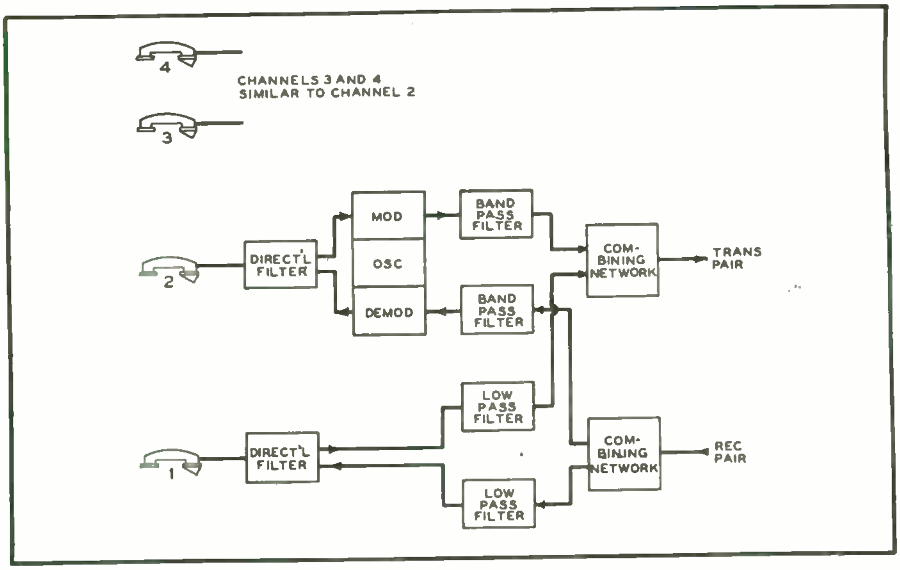


FIG. 2. HOW FOUR CONVERSATIONS ARE PUT ON A SPIRAL-FOUR CABLE

will be called upon to handle. Radio link is normally used in conjunction with spiral-four cable which, in turn, is usually connected to 4-channel carrier equipment at the terminals of the line. The use of carrier makes the most effective use of the capabilities of the cable, but it imposes severe requirements on the radio link equipment.

Fig. 2 shows, in block form, how the carrier equipment puts four telephone conversations on a four wire cable. Each telephone is connected to a directional circuit which separates incoming and outgoing signals. The outgoing signal from Telephone No. 1 is sent through a simple low-pass filter, so that it is restricted to frequencies below 2,800 cycles. The signal from Telephone No. 2 is heterodyned against a local oscillator, operating at 5,900 cycles, in a modulator unit.

The output of the modulator is fed through a band-pass filter which eliminates the oscillator frequency and the upper sideband frequencies, leaving only the lower sideband frequencies from 3,100 cycles to 5,700 cycles. In a similar manner, the outgoing signals on channels 3 and 4 are heterodyned against local oscillators to produce new bands of frequencies from 6,050 to 8,650 cycles and 9,000 to 11,600 cycles respectively. Therefore, the signals which go down one pair of wires contains frequencies as high as 11,600 cycles. Signals to be received come back on the other pair of wires and are put through the reverse of the process just described before being fed to the individual directional circuits and thence to the telephones. Both pairs of wires in a spiral-four cable may be expected to carry signals at the same time; therefore, the primary requisite of a radio relay system is that it be capable of transmitting and receiving signals simultaneously, with a flat audio response up to approximately 12,000 cycles.

Aside from wide-band audio characteristics, there are many other requirements of a successful military radio relay system. One of these requirements is low noise level, to keep static and man-made interference from hindering the communication. Privacy is also important, for it is not healthy to broadcast information over a wide area where it can be picked up by the enemy.

Another important characteristic that must be built into military radio equipment is ruggedness and inherent frequency stability. Since equipment takes a tough beating as it is transported from place to place, it must be designed to take the shocks, go on the air on the right frequency when it is set up, and then stay on that frequency over long periods and under all climatic conditions. Other desirable features include ease of transportation and installation, and simplicity of operation.

Successful Operation on FM ★ The selection of a Frequency Modulation system led to a solution of many of the problems confronting the designers of radio link equipment. First of all, it can carry the higher modulation frequencies without any increase in the normal channel allotments given to FM. Second, the low noise level in an FM system makes it desirable for relay work. Third, the high FM carrier frequencies make practical the use of directional antennas, thereby giving increased signal gain in the desired direction while, at the same time, giving more privacy by restricting the signal angle and range.

Moreover, FM circuits employing phase-shift modulation, with a crystal in the oscillator, impart the inherent frequency stability required in this service. The deviation in frequency brought about by phase modulation is very slight, so it is necessary to use many stages of frequency multiplication in order to bring the frequency deviation of the emitted signal up to the required point. Frequency multiplication involves extra tubes and circuits, but the disadvantage of additional tubes is more than offset by the advantage of crystal stability. Therefore, a phase-shift system was selected by the designers of the equipment.

The compactness and portability of the actual equipment is evident from Figs. 3, 4, and 5. The entire assemblage of equipment necessary to maintain a terminal

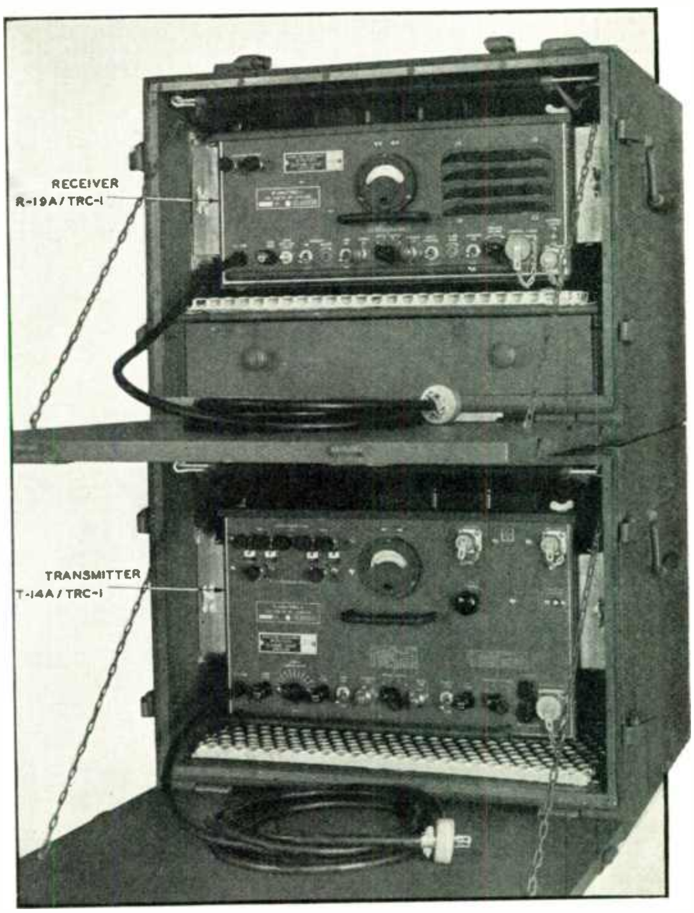


FIG. 3. COMPLETE FM CARRIER TRANSMITTER AND RECEIVER

station on 24-hour service is called a Radio Terminal Set AN/TRC-3, while the same equipment plus the additional receiving, transmitting, antenna, and power supply components for a complete relay station is called the Radio Relay Set AN/TRC-4. The equipment illustrated was developed and manufactured for the Signal Corps by the Link Radio Corporation, of New York. Similar equipment is being manufactured by Lear, Inc., Radio Division, of Grand Rapids, and the Rauland Corp., Chicago.

Details of Transmitter ★ A block diagram of the Link transmitter is shown in Fig. 6. Of particular interest are the unique crystal oscillator and phase-shift circuits. These are shown in detail in Fig. 7.

The oscillator operates at 1/96th of the carrier frequency. Carrier frequencies range from 70 mc. to 100 mc. in 100-kc. steps, so crystals are provided from 729.17 kc. to 1041.67 kc., in steps of 10.417 kc. For greatest stability, low-drift CT cut crystals are used, and the crystal in operation is enclosed in a temperature-controlled oven.

The oscillator circuit is aperiodic; that is, it operates at whatever may be the frequency of the crystal that is plugged in, without any further oscillator tuning adjustments by the operator. Feedback from plate to grid is obtained through the crystal, so oscillations take place close to the series resonant frequency of the crystal. Coil L_1 and capacitor C_1 resonate at a frequency above the highest oscillator frequency to be used, and together they control the feedback to produce stable oscillations over a wide range of crystal activity.

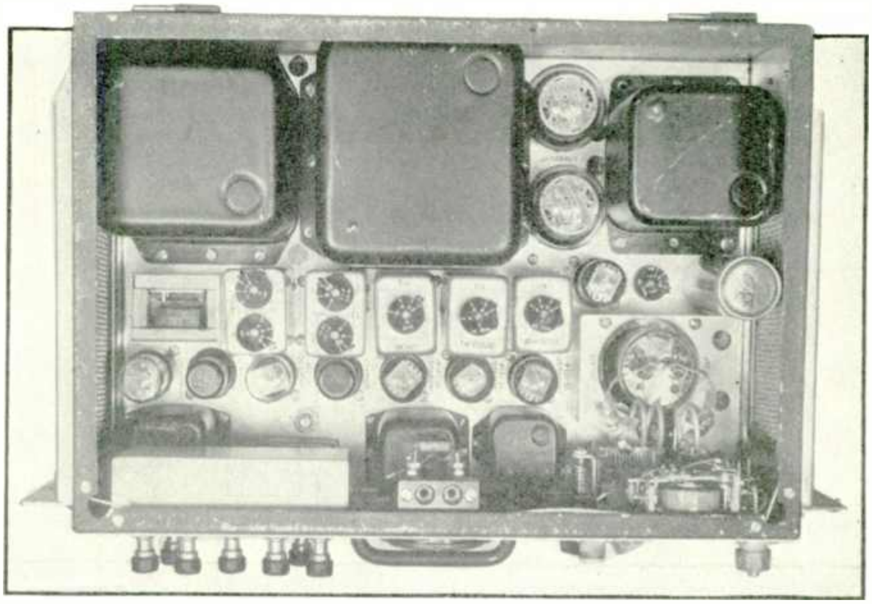


FIG. 5. INTERIOR OF THE 50-WATT TRANSMITTER SHOWS SIMPLE DESIGN

The output of the oscillator is small, and its amplitude varies as different crystals are used. To deliver a strong signal of constant amplitude, the oscillator output is fed through a limiting amplifier. This stage acts just like the limiter in an FM receiver, delivering constant output regardless of variations in input amplitude.

The phase-shift circuit used in this transmitter is particularly interesting because it employs only one triode section to accomplish its task. This triode is connected as an ordinary degenerative amplifier, with an inductance as the plate load and a 30,000-ohm cathode resistor to introduce the degeneration.

The action of the circuit is based on the fact that the voltage that appears across the plate coil is the resultant of two components. Electronic amplification pro-

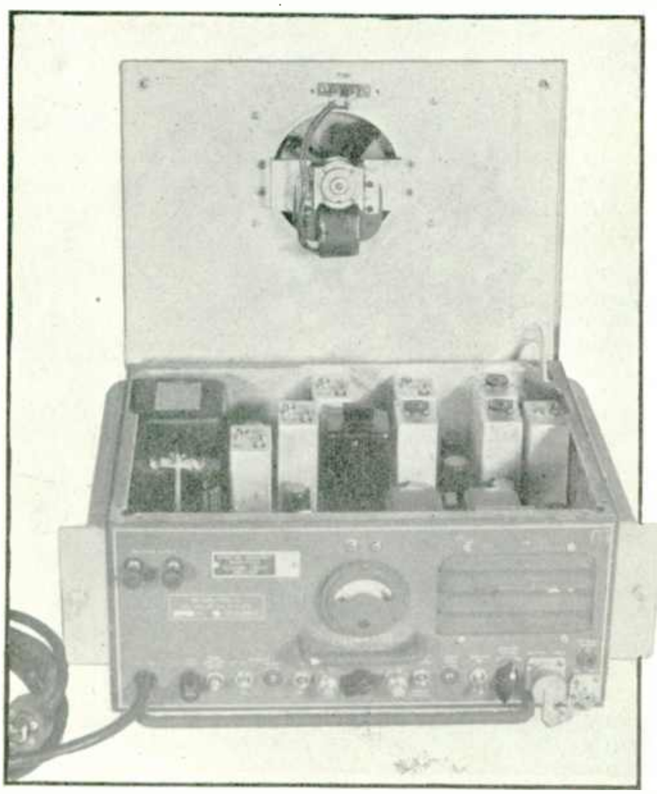


FIG. 4. THE RECEIVER, LEFT, AND THE TRANSMITTER, RIGHT, REMOVED FROM THE CARRYING CASES SHOWN IN FIG. 3

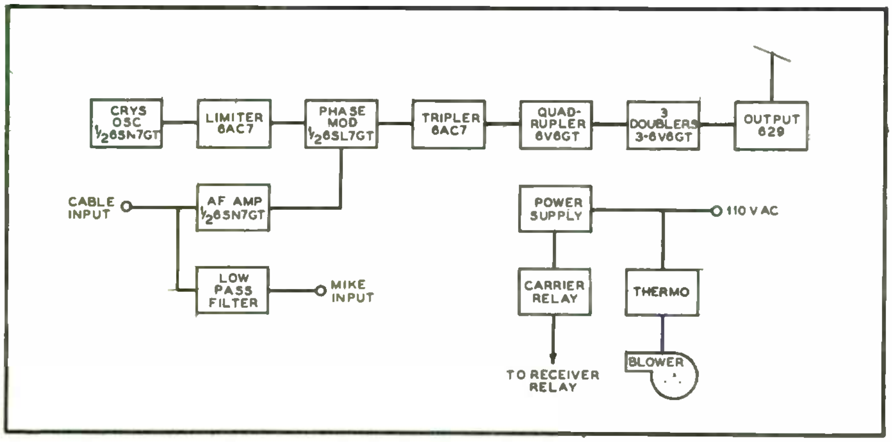


FIG. 6. BLOCK DIAGRAM SHOWING TUBE TYPES AND FUNCTIONS OF THE TRANSMITTER

duces a component that lags the grid voltage by about 90°. The grid-plate capacitance and the load inductance, acting in series, form a resonant circuit, thereby producing another component of voltage across the coil that leads the applied voltage by about 90°. Cathode degeneration and the proper choice of circuit constants keep the two components nearly equal and about 180° out of phase. They add vectorially as shown in Fig. 8 to form a small resultant.

Modulation of the phase of the resultant voltage is accomplished by the varying magnitude of the electronically amplified component. The dotted lines in Fig. 8 show how the phase changes when amplification is increased. The easiest way to change amplification is to change grid bias; therefore, the modulating voltage is simply introduced as a varying bias, through the isolation resistor R_{11}.

Modulation of the phase of an RF carrier wave is necessarily accompanied by a certain amount of frequency modulation. For a given phase deviation, the corresponding frequency deviation increases in proportion to the modulating frequency; and if no correction were made, higher audio frequencies would seem to be unduly emphasized in an FM receiver. To correct for this effect, the R-C filter R_9, C_6 is inserted in the audio circuit. With higher audio frequencies, a smaller audio voltage is applied to the modulator; and the resultant frequency deviation is independent of audio frequency.

The output of the modulator is of very small amplitude, and its frequency deviation is only a few hundred cycles. Accordingly, it is necessary to amplify the signal considerably and multiply its frequency many times to produce a strong signal whose frequency deviation approaches the desired value of ± 30 kc. The necessary multiplication is accomplished in four stages.

The first stage following the modulator is a high gain pentode, 6AC7, operating as a tripler. This tube gives sufficient gain

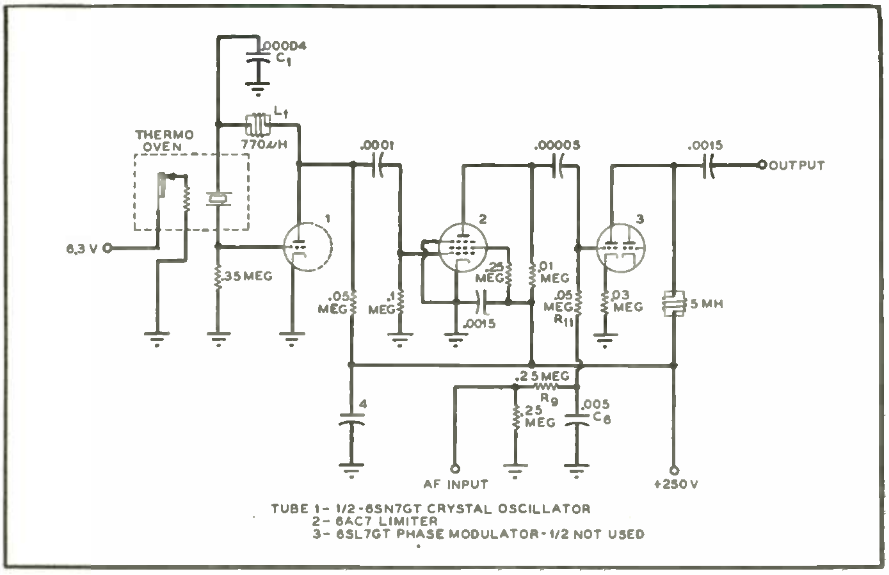


FIG. 7. CRYSTAL OSCILLATOR AND PHASE SHIFT CIRCUITS OF THE TRANSMITTER

to drive a 6V6GT quadrupler which, in turn, feeds a series of three 6V6GT doublers. To complete the RF chain, a type 829 tube is used as the final amplifier. This beam-power double pentode, connected in push-pull, delivers a nominal carrier power output of 50 watts.

There are several features of the audio circuit, shown in Fig. 9, which reflect the specialized requirements of a radio link transmitter. First of all, the audio system must be capable of uniform response up to 12,000 cycles. It is fortunate that virtually no power is needed to drive the phase modulator. This eliminates the need for a power stage, with its attendant frequency response problems. A simple resistance-coupled amplifier, using one triode section of a 6SN7GT, does the job.

When the radio link is connected in a wire system handling 4-channel carrier, it is to be expected that the audio input will consist of 4 independent signals, one on each of the 4 carrier channels. The normal signal level on the line is such that each of the signals has a level of 0 dbm.[1]

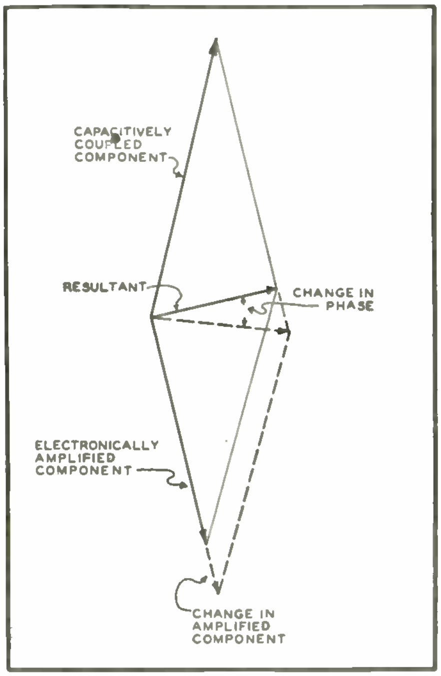


FIG. 8. HOW MODULATION IS ACCOMPLISHED

It is conceivable that all 4 signal voltages might reach peak value in the positive or negative direction at the same time. To prevent excessive modulation, the audio gain in the transmitter would have to be adjusted so that each signal alone could cause only 25% of the maximum permissible frequency deviation. Actually, the four signals never reach peak value simultaneously, so in practice the audio gain is adjusted to produce 30% of the maximum deviation (± 9 kc.) with a 0 dbm signal coming in on any one channel.

Although the signal level at the output

[1] *dbm* is a telephone term indicating that zero level is referred to 1 milliwatt.

of the telephone terminal or carrier equipment is always adjusted to 0 dbm, the attenuation in the miles of cable between the telephone terminal and the radio link will cause the input to the radio link to drop below this value. Accordingly, an audio gain control, called a cable compensator, is placed on the front panel for the operator. This control is calibrated directly in dbm, and the operator can compensate for cable loss by advancing it at the rate of about 0.8 dbm per mile of spiral-four cable.

To coördinate the operation of a radio link system, it is necessary that the operators have a means of monitoring the signal and communicating with each other. The band of audio frequencies comprising channel No. 1 is usually reserved for this purpose. The operator's microphone circuit is connected in series with the regular cable input transformer, and a low-pass filter is included in the microphone circuit to prevent interference on channels 2, 3, and 4.

The physical construction of the transmitter is designed for maximum reliability, convenience, and ruggedness. A thermostatically controlled exhaust fan keeps the temperature inside the case at a constant, low value. Tuning controls for the RF circuits are all accessible through the top of the cabinet or on the front panel; and a metering circuit, controlled by a switch on the front panel, enables the operator to tune up on a new frequency with no supplementary test equipment. Ceramic and mica capacitors are used throughout, with few exceptions, in order to provide trouble-free operation.

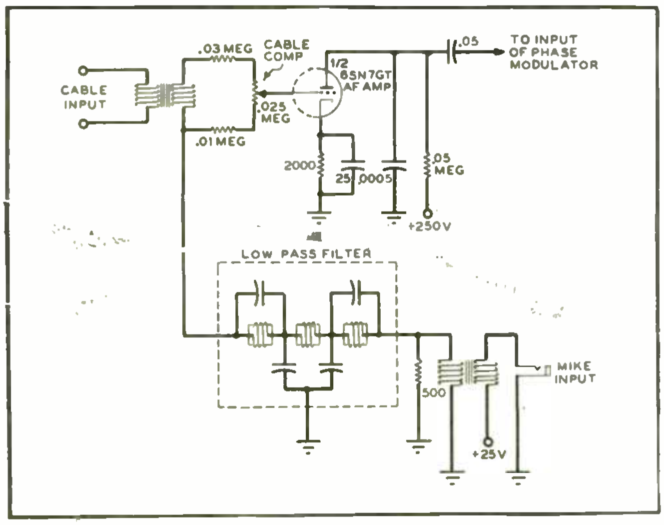


FIG. 9. AUDIO CIRCUIT OF THE FM CARRIER TRANSMITTER

Details of Receiver ★ Turning from the transmitter to the receiver, it is found that it, too, embodies many interesting features which grew out of the special requirements for the link system. Some of these are: good image rejection, high selectivity, stability to match that of the transmitter, and a good squelch circuit.

A block diagram of the receiver is shown in Fig. 10. This receiver employs a double superheterodyne circuit to attain maximum selectivity and image rejection. One local oscillator supplies signal to both mixing circuits and, to insure frequency stability, the oscillator is crystal controlled.

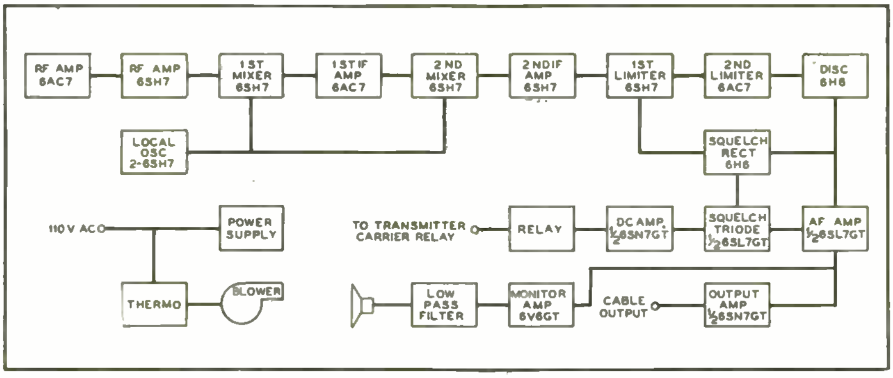


FIG. 10. BLOCK DIAGRAM SHOWING THE RECEIVER TUBE TYPES AND FUNCTIONS

A receiving crystal is supplied to correspond with each transmitting crystal. The receiving crystal is ground so that the receiver oscillator frequency is one-half of the transmitting frequency plus 5 mc. If, for example, the transmitting frequency is 70 mc., the receiver oscillator output is 40 mc. The first conversion yields an intermediate frequency of 35 mc. In the second mixer, the 35- and 40-mc. signals heterodyne to produce a second intermediate frequency of 5 mc.

It will be noted that the first intermediate frequency will be different for different operating frequencies. Therefore, the first IF transformers must be tuned when changing frequencies, as well as the RF, mixer, and oscillator plate circuits. To facilitate these adjustments, a small test oscillator is supplied, into which can be plugged the corresponding transmitter crystal. This oscillator supplies a signal at the carrier frequency, thereby enabling the operator to line up the receiver with the aid of a built-in metering circuit.

The squelch system used in the receiver is particularly efficient. Its action depends on two factors: the rectified first limiter grid current, and the high frequency noise components of the discriminator output. A diagram of this circuit is shown in Fig. 11.

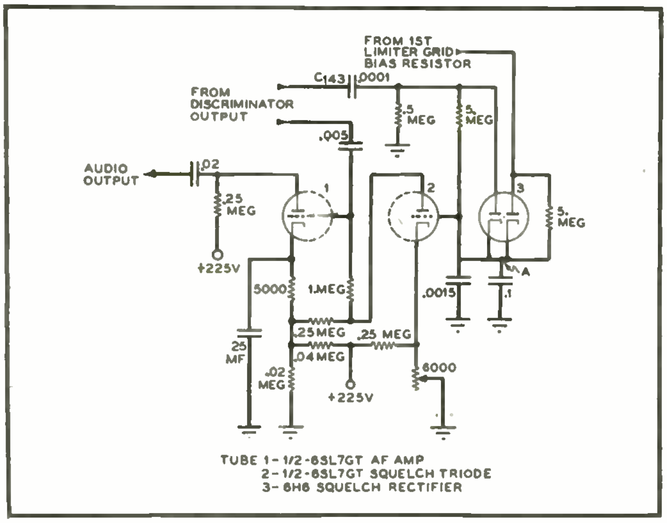


FIG. 11. CIRCUIT OF THE SQUELCH SYSTEM OF THE RECEIVER

Under no-signal conditions, there is a small AC voltage at the discriminator output due to fluctuation noise. This noise contains many high frequency components which are passed through the small coupling capacitor C_{143}. When rectified by one-half of the 6H6 double diode, they tend to cause a small positive potential at point A. At the same time, the tube noise produces an AC voltage at the limiter grid. This voltage is rectified by the other half of the 6H6, and it, too, tends to cause a positive potential at point A.

The circuit constants of the squelch triode are such that when the potential at point A is zero or slightly positive, the tube conducts. Under this condition, a large voltage drop appears across the resistor, biasing the audio tube to cut-off.

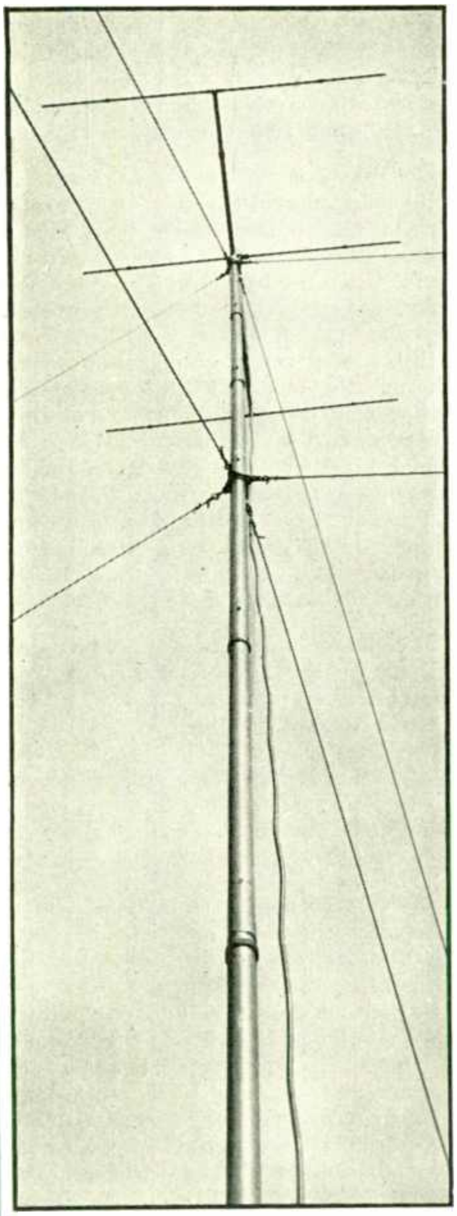


FIG. 12. THE ANTENNA IN OPERATION

When a signal comes into the receiver, the high-frequency noise components disappear from the discriminator output and, at the same time, a negative bias is developed at the limiter. The combined effect of these two actions is to cause point A to go negative. The squelch triode stops conducting, and the high negative bias is removed from the audio tube. The audio amplifier can then operate normally.

The feature of this squelch circuit is that sharp pulses of interference do not open the squelch. When an interference pulse does come through, a momentary negative voltage appears at the limiter grid; but it does not stay negative long enough for the charge at point A to change. At the same time, the noise pulse appears at the discriminator output and, when rectified, tends to drive point A positive. The two actions cancel themselves out, and the squelch remains closed. In practice, it has been found that a 1-microvolt signal can open the squelch, but noise pulses of considerable amplitude do not.

Like the transmitter, the receiver has an additional audio channel for monitoring. The input to this channel is in parallel with the input to the wide band audio channel. A low pass filter in the plate circuit of the monitor amplifier allows only the voice frequencies of channel No. 1 to pass into the monitor speaker.

At relay stations, the receiver output is fed directly into an associated transmitter for relay to the next station. Where there is little traffic on the circuit, it is desirable to have the transmitter carrier cut off the air except during the time a signal is coming through from the terminal station. A relay, included in the receiver, is used to control the transmitter automatically. This relay is operated by the squelch circuit, so that when a signal comes through from the terminal station, the transmitter carrier is turned on.

Antenna System ★ No radio system is complete without a good antenna. The requirements for the link antenna system include directivity and gain, light weight, ease of installation, and as much height as possible. A good compromise between all these factors is effected in the antenna system shown in Figs. 12 and 13.

The antenna itself consists of a half-wave dipole radiator with a reflector and a director. The radiator is fed at its center by a coaxial cable, and the other elements operate parasitically. All of the elements can be adjusted as to length with telescoping sections for the proper frequency of operation. More elaborate antenna arrays would give more gain, and they are used in some special applications; but the simple array described gives the best compromise between performance and portability.

To get the greatest possible distance, the antenna array is mounted atop a 40-ft. mast. Ordinarily, such a mast is thought of as involving a difficult erection job, but the portable mast included with this equipment can be put up in a few minutes. The mast consists of eight 5-ft. tubular steel sections. Three more sections are used as a gin pole, making it possible for one man to raise the mast.

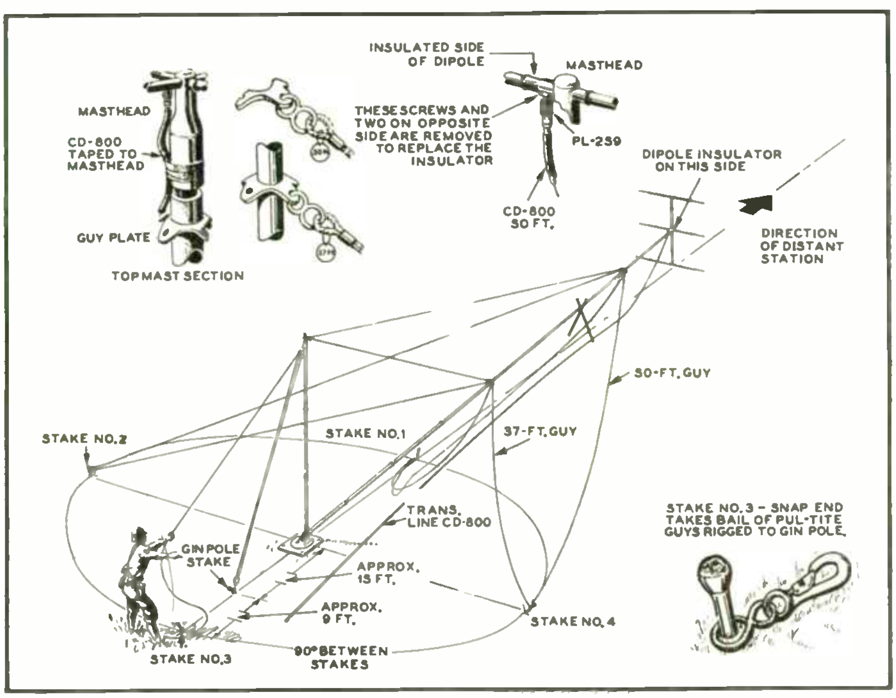


FIG. 13. DETAILS OF THE ANTENNA, AND THE METHOD BY WHICH IT IS ERECTED

The construction of the receiver is, of course, similar to that of the transmitter from the standpoint of ruggedness and reliability. An exhaust fan keeps the compartment temperature constant. Ceramic and mica capacitors are used extensively, and all circuit elements are well tied down to avoid trouble from vibration.

Simple as it is, the erection of the antenna masts constitutes the major part of the installation procedure for a radio link station. The receivers and transmitters can be operated while still in their carrying chests. It is necessary only to interconnect the various elements by con-

(CONCLUDED ON PAGE 85)

SPOT NEWS NOTES

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

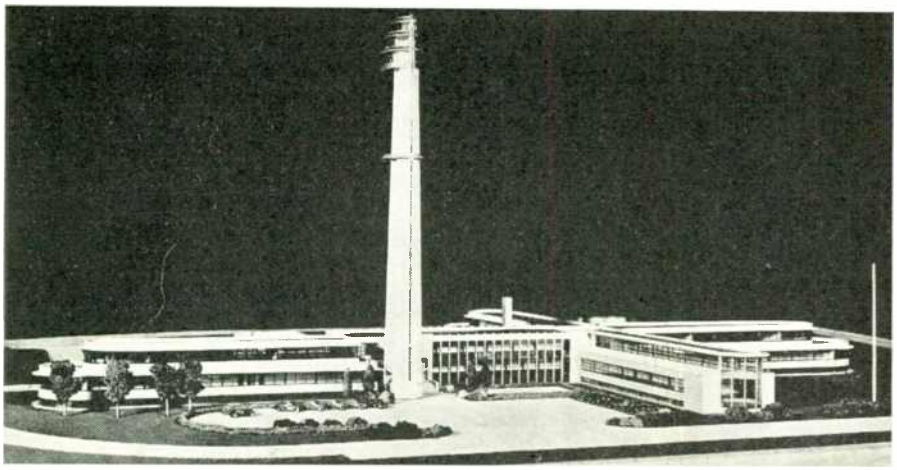
I.R.E. Building Fund: Have you sent in your contribution? Make it as big as you can, but don't be ashamed if it isn't as big as you'd like it to be. At least, you can contribute a couple of bricks!

New Stalling Technique?: In its issue of April 16, *Broadcasting*, always responsive to views of broadcast executives, warns that FM threatens investments in AM installations. It's no secret that, prewar, some AM operators filed FM applications simply for protection, and then stalled on taking delivery of equipment. Is the enthusiastic support of Mr. Norton's F2 testimony by AM nets and larger independents a postwar modification of that technique? The FCC should examine this aspect of the pressure being exerted to bring about a radical shift of the FM band, and the consequent delay in the spread of this better service.

Capt. J. B. Dow: Director of Electronics for the Bureau of Ships: "It is the earnest hope of those who have had the responsibility for supplying the Navy with modern electronic equipment that when peace comes our people will not fail to support strongly an adequate research and development program. It has been estimated that a minimum of $25,000,000 per year would be required by the Navy to carry out an adequate program in the fields of radio, radar, and sonar. The expenditure of this sum would insure the technical lead over other nations which has proved to be so essential to Victory."

Ralph R. Beal: Assistant to the vice president in charge of RCA Laboratories, and for nine years research director of RCA, has been elected vice president of RCA Communications, Inc. in charge of engineering.

New Quartz Technique: Following the discovery that X-rays can be used to alter the elastic constants of quartz crystals, The Reeves-Ely Laboratories, New York, are using this treatment to obtain the final adjustment of crystals to exact frequency values. Since the change in frequency resulting from this technique 's downward, plates which have been lapped too thin can be salvaged. Commercial X-ray equipment, built by North American Philips, is used. Dr. Clifford Frondel, head of the Reeves-Ely research division, is credited with this discovery. He has prepared an engineering report on the subject which can be obtained by writing to the Company, 62 W. 47 Street, New York.



PROJECTED HEADQUARTERS OF THE INTERNATIONAL TELECOMMUNICATION LABORATORIES, INC.

F. R. Lack: Vice president of Western Electric and manager of the radio division has been elected to the board of directors. He has been associated with this Company and Bell Telephone Laboratories since 1911, when he started as an assembler. In 1823, he entered Harvard as a special student, and earned his B.S. degree with high honors in two and a half years.

Larger Quarters: Trav-Ler Karenola Radio & Television Corp. has moved its general offices, research laboratory, and showroom to a remodeled four-story building at 571 W. Jackson Boulevard, Chicago. All manufacturing will still be done at their plant in Orleans, Ind.

FM in France: Ordinary commercial transactions have not yet been opened in France. However, 50 copies of *FM* AND TELEVISION per month are being shipped to France as part of a specially selected group of American publications chosen for their "compelling interest."

New York-Boston: A.T. & T. has announced the following route for their experimental radio relay system: Jackie Jones Mountain, Haverstraw Township, N. Y., 35 miles from the New York City terminal; 35 miles to Birch Hill, 5 miles southeast of Pawling, N. Y.; 30 miles to Spindle Hill, 4 miles southwest of Bristol, Conn.; 27 miles to John Tom Hill, 7 miles east of Glastonbury, Conn.; 23 miles to Bald Hill, 3 miles east of Staffordville, Conn.; 27 miles to Asnebumskit Mountain, 5 miles northwest of Worcester, Mass.; 32 miles to Bear Hill, 1 mile northwest of Waltham, Mass.; 11 miles to the terminal in Boston. Frequencies of 2,000, 4,000, and 12,000 mc. will be used for the initial tests.

Correction: The draftsman who prepared the sketch for Major Armstrong's Fig. 1 in his brief presented at the FCC's Oral Argument identified the reflecting layer as the Troposphere. Obviously, it should have been identified as the Ionosphere. This correction also applies to the reproduction of the sketch which appeared on page 29 of our March 1945 issue.

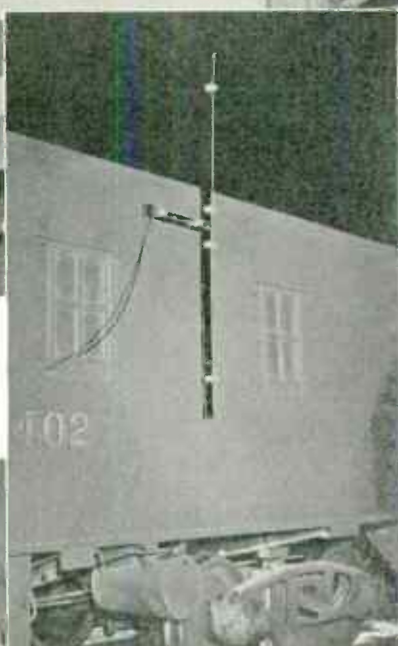
Research Laboratory: International Tele-Communication Laboratories, a $2,000,000 corporation, has been organized by the International Telephone & Telegraph Corporation and its subsidiary, International Standard Electric Corporation. Through the new corporation the engineers and scientists of I.T. & T., functioning in America and numerous other countries, will be grouped in a world-wide organization, with headquarters in the United States. E. L. Deloraine, general director of Federal Telephone and Radio Laboratories, is president of the research organization.

The accompanying illustration shows the architect's sketch for the new headquarters laboratory building. It is planned that I.T.L. will concentrate on initiating and developing inventions, and provide an interchange of information with I.T. & T. laboratories and manufacturing and communications subsidiaries now located in many parts of the world.

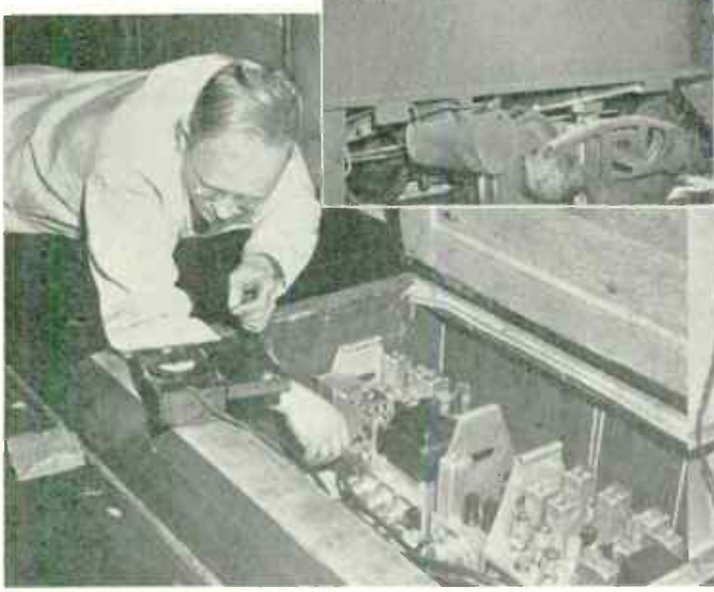
George L. Beers: Has been appointed assistant director of engineering in charge of advance development at RCA Victor. Associated with the Company since 1921, he

(CONTINUED ON PAGE 78)

INSTANTANEOUS RADIO COMMUNICATION BETWEEN ENGINEER AND CONDUCTOR CAN CONTRIBUTE MUCH TO SPEEDING UP THE OPERATION OF FREIGHT TRAINS



RIGHT: THIS TYPE OF ANTENNA PROVED EFFECTIVE EVEN WHEN THE TRAIN PASSED THROUGH LONG TUNNELS



WORKING WITH EDWARD MUSGROVE, RIO GRANDE'S RADIO SUPERVISOR, MOTOROLA ENGINEER HENRY KOLL, LEFT, MADE THIS FM INSTALLATION TO CHECK PERFORMANCE FROM DENVER TO SALT LAKE CITY THROUGH 50 TUNNELS. LONGEST IS 6½ MILES

NEWS PICTURE

THE use of FM communications for railroads, actively sponsored by *FM and TELEVISION* for nearly two years, is now making definite progress. These pictures show an FM test installation which performed very successfully on a 65-car Denver & Rio Grande Western freight train operating between Denver and Salt Lake City. Because engineer George O'Biren could talk directly to the conductor in the caboose, without delays occasioned by dependence on hand, whistle, and air-brake signals, 3 hours were cut off the normal running time. Edward Musgrove, radio supervisor for the road, described the performance as highly successful. Equipment was installed by Motorola.

FM BROADCASTING & COMMUNICATIONS HANDBOOK

Chapter 3: Operational Advantages of Propagation at the FM Frequencies

BY RENÉ T. HEMMES

THE two previous chapters have explained the notable improvements that are obtained when a well-designed system of FM transmission and reception is substituted for AM. The advantages in the favor of FM that were enumerated are inherent in the FM circuits, and are not dependent upon the signal carrier frequencies employed in the two systems.

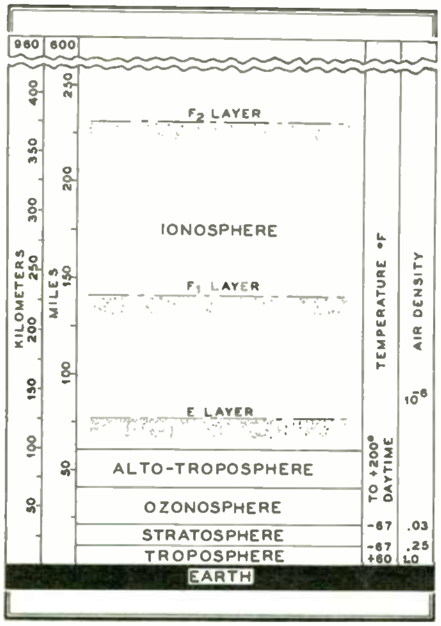


FIG. 1. ARRANGEMENT OF THE SHELLS OF THE EARTH'S ATMOSPHERE

As a practical matter, however, since FM requires a greater channel width than AM, FM stations must be assigned to a higher portion of the frequency spectrum, where a greater band of frequencies is available.

For example, the FM broadcast station channel width is 200 kc., while the channel width of the AM station is 10 kc. The present standard broadcast band, extending from 550 to 1,600 kc., provides 106 10-kc. channels for the AM stations but could furnish only 5 channels 200 kc. wide Hence it has been necessary to assign frequencies above 40 mc. to the FM broadcast stations. For the same reason, the frequencies allocated to police radio and other emergency communication systems are considerably higher in the case of FM than with AM.

This shift to a very high carrier frequency, incidental to setting up an FM system, introduces additional advantages in terms of improved signal coverage, as will be explained in this chapter.

In particular, the FM signals suffer less from the effects of the Ionosphere than AM signals at the lower carrier frequencies. With a view to understanding the difference between the propagation characteristics of the FM and AM frequencies, it is desirable to review briefly the nature of the Ionosphere and its effects upon radio signals.

Nature of the Ionosphere ★ The atmosphere of the earth can be regarded as consisting of a number of concentric shells or layers of various thicknesses above the earth's surface, as shown in Fig. 1. Each layer has its own distinguishing characteristics and certain of the layers exercise an influence upon radio waves, as will be shown presently.

The shell nearest to the earth's surface is called the *Troposphere*, extending upward about 10 miles. It is the weather belt of the earth, with fluctuating temperatures and barometric pressures.

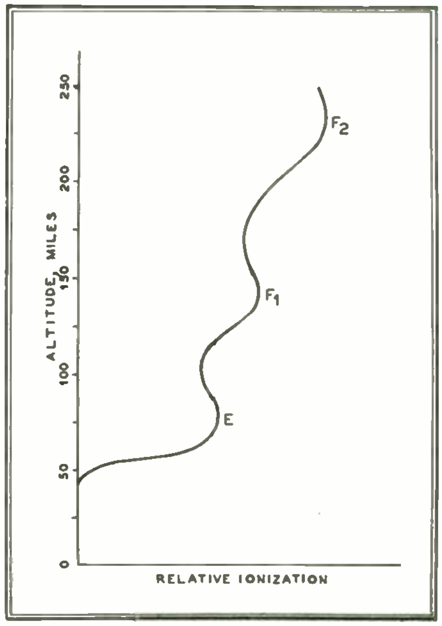


FIG. 2. DEGREE OF IONIZATION AS A FUNCTION OF HEIGHT ABOVE THE EARTH

Above the Troposphere in Fig. 1 is shown the *Stratosphere* or Isothermal layer of thin air, whose distinguishing characteristic is a constant temperature of about − 67° F.

The *Ozonosphere*, a third layer about 18 miles in thickness above the Stratosphere, contains free oxygen which serves to absorb the actinic rays of the sun. Its temperature rises as high as 200° F. during the daytime but falls to − 67° F., like that of the Stratosphere, at night. Above the Ozonosphere is a layer about 20 miles thick, called the *Alto-troposphere*. This layer also absorbs sunlight and undergoes wide variations of temperature between day and night. The temperature variations cause changes in atmospheric pressure of an appreciable percentage, but the order of all pressures at these altitudes is, of course, quite low.

The fifth layer is the *Ionosphere*, beginning at a height of about 60 miles above the earth and extending upward for several hundred miles, at least. It is characterized

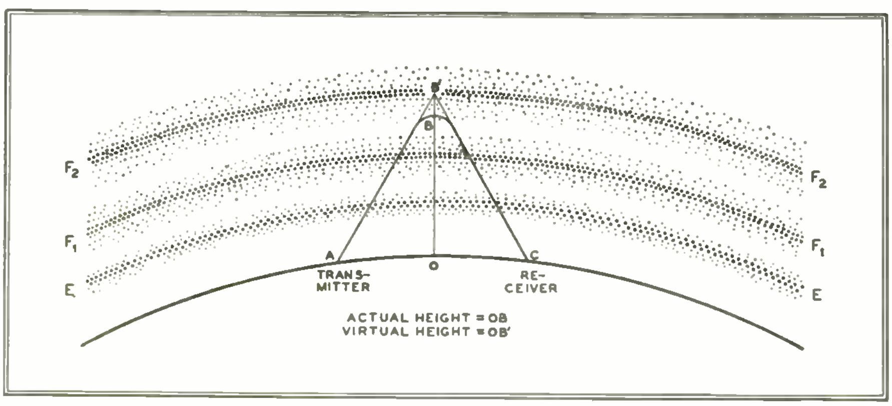


FIG. 3. TYPICAL PATH OF A WAVE RETURNED TO EARTH FROM THE F2 LAYER

by an air pressure as low as .00000001 of the normal pressure at the surface of the earth. The pressure within the Ionosphere is, therefore, in the order of that found within a vacuum tube.

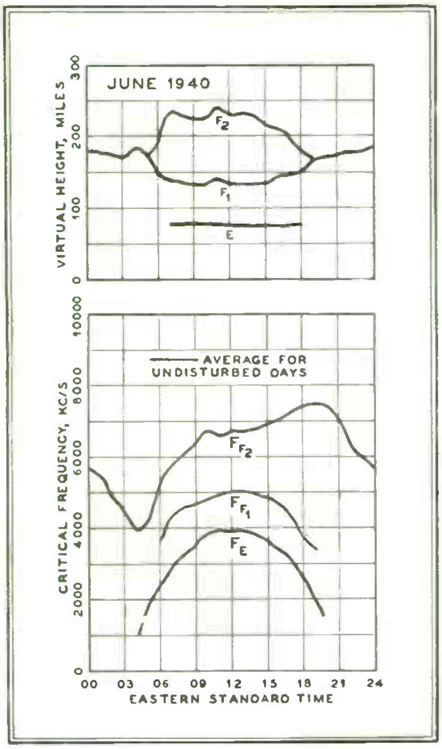


FIG. 4. VIRTUAL HEIGHTS AND CRITICAL FREQUENCIES OF IONOSPHERE LAYERS

Throughout the earth's atmosphere there is ionization, that is, radiation from the sun acting upon the molecules of the gases of the air causes the liberation of electrons and the creation of ions. The ionization is very slight in the Troposphere but tends to increase with altitude, because in regions of reduced atmospheric pressure the likelihood of a rapid recombination of electrons and ions diminishes. Particularly in the Ionosphere, where the pressure is extremely low, a liberated electron can travel for a relatively long time before encountering an ion. Thus comparatively large numbers of free electrons and ions exist at the high altitudes of the Ionosphere, as indicated by the curve of Fig. 2.

It will be noted that the ionization within the Ionosphere, Fig. 2, is not of uniform density but is concentrated in at least three layers, designated E, F_1 and F_2, at various heights. This is believed to be due to a difference in the proportions of the several gases at various levels in the Ionosphere, since the gases differ in their ability to absorb energy from solar radiation.

When a radio wave from the earth approaches one of these layers of ionization, it will tend to be reflected or refracted back toward the earth, as shown in Fig. 3, provided the frequency of the wave is not too high. The mechanism of bending is explained as follows: When the wave enters the ionized region, its electric field sets the free electrons and ions into a vibratory motion. The movement of the heavy ions is so slight as to be unimportant, but the movement of the electrons is appreciable. The path of movement of the electrons is determined by the orientation and the direction of motion of the electric field, and by the magnetic field of the earth. The vibrating electrons represent a current that creates a reradiated field, which, together with the original field, causes a bending of the direction of motion of the wave, away from the region of more intense ionization.

As the frequency of the wave is lowered, the refraction or bending is greater. On the other hand, if the frequency of the wave is sufficiently high, the wave can penetrate one layer, but may be refracted by the next higher layer, which has a greater degree of ionization. It is also possible for the frequency of the wave to be so high that it will penetrate all layers and be lost in space. Whether or not the wave will be bent back to earth depends, therefore, upon the frequency of the wave, the height of the refracting layer, and its density of ionization.

The density of ionization of a layer is measured by determining the highest frequency that can be returned to earth from the layer, when the wave enters the layer perpendicularly. This frequency is called the *critical frequency*.

The *virtual height* of a layer is that height at which reflection from a sharply defined plane, in the absence of ionization, would give the same transit time as is taken by the refracted sky wave in traveling over its curved path from the transmitter to the receiver. In other words, in Fig. 3, the same time would be taken to travel over the path $AB'C$ at the velocity of light as is actually required by the wave in traveling its curved path ABC at a velocity which, in the vicinity of B, is less than the velocity of light.

The lowest important ionized layer within the Ionosphere is the E layer, whose virtual height remains practically constant at 70 to 75 miles throughout the daytime during every season of the year. As shown in Fig. 4, the critical frequency of the E layer is variable, with a maximum at local noon. The maximum is higher in summer than in winter.

The next higher daytime layer is designated the F_1 layer, which, as shown in Fig. 4, has a minimum height of about 130 miles at local noon, with somewhat greater heights in the forenoon and afternoon.

The third important daytime layer is the F_2 layer. It is much higher than the F_1 layer during most of the daytime in the summer, but the difference in height is not as great in the winter. The critical fre-

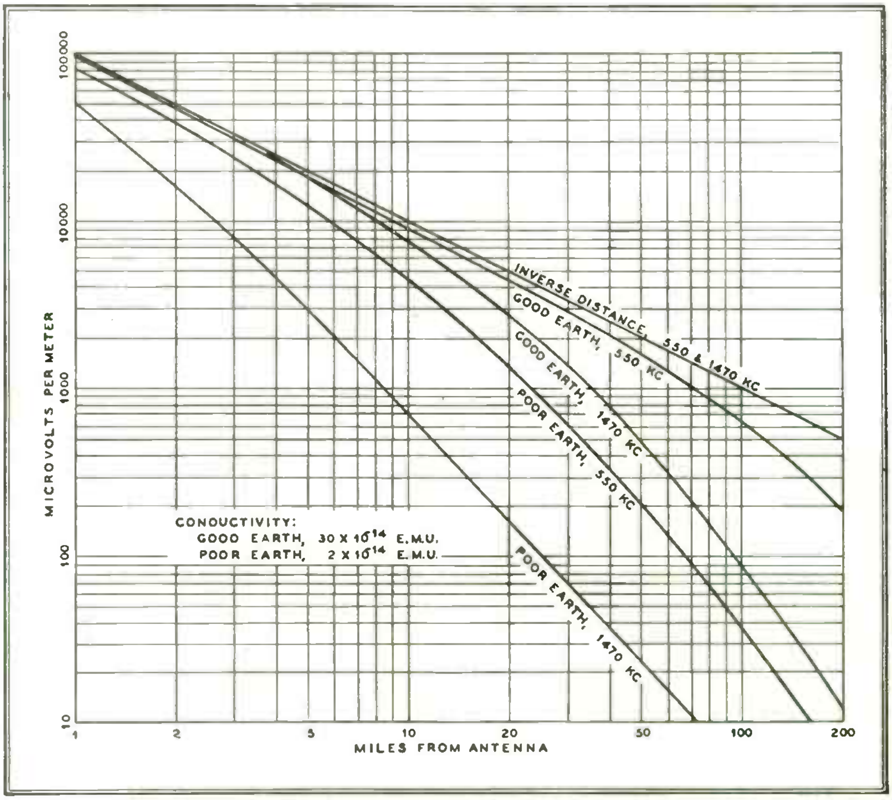


FIG 5. AM FIELD STRENGTH AS A FUNCTION OF DISTANCE AT 550 AND 1470 KC.

quencies of both the F_1 and F_2 layers are variable, being maximum at local noon in the winter and during the late afternoon in the summer.

With the approach of sunset, the height of the F_1 layer increases while the height of the F_2 layer approaches that of the F_1 layer. At sunset, the layers merge to form a single F layer which remains throughout the night, rising to a maximum height of about 200 miles at local midnight. Shortly after sunrise, the F layer separates into the F_1 and F_2 layers previously mentioned, except on winter days during a year of great sunspot activity, when the layers do not separate appreciably.

While the virtual heights of the layers vary with the time of day and the season of the year, the cycle of variations of virtual height is repetitive with little change from year to year. The critical frequencies of the layers, however, are affected by the sunspot numbers, and hence are subject to variation over the period of the 11-year sunspot cycle. In a year of large sunspot numbers, the critical frequencies of all layers, particularly that of the F_2 layer at local noon in the winter, are very much higher than in the years of slight sunspot activity.

Sufficient knowledge of the general trends of the variations of the Ionosphere characteristics has been gathered during the past decade to permit the prediction of Ionosphere propagation characteristics in advance. The predictions have considerable reliability, except for short periods of unusual sunspot activity.

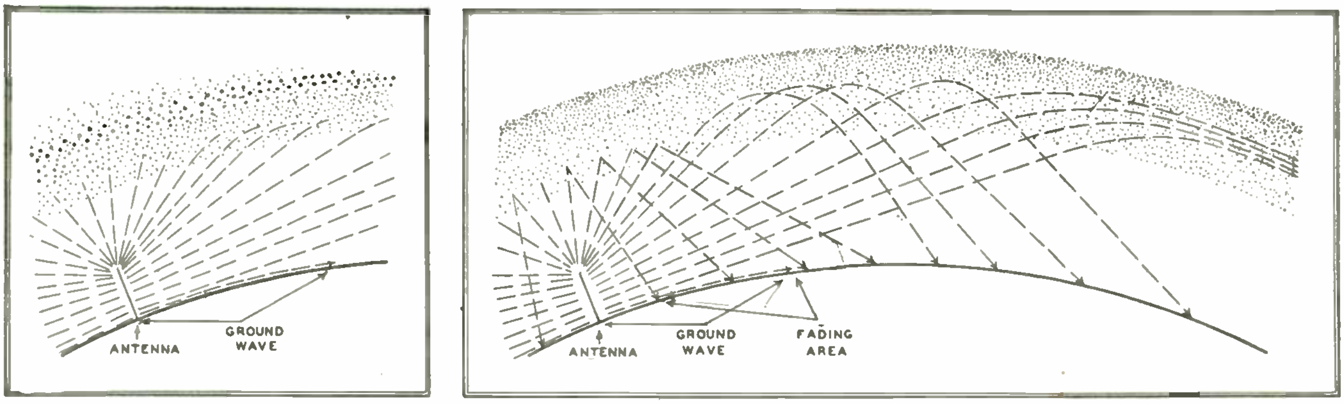


FIG. 6. LEFT: AM BROADCAST TRANSMISSION DURING DAYLIGHT HOURS IS BY MEANS OF THE GROUND WAVE. SKYWARD TRANSMISSION IS ABSORBED IN REGION BELOW E LAYER. RIGHT: AT NIGHT, SKYWAVES, RETURNED TO EARTH, GIVE LONG-DISTANCE COVERAGE, BUT CAUSE FADING IN THE OUTER PORTION OF THE AREA REACHED BY THE GROUND WAVE

Effects of the Ionosphere ★ It has been stated that the Ionosphere has more effect upon the radio waves of the standard AM broadcast frequencies than upon the radio waves at FM frequencies. The reason is quite simple. FM broadcast frequencies are in excess of 40 mc., and hence are greater than the maximum critical frequencies of all the ionized layers, with the exception of the F_2 layer during short periods around noon on winter days in the years of greater sunspot activity, when long distance transmission by F_2 layer refraction can occur at frequencies somewhat in excess of 40 mc. In general, however, the skyward transmissions of radio waves at FM frequencies penetrate the ionized layers and do not return to earth.

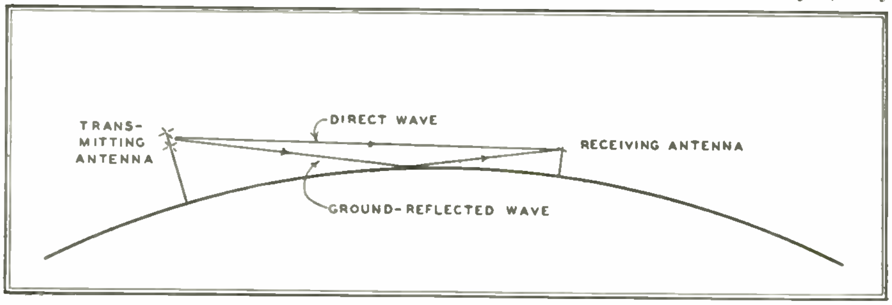


FIG. 7. TRANSMISSION AT VERY HIGH FREQUENCIES IS EFFECTED BY MEANS OF BOTH GROUND-REFLECTED WAVES AND DIRECT WAVES, AS THIS DRAWING SHOWS

On the other hand, the frequencies of the broadcast band, from 550 to 1,600 kc., are well below the critical frequencies of the F_1, and F_2 layers, and also somewhat below the critical frequency of the E layer. It would appear at first thought, therefore, that skywave transmission would occur at the standard broadcast frequencies at all times. Actually, such transmission occurs only at night because in the daytime the absorption of energy in the regions immediately below the E layer is so great at the AM broadcast frequencies that no appreciable energy from the skyward transmission returns to the earth.

The absorption of energy from the radio wave in the upper reaches of the atmosphere is caused by collisions between the free electrons that have been set in vibratory motion by the electric field of the wave and the drifting gas molecules. Within the Ionosphere, from the E layer upward, the absorption is quite small, because while many free electrons are present, the atmospheric pressure is so low that collisions of the electrons with gas molecules are relatively infrequent. On the other hand, when the intense radiation from the sun in daytime causes the ionization to be extended downward in the E layer, and even to regions in the Altotroposphere, just below the E layer, then an area of high absorption characteristics is created because of the higher pressure of the gases within the area. Since waves at AM broadcast frequencies would tend to make their refractive bend largely within this area, below the E layer, they are especially susceptible to absorption and very little skywave energy is returned to the earth at these frequencies in the daytime.

Daytime AM Broadcast Coverage ★ Since skywave transmission is not feasible on AM broadcast frequencies during daylight hours, the area that is served by an AM broadcast transmitter is that which the radio wave traveling over the surface of the earth can reach with sufficient field strength for proper operation of the average broadcast receiver.

The area of usable signal strength in the daytime is commonly assumed to be that within the 500 microvolt-per-meter contour, although in locations where man-made noise and interfering signals are at a minimum, it is possible to obtain satisfactory daytime service with lower field strengths.

The field strength at the receiver depends in part upon the power of the trans-

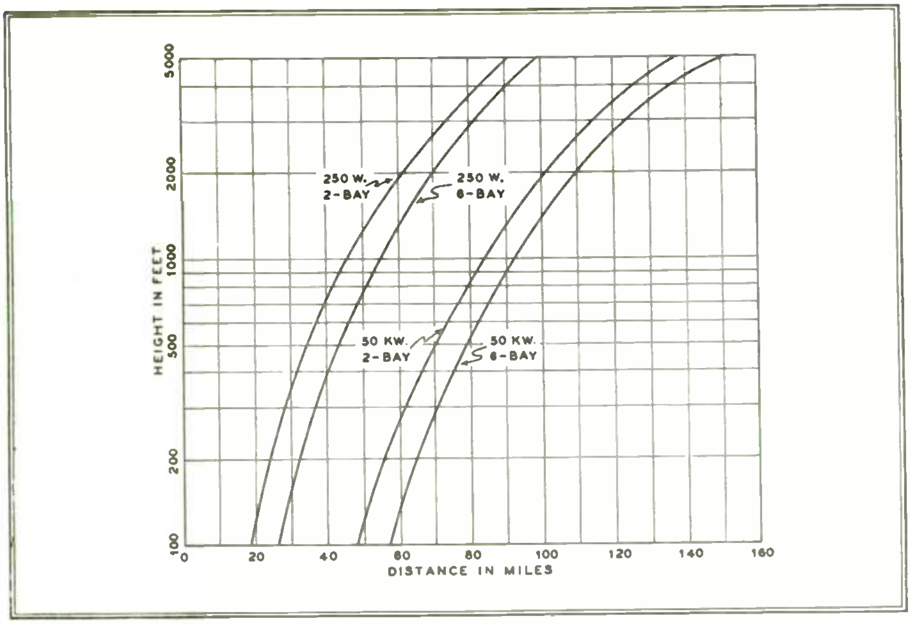


FIG. 9. RELATION OF HEIGHT, POWER, AND DISTANCE TO 50-MICROVOLT CONTOUR

mitter and upon the efficiency of the radiating system, since these factors determine the strength of the field that is initially established in the immediate vicinity of the transmitting antenna. However, the field strength at the receiver also depends upon the loss sustained by the ground wave in traveling from the transmitter to the receiver. The amount of this loss depends upon the distance traveled, the conductivity of the ground, and the frequency of the transmitter.

The field strength would vary inversely as the distance if there were no ground losses, as shown by the straight line inverse distance curve in Fig. 5. Actually, there is a continuous loss of energy as the wave passes over the ground, which is greater when the soil conductivity is poor and the frequency is high, as shown by the other curves of Fig. 5.

For example, when the inverse distance signal strength at one mile is 100 millivolts per meter, Fig. 5 shows that the distance to the 500 microvolt-per-meter contour would be 200 miles if there were no loss in the ground.

If the radio wave from the station mentioned above has a frequency of 550 kc. and is passing over ground having relatively good conductivity (30×10^{-14} electromagnetic units), such as might be found in regions of rich soil and low hills, the distance to the 500-microvolt contour, by reference to Fig. 5, is about 115 miles. On the other hand, if the ground conductivity were rather poor (2×10^{-14} electromagnetic units), as in the regions of steep hills and rocky soil, then the distance to the 500-microvolt contour would be only about 33 miles at the same frequency. If the frequency of the station in the latter case were increased from 550 to 1,470 kc., the distance to the 500-microvolt contour would be reduced to about 12 miles!

Thus the range of usable signal in the daytime for broadcast stations at AM frequencies having the same field strength at one mile depends to a very great extent upon the conductivity of the earth and the frequency of the station.

Night-time AM Broadcast Coverage ★ The ionization in the region just below the *E* layer, where heavy absorption occurs during the day, is largely dissipated shortly after sunset. Thus energy transmitted skyward at night can be reflected back to earth with only moderate losses, as shown in Fig. 6.

Since the paths traveled by the skywave and the ground wave are unequal in length, it can be expected that they will be out of phase in the area where the sky wave returns to the earth and meets the ground wave. Furthermore, since the height of the ionized layer is not constant, the length of the skywave path is not con-

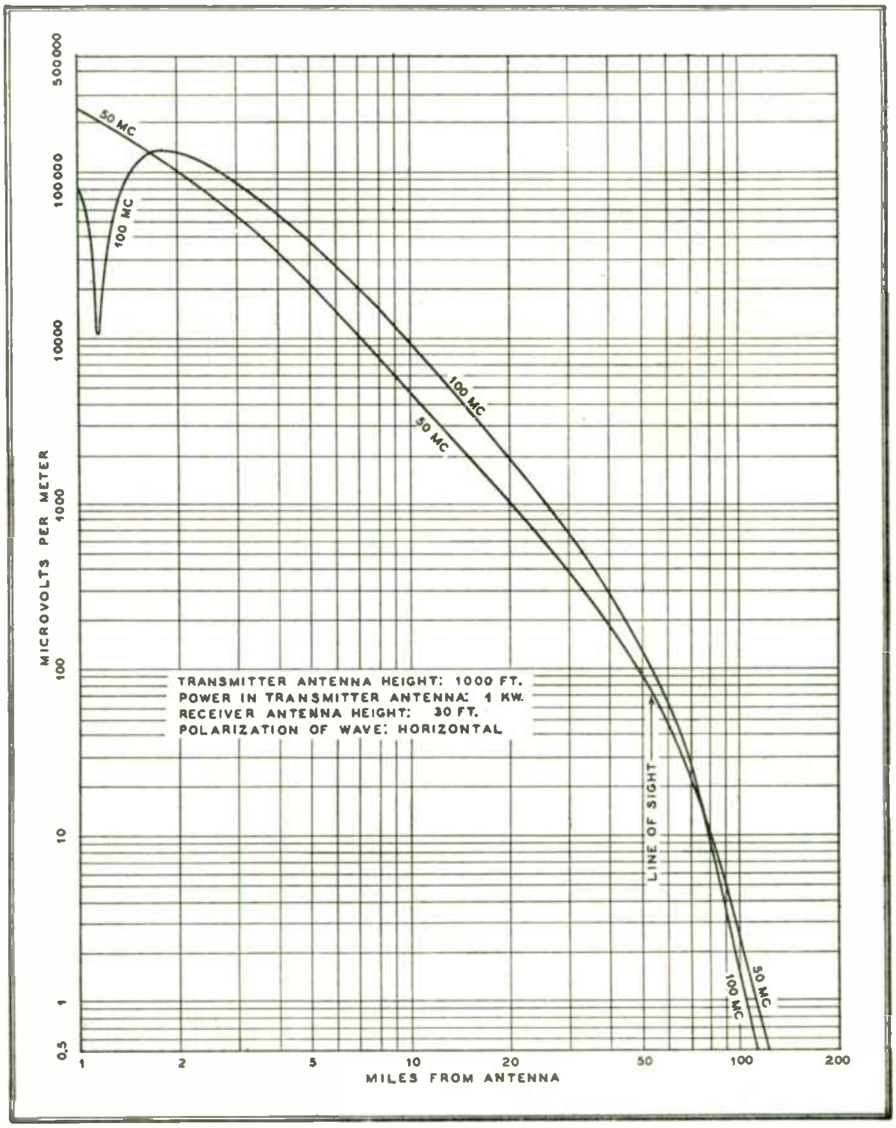
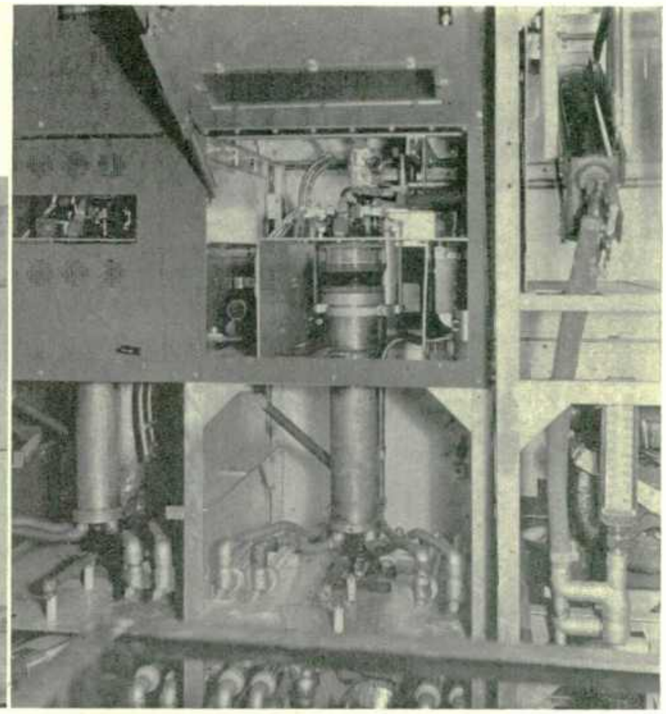
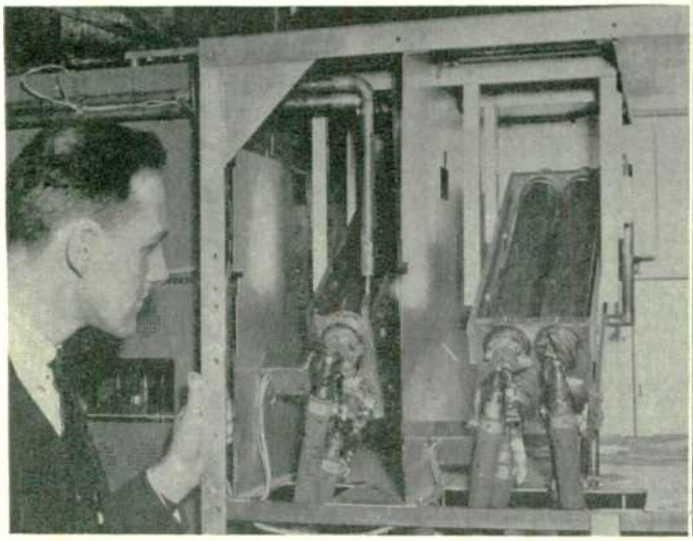


FIG. 8. FIELD STRENGTH AS A FUNCTION OF DISTANCE AT VERY HIGH FREQUENCIES

FIG. 30, RIGHT: FINAL STAGE OF THE 40-KW. VIDEO TRANSMITTER, USING GL-8009 TUBES IN PUSH-PULL. FIG. 31, BELOW: WATER-COOLED GRID LOADING RESISTORS FOR THE 12- AND 40-KW. STAGES





The Video System ★ The upper part of Fig. 26 shows a block diagram for the 40-kw. visual transmitter system at WRGB, while the lower part is a block diagram of the 40-watt relay transmitter at the studio. The visual signals, transmitted from the studio in downtown Schenectady by the radio-relay equipment, are picked up at the main transmitter by the corner-reflector antenna shown in Fig. 27. This antenna is located just over the brow of the hill about 50 ft. from the transmitter building, and is oriented so that it points toward the relay antenna at the studio, 12½ miles away. The antenna itself consists of two large-diameter copper tubes forming a dipole which is connected to a ⅞-in. coaxial transmission line by a matching section.

A similar corner reflector antenna is located about 600 ft. behind the transmitter building on top of a hill which has clear line-of-sight to the relay station. This latter antenna is used to pick up the picture signals transmitted by the relay station at New York City. Both corner reflector antennas are cut for operation on the television channel No. 8, 163.25 mc.

Picture signals picked up by either of these antennas are fed to the receiver-converter, Fig. 28. This unit includes a 6-tube radio-frequency amplifier, operating at 163.25. mc., which amplifies the picture signals received either from the studio or the relay station. A simple switching arrangement allows this converter unit to be connected to either one of the corner reflector antennas.

The high gain radio-frequency amplifier feeds into a type GL832 converter tube, where the signal is mixed with a 96-mc. signal generated by a 6-mc. master oscillator with two doubler stages and a quadrupler stage. This converter changes the frequency of the incoming picture signals from channel No. 8, 163.25 mc., to channel No. 3, 67.25 mc., the operating frequency of WRGB. The receiver-converter unit contains three additional stages of Class B RF amplification, providing an output of 50 watts which is then fed to the main WRGB picture transmitter through a pair of small coaxial lines.

A small amount of radio-frequency energy at 67.25 mc. is fed from the output of the receiver-converter unit to a type 6AC7 converter tube. Here it is compared with a 60.8-mc. RF signal generated by a crystal oscillator. The resulting 6.45 mc. difference frequency, therefore, varies as the frequency of the main transmitter changes. The difference frequency is fed into a type 6H6 discriminator tube and the DC voltage resulting from deviations from this center frequency is applied to a reactance tube. The reactance tube controls the frequency of the 6-mc. master oscillator which is used to supply, through its doubler stages, the 96-mc. signal used to convert the incoming signal from channel No. 8 to channel No. 3.

This automatic frequency control unit

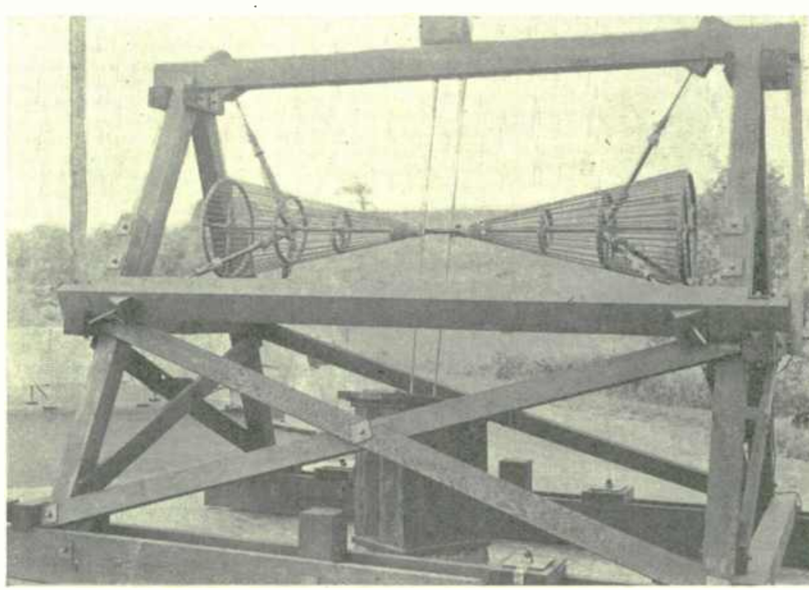


FIG. 32. CONICAL DOUBLET USED AS THE PICTURE TRANSMITTING ANTENNA

keeps the main WRGB transmitter on frequency even though the received signals from either the studio or the relay station vary in frequency over a considerable range. A variation in the frequency of the incoming signal causes a shift in the main transmitter frequency. This shift is immediately off-set, however, by the automatic frequency control circuit. The main WRGB transmitter remains on a constant frequency irrespective of the variation in frequency of the incoming signal. If the relayed carrier from either the relay station or the studio is removed, the RF output of the transmitter drops to zero because the transmitter is actually only an RF amplifier.

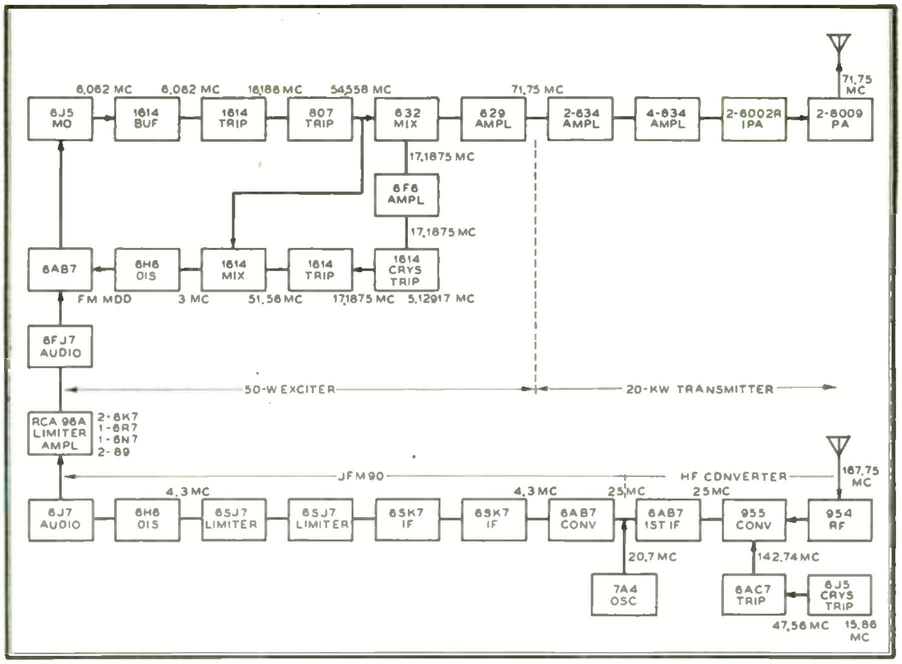


FIG. 34. SOUND RECEIVER WHICH FEEDS THE 20-KW. SOUND TRANSMITTER

40-Kw. Video Transmitter ★ As mentioned above, the radio-frequency signal, including picture information and synchronizing pulses, are carried from the receiver-converter unit, 3A in Fig. 25, to the visual transmitter, 2A in Fig. 25, by two ¼-in. coaxial transmission lines. The main transmitter, Fig. 29, includes six Class B radio-frequency power-amplifier stages. The first stage raises the power level to 120 watts and succeeding stages raise this level to the 40-kw. peak power output. Fig. 30 shows the final power amplifier stage of the visual transmitter. The push-pull type GL-8009 tubes can be seen in the center of the picture. Filament center tap resistors, transmission lines to the grid loading resistors, and the filament leads are grouped around the top of the tube. The inductive coupling from the preceding stage can be seen to the left of the picture.

Some of the power amplifier stages are coupled with triple-tuned links and others with double-tuned links. The radio-frequency tank consists of a pair of parallel lines electrically ¼-wave long. The output of the transmitter is inductively coupled to the antenna transmission line. To obtain the broad band necessary to pass the picture signals, the power amplifier stages are loaded by means of grid resistors. The grid resistors used in the 12-kw. and 40-kw. stages are water-cooled. They are shown in Fig. 31. These grid resistors are located outside the final amplifier cabinet and adjacent to it. They are connected to the grids of the tubes by means of the transmission line which can be seen in Fig. 30.

The type GL8002, GL889 and GL8009 tubes in the transmitter are all water-cooled. Further, the seals of all of these tubes are cooled by an air blast from above.

The main transmitter cabinet, Fig. 29, includes the six final power amplifier stages, the power supply for these stages, and the 20-kw. FM sound transmitter which will be discussed later.

Video Transmitter Antenna ★ A conical doublet, Fig. 32, mounted about 8 ft. off the roof of the transmitter building, is used to transmit the visual signal over the service area. This unit is experimental and will be replaced with a new and more modern antenna on a tower after the war. Fig. 33 shows the calculated field strength con-

(CONTINUED ON PAGE 86)

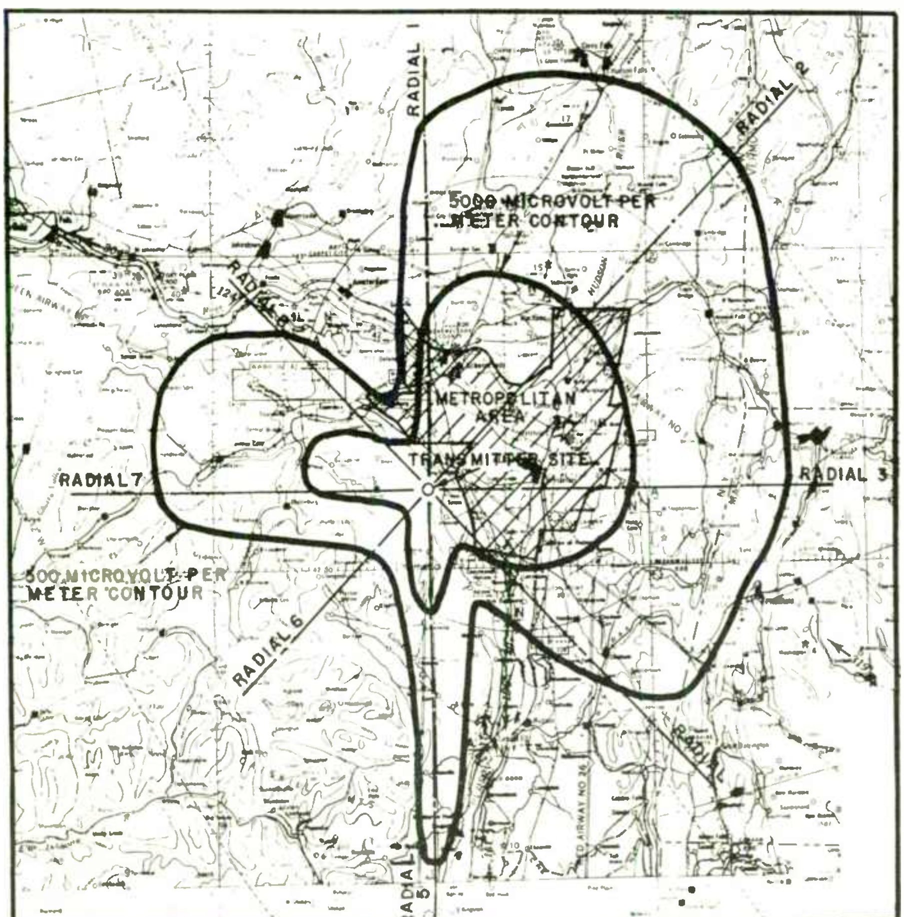
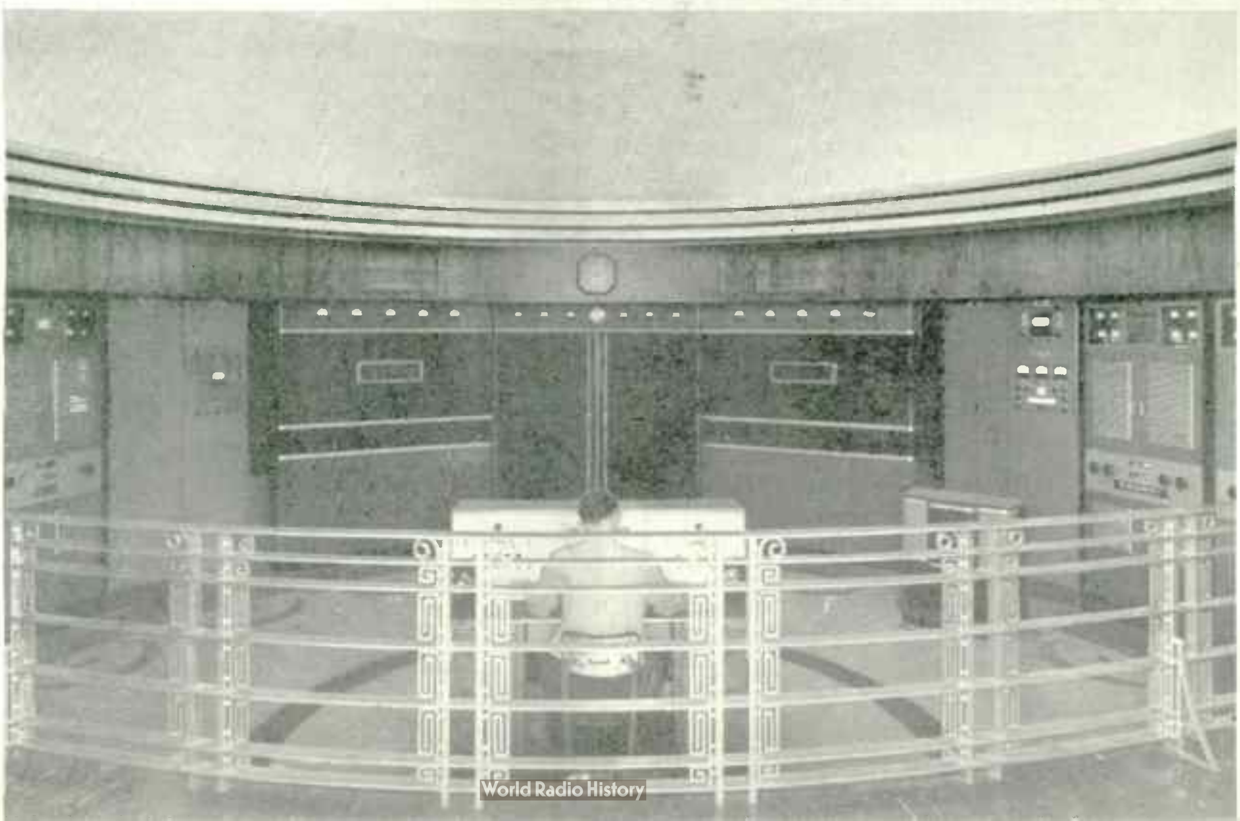


FIG. 33. CALCULATED 500- AND 5,000-MICROVOLT CONTOURS OF TELEVISION STATION WRGB

FM Station WSBF uses from

Left — The control room in the studios shared by FM station WSBF and AM station WSBT. Two RCA 76-B2 Consolettes handle the output of two studios. A master control console (center) provides monitoring and switching of outgoing lines to the two transmitters. The RCA 70-C Turntables may be seen in the foreground. In the studios RCA 44-BX Microphones are used.

Below — The FM-10-A Transmitter at WSBF is installed in the center of the operating room. This 10 KW Transmitter, presently operated at reduced power, will resume operation at full-power rating as soon as wartime restrictions are lifted. To the left and right of the FM transmitter are racks containing the AM and FM monitors; and beyond them, at either end, are the main and standby transmitters of WSBT.



RCA Equipment Microphone to Antenna

WSBF, the FM station of the South Bend Tribune, uses RCA equipment throughout. In the studios are RCA 44-BX Microphones; in the control room are RCA 70-C Turntables, RCA 76-B Consolettes and a special RCA-built master control console. At the transmitter building are an RCA FM-10-A Transmitter and RCA frequency and modulation monitors. The antenna is an RCA-developed four-bay turnstile using concentric feeders.

WSBF is a sister station of WSBT, the AM station operated by the South Bend Tribune. It is interesting to note that WSBT, like hundreds of other AM stations is also completely RCA equipped. Operators of AM stations know the meaning of "RCA all the way." And they know that in RCA FM equipment they will find the same dependability and the same advanced design features that they have come to expect in RCA AM equipment.

Operators of both AM and FM stations—and station applicants—can make reservations right now for early delivery of RCA postwar broadcast equipment. For information on our Broadcast Equipment Priority Plan write Broadcast Equipment Section, Radio Corporation of America, Camden, N. J.

BUY WAR BONDS

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

In Canada, RCA VICTOR COMPANY LIMITED, Montreal

Below—The transmitter building and antenna system of the South Bend Tribune's dual installation. This building houses the 10 KW FM Transmitter of WSBF, the 1 KW AM Transmitter of WSBT, an auxiliary AM transmitter, audio and monitoring equipment for both AM and FM systems and necessary maintenance facilities. The 4-bay turnstile of WSBF is mounted on the top of one of the towers of WSBT's 3-tower directional array.

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JOYCE, THOMAS F.
NAB Panel Address . . . Sept. 1944

KAHN, MORTON B.
1-Kw. Temco CW Transmitter Design . . . May 1943

KELSEY, KEITH
Do You Plan to Build an FM Station? . . . Dec. 1944

KESTEN, PAUL W.
CBS Report on Television Standards . . . May 1944

KLINGENSCHMITT, F. A.
Architects Specify FM-AM Antenna Systems . . . Oct. 1941

KNOWLSON, JAMES S.
The Manufacturers Say: . . . May 1941

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Analyzer for Aircraft Circuits . . . Feb. 1943

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LAESER, PHIL B.
Co-Channel Synchronous FM Satellite . . . Dec. 1944

LANDSBERG, KLAUS U.
Television Camera Equipment, DuMont System . . . Nov. 1941

LANGDON, G. G.
2-Way FM for Power Maintenance . . . May 1941

LESCABOURA, AUSTIN C.
Making a Start in Television . . . Dec. 1941, Jan.-Feb. 1942
High Frequency Iron Cores . . . July-Aug.-Oct. 1942

LEVENSON, WILLIAM B.
FM for Cleveland Schools . . . Apr. 1941

LEVY, M. L.
Stromberg-Carlson Model 535 . . . Feb.-Mar. 1941

LEWIS, WILLIAM B.
Possibility of a Fifth Network . . . Nov. 1944

LIEBLICH, M.
Use of the Limit Bridge . . . July-Aug. 1942

April 1945 — formerly *FM* RADIO-ELECTRONICS 51

LINK, FRED M.
The Manufacturers Say: .... Sept. 1941
LODGE, WILLIAM B.
SLEEPER, MILTON B.
Why Manufacturers Plan to Push FM .... Nov. 1940
Radio News, Recorded Music, Threat to Advertising .... Dec. 1940

limiting without distortion. Frequency characteristic is rated at ± 1 db from 20 to 20,000 cycles.

Mica Trimmers: A wide variety of ceramic-base mica trimmers is illustrated in a bulletin from Automatic Mfg. Corporation, 900 Passaic Avenue, E. Newark, N. J. For the use of designers and engineers, dimension drawings and very complete specifications are given on trimmers and brackets for mounting on coils and transformers, or on metal chassis. Sample trimmers are available to set manufacturers without charge.

Lever & Turn Switches: Two new series of switches are announced by Donald P. Mossman, Inc., 612 N. Michigan Avenue, Chicago 11. Series 4200, Fig. 5, is a light, compact lever design, capable of carrying any combination of springs with 2 piles on each side. Series 6300, Fig. 6, also carrying double contact piles, is a heavy-duty turn switch. It can be furnished for 2 or 3 positions, locking or non-locking.

Terminal Blocks: New designs and refinements in terminal blocks for the power circuits of radio equipment are shown in a catalog just published by Burke Electric Company, Erie, Pa. Fitted with various types of connectors, these blocks take 2 to 12 lines. Multiple jumper bars are furnished where internal connections are required, and target strips are provided for identifying each lead.

Combination Meter: A compact combination power level meter, voltmeter, and output meter is now in production by Weston Electrical Instrument Corporation, Newark 5, N. J. It is an 11-range rectifier-type voltmeter, with a constant impedance of 20,000 ohms. Thus, while connected across a line, the range can be shifted without affecting the line impedance. A self-contained condenser, available through a pin-jack, is provided to stop off any DC component. This is illustrated in Fig. 4.

The instrument is calibrated for 500-ohms lines, with a zero level of 6 milliwatts or 1.732 volts. A chart gives interpolation values for other lines of 5 to 10,000 ohms at 6 milliwatts zero level. Dimensions are 5½ by 3¾ by 3⅛ ins.

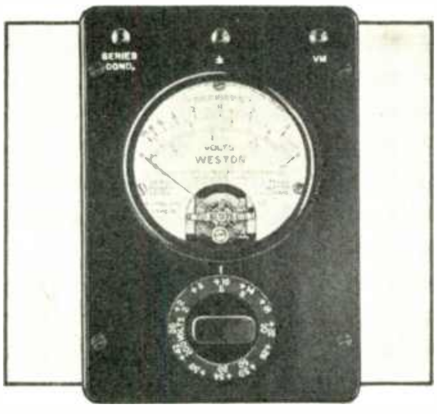


FIG. 4. COMBINATION TESTING METER

Laboratory & Test Instruments: Two new signal generators, type SG-2A and SG-3A, have been announced by General Electric's Electronics Department, Schenectady, N. Y. The first is a signal source only, while the latter provides calibrated output readings of .5 to 100,000 microvolts. Frequency range is .1 to 32 mc., in 5 scales. By using the second harmonic, frequencies up to 64 mc. are available.

Another new instrument is the AD-2 beat frequency oscillator, for checking audio amplifiers and speakers, and making frequency measurements. The direct-reading scale is calibrated from 25 to 15,000 cycles. Output can be controlled from 0 to 120 milliwatts.

A third new instrument is the UM-4 meter designed particularly for measuring high voltages in cathode-ray tube and television circuits. On DC it covers 0 to 10,000 volts at 20,000 ohms per volt, and 100 microamperes to 10 amperes in 6 steps; 5 steps cover resistance from 3,000 ohms to 10 megohms. The AC range, 0 to 10,000 volts, is at 5,000 ohms per volt.

Blower: Latest addition to the line of small blowers produced by L. R. Manufacturing Company, Torrington, Conn., is illustrated in Fig. 7. Employing a high-impact phenolic case, cadmium-plated steel wheel, and aluminum motor mounting plate, the unit weighs only 3½ oz. Although the blower measures only 4½ ins. from top to bottom, it delivers 50 C.F.M. at 8,000 R.P.M. Shaft is either .1895 or .250 in. in diameter.

Jumbo Socket: Dimensions have been reduced in the jumbo 4-prong steatite socket, Fig. 8, now offered by E. F. Johnson, Waseca, Minn. Designed for 8008, BR6, GL146, SC22, GL152, GL159, and GL169 tubes, it measures only 2⅝ by 2⅝ by ¾ ins. Bosses on the top of the 1-piece base are ground to present a flat surface for under-chassis mounting. Cadmium-plated brass contacts are riveted to the base in such a way that they cannot turn.

UHF & Television Nomographs: Engineers of Federal Telephone & Radio Corporation, 32 Central Avenue, Newark, N. J., have prepared a highly valuable series of twenty-five nomographs of which six are for use in designing double- and triple-tuned band-pass circuits in the UHF ranges; two cover series- and shunt-peak-

(CONTINUED ON PAGE 68)

FIG. 6, RIGHT: HEAVY-DUTY TURN SWITCH. BOTH TYPES CAN BE FURNISHED WITH A WIDE VARIETY OF CONTACT COMBINATIONS

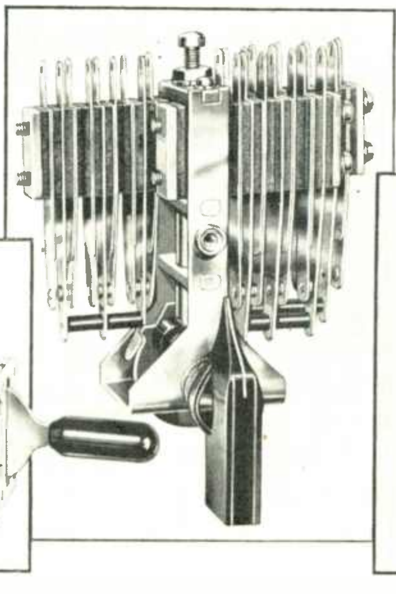


FIG. 5, BELOW: A NEW LEVER SWITCH OF COMPACT DESIGN

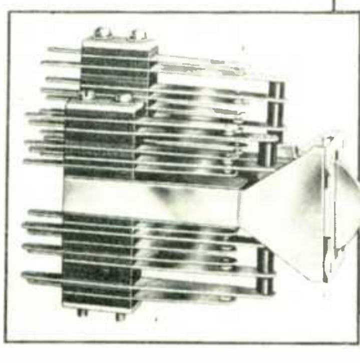


FIG. 7, BELOW: A 4½-IN. BLOWER THAT DELIVERS 50 CUBIC FEET PER MINUTE

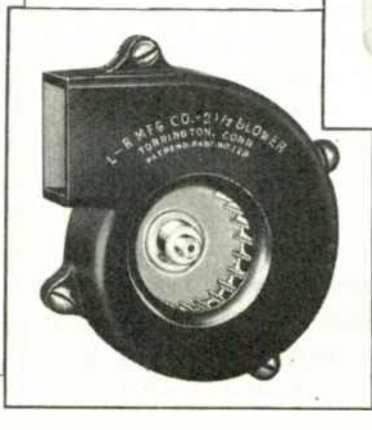
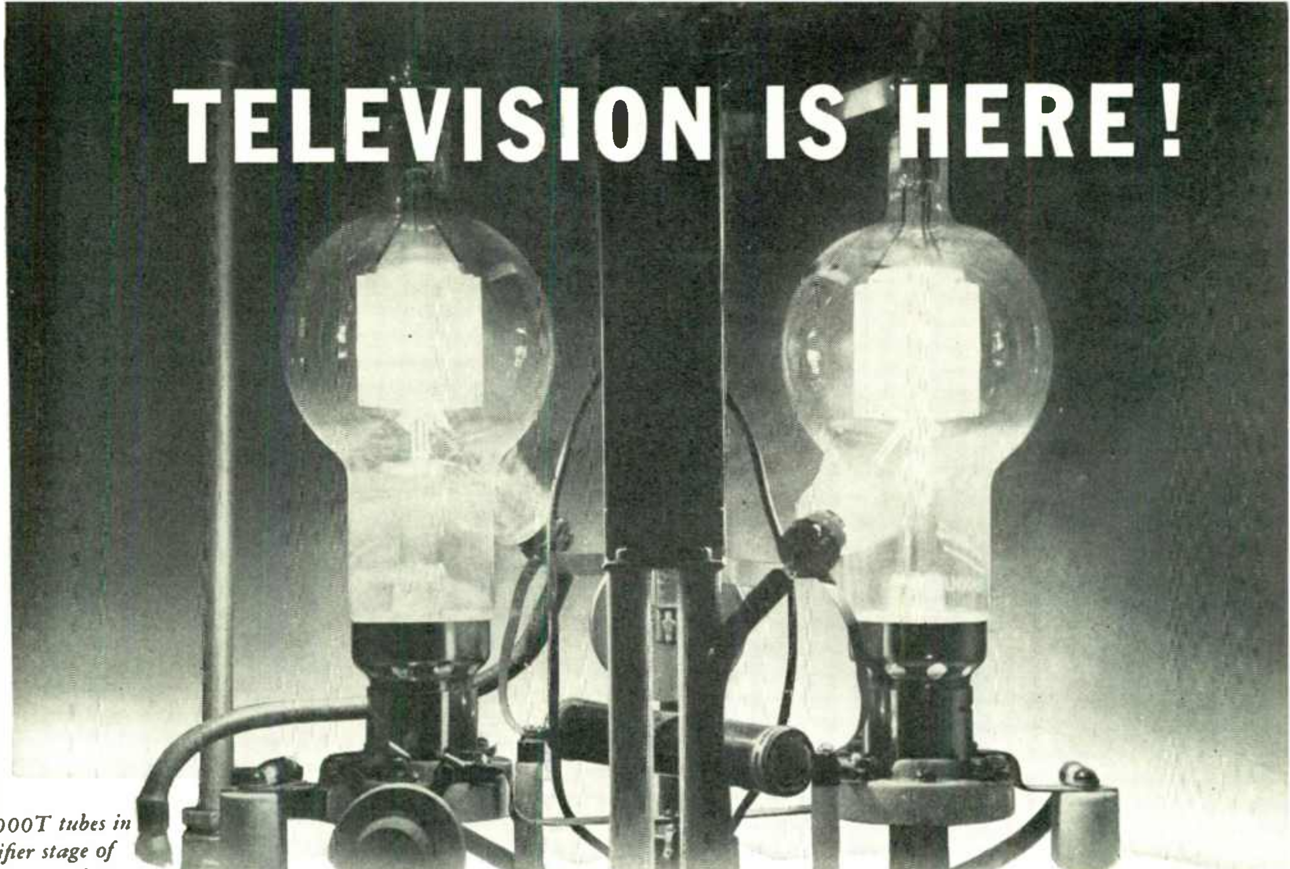


FIG. 8, ABOVE: THE DIMENSIONS OF THIS SOCKET HAVE BEEN REDUCED SUBSTANTIALLY OVER SIMILAR, PRECEDING TYPES



Eimac 1000T tubes in an amplifier stage of W6XAO transmitter, Hollywood

At Don Lee Hollywood... Station KTSL using EIMAC TUBES *since* 1938

Julia Lee Wright, noted Home Economics Director of "The Family Circle" magazine being interviewed, and telecast revealing tricks of her trade.

Two young comedians, Robert Sweeny and Hal March, currently on transcontinental radio show, give a preview of their talents for television broadcast over W6XAO.

Write for your copy of Electronic Telesis — a 64 page booklet fully illustrated — covering the fundamentals of Electronics and many of its important applications. In layman's language.

Work on television station W6XAO (Commercial station KTSL) began in November 1930; and thirteen months later, Dec. 23, 1931, it was on the air on the ultra high frequencies, the first present day television to operate on schedule. Today the station occupies elaborate copper sheathed studios which stand 1700 feet above Hollywood with an antenna on a 300-foot tower.

The program log shows almost every type of presentation. Highest in interest and achievement are the remote pick-ups and special event broadcasts made simultaneously or recorded on film for release later. Studio presentations, especially those directed to war activities, have become a duration standard.

Under the direction of Harry R. Lubcke, television station KTSL will be in daily schedule immediately after the war. Mr. Lubcke says: "We have been using Eimac tubes in our television transmitter since about 1938... We have found them good and reliable performers...their design is such that a favorable ratio of power output to tube and circuit capacitance is obtained... we look forward to using new Eimac tubes which may be forthcoming."

Here again is a statement from a leader in the field, which offers clear evidence that Eimac tubes are first choice of leading electronic engineers throughout the world.

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EITEL-McCULLOUGH, Inc. 991 San Mateo Avenue, San Bruno, Calif.
Plants located at: San Bruno, California and Salt Lake City, Utah
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco 11, Calif., U. S. A.

FM & TELEVISION PRODUCTS DIRECTORY

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

NEW LISTINGS ADDED THIS MONTH

Company addresses will be found in the Directory listings

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

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

AIRPORT RADIO Installations
Wilcox-Gay Corp.

BINDING POSTS
General Radio Company

CERAMICS, Bushings, Washers, Special Shapes
Mycalex Corporation of America

CHOKES, RF
General Radio Company

CONDENSERS, Trimmer
Comar Electric Company

CONTACT POINTS
Wilson Company, H. A.

DISCS, Recording
Pilot Radio Corp.
Wilcox-Gay Corp.

FREQUENCY STANDARDS, Secondary
General Radio Company

HANDSETS, Telephone
Universal Microphone Company

INSULATORS, Ceramic
Mycalex Corporation of America

JACKS, Telephone
Presto Electric Company

METERS, Frequency
Daven Company

MONITORS, Frequency
Doolittle Radio, Inc.

PLATINUM
Wilson Company, H. A.

PUMPS, Dry Air
Andrew Company

RADIO RECEIVERS & TRANSMITTERS
Doolittle Radio, Inc.

RESISTORS, Fixed Precision
Presto Electric Company

RESISTORS, Variable, Ceramic Base
Presto Electric Company

SUPPLY HOUSES
Continental Sales Company

SWITCHES, Key
Presto Electric Company
Western Electric Company

TURNTABLES, Record
Wilcox-Gay Corporation

WIRE, Silver Jacketed on Steel, Copper, Invar
Wilson Company, H. A.

SUPPLY HOUSES

CALIFORNIA
SAN FRANCISCO, Zack Radio Supply Co., 1426 Market St.

CONNECTICUT
BRIDGEPORT, Hatry & Young, 117 Cannon St.
HARTFORD
Hatry & Young, 203 Ann St.
Scell & Co., 227 Asylum St.
NEW HAVEN, Hatry & Young, 1172 Chapel St.

DISTRICT OF COLUMBIA
WASHINGTON, Southern Wholesalers, Inc., 1519 L St. N. W.

GEORGIA
ATLANTA
Concord Radio Corp 265 Peachtree St.
Yancey Co., Inc., W. Peachtree St.
MACON, Specialty Dist. Co.
SAVANNAH, Specialty Dist. Co.

ILLINOIS
CHICAGO
Allied Radio Corp., 833 W. Jackson Blvd.
Chicago Radio App. Co., 4155 S. Dearborn St.
Concord Radio Corp 901 W. Jackson Blvd.
Radio Parts Co 612 W Randolph St
Walker-Jimieson, Inc., 311 S. Western Ave.
ELGIN, Fox Elec. Supply Co., 67 N. State St.
PEORIA, Klaus Radio & Elec Co Main St

INDIANA
INDIANAPOLIS, Kiefer-Stewart Co., W. Georgia St.

IOWA
CEDAR RAPIDS, Checker Elec. Supply, Inc., 1st S. E.
DAVENPORT, Midwest-Timmerman Co., Western Ave.

KENTUCKY
LOUISVILLE, Smith Dist. Co., E. B'way

MARYLAND
BALTIMORE, D & H Distributing Co., 202 S. Pulaski St.

MASSACHUSETTS
BOSTON, Radio Wire Television, Inc., 110 Federal St.
CAMBRIDGE, Eastern Co.
SPRINGFIELD, Cushing, T. F.
WORCESTER, Radio Maint. Supply Co.

MICHIGAN
FLINT, Shand Radio Spec., W. Kearsley St.

MISSOURI
KANSAS CITY, Burstein Applebee Co., 1012 McGee St.
ST. LOUIS, Interstate Supply Co., 10th & Walnuts Sts.

NEW JERSEY
NEWARK
Continental Sales Co 195 Central Ave.
Krich-Radisco Inc 422 Elizabeth Ave
Lippman & Co., Aaron, 246 Central Ave.
Radio Wire Television, Inc., 24 Central Ave.

NEW YORK
BINGHAMTON, Morris Distributing Co., Inc., 25 Henry St.
GLOVERSVILLE, Fulton County Dist. Co.
ITHACA, Stallman of Ithaca, N. Tioga St.
NEW YORK
Bruno-New York Inc 460 W 34th St
Com. Radio-Sound Corp., 570 Lexington Ave.
Harrison Radio Corp., 12 W. B'way
Harvey Radio Co., 103 W. 43 St., N. Y. C.
Radio Wire Television, Inc., 100 Sixth Ave.
Sanford Electronics Corp., 136 Liberty St.
Sun Radio & Electronics Co., 212 Fulton St.
Terminal Radio Corp., 85 Cortlandt St.
SYRACUSE, Morris Distributing Co., Inc., 412 S. Clinton St.

NORTH CAROLINA
RALEIGH, Southeastern Radio Supply Co., E. Hargett St.

OHIO
CLEVELAND, Goldhamer Inc Huron Rd

PENNSYLVANIA
HARRISBURG, D & H Distributing Co., 3115 Cameron St.
PHILADELPHIA, Radio Elec. Service Co., 7th & Arch Sts.
PITTSBURGH
Cameradio Co., 963 Liberty St.
Tydings Co., 623 Grant St.

RHODE ISLAND
PROVIDENCE, Edwards Co., W. H., 94 B'way

SOUTH DAKOTA
SIOUX FALLS, Power City Radio Co., S. Main Ave.

TENNESSEE
KNOXVILLE, McClung Co., C. M.
MEMPHIS, Bluff City Dist. Co., Union Ave.
NASHVILLE, Electra Dist Co W End Ave

TEXAS
HOUSTON, Hall, R.C. & L.F. Caroline St.

UTAH
SALT LAKE CITY, Radio Studios, Inc., E. B'way

VIRGINIA
DANVILLE, Five Forks Battery Station
RICHMOND, Wyatt-Cornick, Inc., Grace St.

WASHINGTON
SEATTLE
Seattle Radio Supply, Inc., 2nd Ave.
Zobrist Co., 2016 Third Ave.

WEST VIRGINIA
CHARLESTON, Chemcity Radio Elec. Co., E. Washington St.
MORGANTOWN, Trenton Radio Co.

WISCONSIN
RACINE, Standard Radio Parts Co., State St.

AIRPORT RADIO Installations
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Air Associates, Inc., Los Angeles, Calif.
Bendix Radio, Towson, Md.
Collins Radio Co Cedar Rapids Ia
Communications Equip. Corp., 134 Colorado St., Pasadena, Calif.
Erco Radio Labs. Inc., Hempstead, L. I., N. Y.
Radio Receptor Co., Inc., 251 W. 19 St., N. Y. C.
Wilcox-Gay Corp. Charlotte Mich.

AMPLIFIERS, Public Address
David Bogen Co Inc 663 Bway NYC 12
Langevin Co 37 W 65 St N Y C 23
Operadio Mfg. Co St Charles Ill
Radio Corp. of Amer. Camden N J
Western Electric Co 195 Bway N Y C

AMPLIFIERS, Studio
Fairchild Camera & Inst Corp Jamaica I N Y
Langevin Co 37 W 65 St N Y C 23
Radio Corp. of Amer. Camden N J
Western Electric Co 195 Bway N Y C

ANTENNAS, Loop, Built-in
DX Crystal Co 1200 N Claremont Ave Chicago 22
Sickles Co F W, Chicopee Mass.

ANTENNAS, Mobile Whip & Collapsible
Air Associates, Inc., Los Angeles
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Bendix Aviation Corp., Pacific Div., 116 Sherman Way, N. Hollywood
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Brach Mfg. Corp., L. S., Newark, N. J.
Camburn Elec. Co., 484 Broome St., N. Y. C.
Galvin Mfg. Corp., Chicago, Ill.
Link, F. M., 125 W. 17th St., N. Y. C.
Premax Products, 4214 Highland Ave., Niagara Falls, N. Y.
Radio Eng. Labs., Inc., L. I. City, N. Y.
Snyder Mfg Co 2218 W Ontario St Phila
Tech. Appl. Co., 516 W. 34 St., N. Y. C.
Ward Products Corp., 1523 E. 45 St., Cleveland, O.

ANTENNAS, Tower Type
Blaw-Knox Co., Pittsburgh, Pa.
Harco Steel Cons. Co., E. Broad St., Elizabeth, N. J.
Lehigh Structural Steel Co., 17 Battery Pl., N. Y. C.
Lingo & Son, John E., Camden, N. J.
Truscon Steel Co., Youngstown, O.
Wincharger Corp., Sioux City, Iowa

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

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

BEARINGS, Glass Instrument
Bird, Richard H., Waltham, Mass.

BERYLLIUM
Clifton Products Inc Painesville O

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

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

BLOWERS, for Radio Equipment
L-R Mfg. Co., Torrington, Conn.
Trade-Wind Motorfans, Inc., 5725 S. Main St., Los Angeles

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

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

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

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

CABINETS, Metal
Cole Steel Equip. Co 349 Bway N Y C
Corry-Jamestown Mfg Corp Corry Pa
Insuline Corp of Amer L I City N Y
Karp Metal Prod. Co Inc 126 30th St Bklyn 31
Par-Metal Prod. Corp., 32-49th St., L. I. City, N. Y.
Porter Metal Prod Co 490 Johnson Av Bklyn

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

CABLE, Coaxial
American Phenolic Corp., 1830 S. 54 Av., Chicago
Anaconda Wire & Cable Co., 25 B'way, N. Y. C.
Andrew Co 363 E 75 St Chicago
Belden Mfg. Co., 4673 W. Van Buren, Chicago
Boston Ins Wire & Cable Co Boston
Comm Prods Co 346 Bergen Av Jersey City 5 N J
Cornish Wire Co., 15 Park Row, N. Y. C.

• The reproducer unit in this loud speaker was especially developed by JENSEN for use in the intercom systems in navy vessels. It reproduces speech clearly and sharply through high levels of noise. Ruggedly built, it withstands extreme shock and vibration, and is weatherproof against severe weather exposure conditions, dust and smoke . . . Like all JENSEN military models, this speaker is built around the most powerful permanent magnet material ever developed, ALNICO 5, as all JENSEN PM Speakers will be when conditions permit.

Now being introduced for the intercom systems on trains, and specifically designed for that purpose, this particular model has many possibilities for use wherever a heavy, rugged speaker with clear, sharp speech reproduction is needed. Write for complete engineering data on this speaker. Samples can be furnished on proper priority.

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Doolittle Radio, Inc., 7521 S. Loomis Blvd., Chicago
General Cable Corp., 420 Lexington, N. Y. C.
General Insulated Wire Corp., 53 Park Pl., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Lenz Electrical Mfg. Co.
Radex Corp., 1308 Elston Ave., Chicago
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Coaxial, Fittings

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

CABLE, Coaxial, Solid Dielectric

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

CABLE, Microphone, Speaker & Battery

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

CABLES, Preformed

Belden Mfg. Co., 4633 W. Van Buren St., Chicago
Wallace Mfg. Co., Wm. T., Rochester, Ind.
Whitaker Cable Corp Kansas City 16 Mo.

CASES, Wooden Instrument

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

CASTINGS, Die

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

CERAMICS, Bushings, Washers, Special Shapes

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

CHANGERS, Record

See Turntables, Record

CHASSIS, Metal

See STAMPINGS, Metal

CHOKES, AF

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

CHOKES, RF

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

CLIPS, Connector

Mueller Electric Co., Cleveland, O.

CLIPS & MOUNTINGS, Fuse

Alden Prods. Co., Brockton, Mass.
Dante Elec. Mfg. Co., Bantam, Conn.

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

CLOTH, Insulating

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

COIL FORMS, Glass

Corning Glass Works, Corning, N. Y.

CONDENSERS, High-Voltage Vacuum

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

CONDENSERS, Small Ceramic Tubular

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

CONDENSERS, Transmitter Neutralizing

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

CONDENSERS, Trimmer

Alden Prods. Co., Brockton, Mass.
American Steel Package Co., Defiance, O

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

COILS, Radio

See Transformers, IF, RF

CONDENSERS, Ceramic Case Mica Transmitting

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

CONDENSERS, Fixed

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

CONDENSERS, Gas-filled

Johnson Co, E. F. Waseca Minn
Lapp Insulator Co., Inc., Leroy, N. Y.

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

CONDENSERS, Variable Receiver Tuning

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

CONDENSERS, Variable Transmitter Tuning

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

CONNECTORS, Cable

Aero Electric Corp., Los Angeles, Calif.
Airadio, Inc., Stamford, Conn.
Alden Prods., Brockton, Mass.
Amer. Microphone Co., 1915 S. Western Av., Los Angeles
Amer. Phenolic Corp., 1830 S. 54th St., Chicago
Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Andrew Co 363 E 75 St Chicago
Astatic Corp., Youngstown, O.

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

CONTACT POINTS

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

CORES, Powdered Iron

See IRON CORES, Powdered

COUPLINGS, flexible

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

CRYSTAL GRINDING EQUIPMENT

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

CRYSTAL HOLDERS

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

CRYSTALS, Quartz

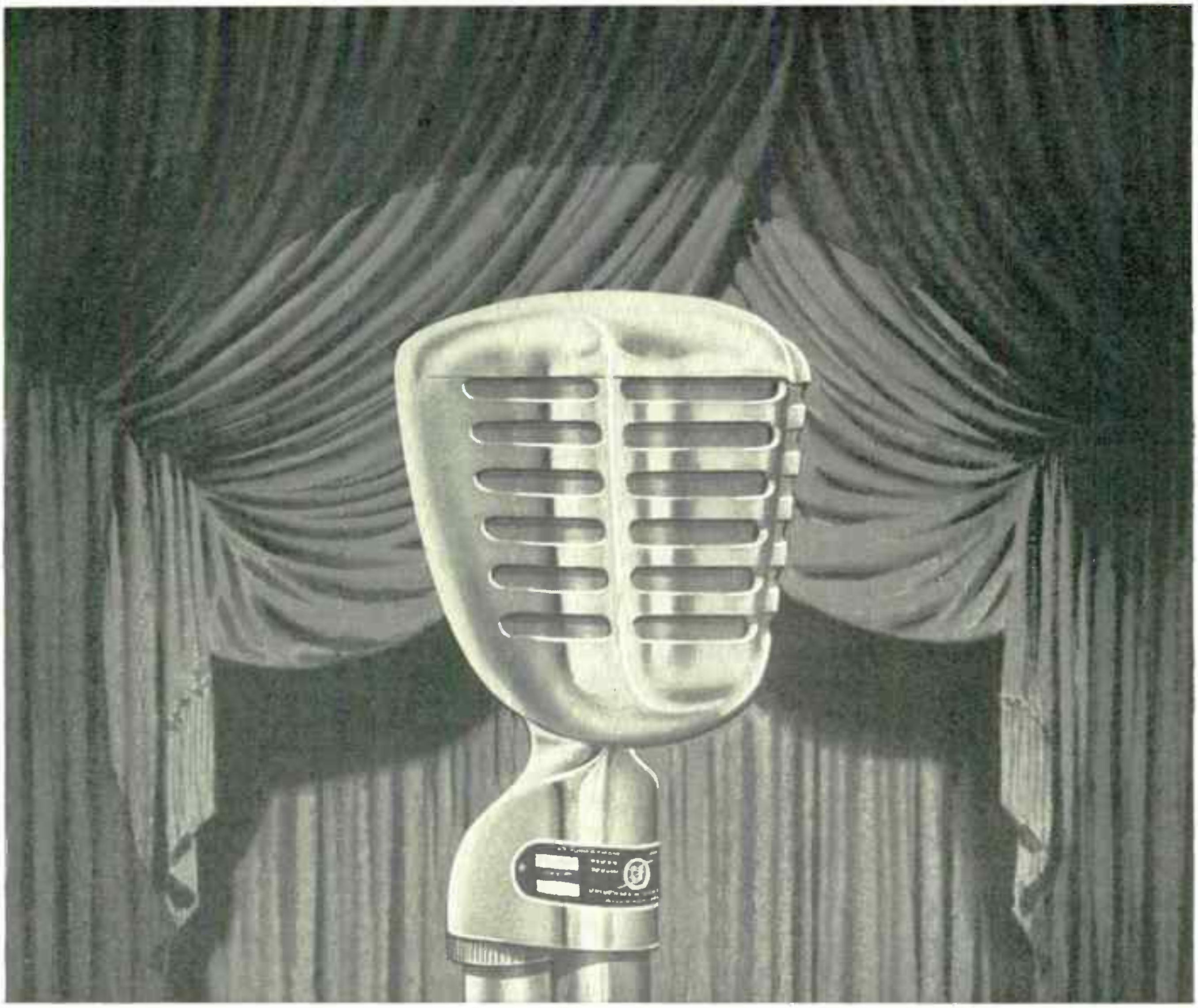
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Bausch & Lomb Optical Co., Rochester, N. Y.
Bliley Elec. Co., Erie, Penna.
Collins Radio Co., Cedar Rapids, Iowa
Crystal Prod. Co., 1519 McGee St., Kansas City, Mo.
Crystal Research Labs., Hartford, Conn.
DX Crystal Co., 1200 N. Claremont, Chicago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

DIAL LIGHTS

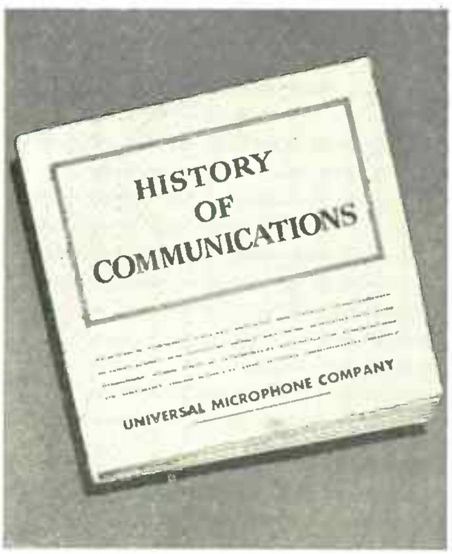
See PILOT LIGHTS

DIALS, Instrument

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



UNIVERSAL'S NEW D-20 MICROPHONE



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DISCS, Recording

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

DYNAMOTORS —

See Motor-Generators, Small

ENAMELS, Wood & Metal Finish

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

ETCHING, Metal

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

FACSIMILE EQUIPMENT

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

FASTENERS, Separable

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

FELT

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

FIBRE, Vulcanized

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

FILTERS, Electrical Noise

Bendix Aviation Corp., Pacific Div. 11600 Sherman Way, N. Hollywood.
Com. Equip. & Eng. Co., N. Parkside Ave., Chicago
Freed Radio Corp., 200 Hudson St., N. Y. C.
General Electric Co Schenectady N. Y.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Miller Co., J. W., 5917 S. Main St., Los Angeles
Solar Mfg. Corp., 285 Madison Ave., N. Y. C. 17
Tobe Deutschmann Corp., Canton, Mass.

FINISHES, Metal

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

FREQUENCY STANDARDS, Primary

General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Secondary

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

FUSES, Enclosed

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

GEARS & PINIONS, Metal

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

GEARS & PINIONS, Non-Metallic

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

GENERATORS, Beat Frequency

Boonton Radio Corp Boonton N J
General Radio Co Cambridge Mass

GENERATORS, Electronic AC

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

GENERATORS, Gas Engine Driven

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

GENERATORS, Hand Driven

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

GENERATORS, Standard Signal

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

GENERATORS, Wind-Driven, Aircraft

General Armature Corp., Lock Haven, Pa.

GLASS, Electrical

Corning Glass Works, Corning, N. Y.

GREASE, for Electrical Contacts & Bearings

Royal Engineering Co. (Royco Grease), East Hanover, N. J.

HANDSETS, Telephone

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

HEADPHONES

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

HORNS, Outdoor

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

INDUCTION HEATING EQUIPMENT

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

INDUCTORS, Transmitter

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

INDUCTORS, Variable Tuning

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

INSTRUMENTS, Radio Laboratory

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

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

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

INTERFERENCE SUPPRESSORS

See FILTERS, Electrical Noise

IRON CORES, Powdered

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

IRONS, Soldering

Acme Electric Heating Co., 1217 Washington St., Boston
Amer. Electrical Heater Co., 6110 Cass Ave., Detroit
Drake Elec. Wks., Inc., 3656 Lincoln Ave., Chicago
Electric Soldering Iron Co., Deep River, Conn.
General Electric Co., Schenectady, N. Y.
Hexacon Elec. Co., Roselle Park, N. J.
Sound Equipment Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Ungar, Inc., Harry A., 615 Ducommun St., Los Angeles 12
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles
Vulcan Electric Co., Lynn, Mass.

JACKS, Telephone

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

KEYS, Telegraph

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

KNOBS, Radio & Instrument

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

LABELS, Coding

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

LABELS, Removable

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

LABELS, Stick-to-Metal

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

LABORATORIES, Electronic

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

LACQUERS, Wood & Metal Finish

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

LOCKWASHERS, Spring Type

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

LUGS, Soldering

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

LUGS, Solderless

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

MACHINES, Impregnating

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

MACHINES, Screwdriving

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

MAGNETS, Permanent

Arnold Engineering Co., 147 E. Ontario St., Chicago 11
General Elec. Co., Schenectady, N. Y.
Indiana Steel Prod. Co., 6 N. Michigan Ave., Chicago, Ill.
Thomas & Skinner Steel Prod. Co., Indianapolis, Ind.

MAIL ORDER SUPPLY HOUSES

See listing at head of Directory

MARKERS, Wire Identification

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

MARKING MACHINES, Letters, Numbers

Marken Machine Co., Keene, N. H.

METAL, Thermostatic

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

METERS, Ammeters, Voltmeters, Small Panel

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

METERS, Frequency

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

METERS, Q

Boonton Radio Corp., Boonton, N. J.

METERS, Vacuum Tube Volt

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

METERS, Vibrating Reed

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

MICA

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

MICROPHONES

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

MONITORS, Frequency

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

MOTOR-GENERATORS, Rotary Converters

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

MOTORS, Very Small Types

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

MOUNTINGS, Shock Absorbing

Gen. Tire & Rubber Co Wabash Ind
Lord Mfg. Co., Erie, Pa.
Pierce-Roberts Co., Trenton, N. J.
U. S. Rubber Co., 1230-6th Ave., N. Y. C.

MYCALEX

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

NAME PLATES, Etched Metal

See ETCHING, Metal

NAME PLATES, Plastic

Crowe Name Plate & Mfg. Co., 3700 Ravenswood Ave., Chicago

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

NICKEL, Sheet, Rod, Tubes

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

NOISE FILTERS

See FILTERS, Electrical Noise

NUTS, Self-locking

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

OSCILLATORS, AF

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

OSCILLOSCOPES, Cathode Ray

Du Mont Laboratories, Inc., Allen B., Passaic, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Millen Mfg. Co., Malden, Mass.
Panoramic Radio Corp., 242 W. 55 St., N. Y. C.
Reiner Electronics Co., 152 W. 25 St., N. Y. C.
RCA Mfg. Co., Inc., Camden, N. J.
Radio City Products Co., Inc., 127 W. 26 St., N. Y. C.

OVENS, Industrial & Laboratory

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

PANELS, Metal Etched (See Etching, Metal)

PANELS, Phenolic, Cast without Molds

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

PHONOGRAPH RECORDING BLANKS

See DISCS, Recording

PHONOGRAPH RECORD PLAYERS

See TURNTABLES, Phonograph

PILOT LIGHTS

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

PHOSPHOR BRONZE

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

PLASTICS, Extruded

Blum & Co., Inc., Julius, 532 W. 22 St., N. Y. C.
Brand & Co., Wm., 276 4th Ave., N. Y. C.
Extruded Plastics, Inc., Norwalk, Conn.
Industrial Synthetic Corp., Irvington, N. J.
Irvington Varnish & Insulator Co., Irvington, N. J.

PLASTICS, Injection Molded

Remler Co., Ltd., 2101 Bryant St., San Francisco
Tech-Art Plastics, 41-01 36th Ave., Long Island City, N. Y.
Universal Plastics Corp., New Brunswick, N. J.

PLASTICS, Laminated or Molded

Acadia Synthetic Prods., 4031 Ogden Av., Chicago
Alden Prods. Co., Brockton, Mass.
American Cyanamid Co., 30 Rockefeller Plaza, N. Y. C.
American Insulator Corp., New Freedom, Pa.
American Molded Prods. Co., 1753 N. Honore, Chicago
Auburn Button Works, Auburn, N. Y.
Barber-Colman Co., Rockford, Ill.
Brandywine Fibre Prods. Co., Wilmington, Del.
Brilhart Co., Arnold, Great Neck, N. Y.
Catalin Corp., 1 Park Av., N. Y. C.
Celanese Celluloid Corp., 180 Madison Av., N. Y. C.
Chicago Molded Prods. Corp., 1024 N. Kolmar, Chicago
Continental-Diamond Fibre Co., Newark, Del.
Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.
Dow Chemical Co., Midland, Mich.
Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Formica Insulation Co., Cincinnati, O.
General Electric Co., Plastics Dept., Pittsfield, Mass.
General Industries Co., Elyria, O.
Gits Molding Corp., 4600 Huron St., Chicago
Imperial Molded Prods. Co., 2921 W. Harrison, Chicago
Industrial Molded Prods. Co., 2035 Charleston, Chicago
Kurz-Kasch, Inc., Dayton, O.
Macallen Co., Boston, Mass.
Mica Insulator Co., 196 Varick, N. Y. C.
Monsanto Chemical Co., Springfield, Mass.
National Vulcanized Fibre Co., Wilmington, Del.
Northern Industrial Chemical Co., Boston, Mass.
Printloid Corp., 93 Mercer St., N. Y. C.
Radio City Products Co., 127 W. 26 St., N. Y. C.
Remler Co., Ltd., 2101 Bryant St., San Francisco
Richardson Co., Melrose Park, Ill.
Rogan Bros., 2000 S. Michigan Ave., Chicago
Rohm & Hass Co., Philadelphia
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Stokes Rubber Co., Joseph Trenton, N. J.
Surprenant Elec. Ins. Co., Boston
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

PLASTICS, Materials

Bakelite Corp., 30 E. 42 St., N. Y. C.
Carbide & Carbon Chemicals Corp., 30 E. 42 St., N. Y. C.

PLASTICS, Transparent

Acadia Syn. Prod. 4035 Ogden Ave Chicago 23
Carbide & Carbon Chemicals Corp., 30 E. 42 St., N. Y. C.
Celanese Celluloid Corp., 180 Madison Ave., N. Y. C.
Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., E. I., Arlington, N. J.
Plax Corp., Hartford, Conn.,
Printloid Corp., 93 Mercer St., N. Y. C.
Rohm & Hass Co., Washington Sq., Philadelphia

PLATING, Metal on Molded Parts

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

PLATINUM

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

PLUGS (Banana), Spring Type

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

PLUGS, Coaxial

Andrew Co 363 E 75 St Chicago 19

PLUGS, Miniature Battery

Intl. Resist. Co 429 N Broad St Phila 8

PLUGS, Telephone Type

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

PLYWOOD, Metal Faced

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

POINTS, Contact

See Contact points

PUMPS, Dry Air

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

QUARTZ, Rods, Tubes, Plates

Hanovia Chem. & Mfg Co Newark 5 N J

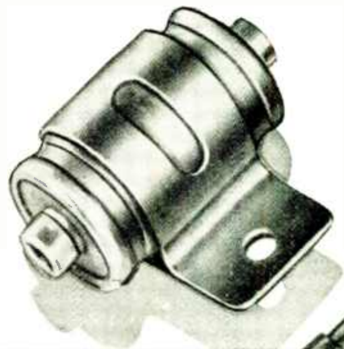
RACKS & PANELS, Metal

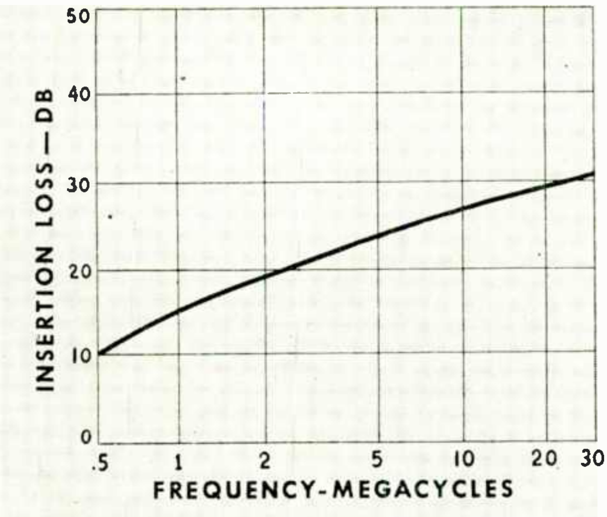
See STAMPINGS, Metal

RADIO RECEIVERS & TRANSMITTERS

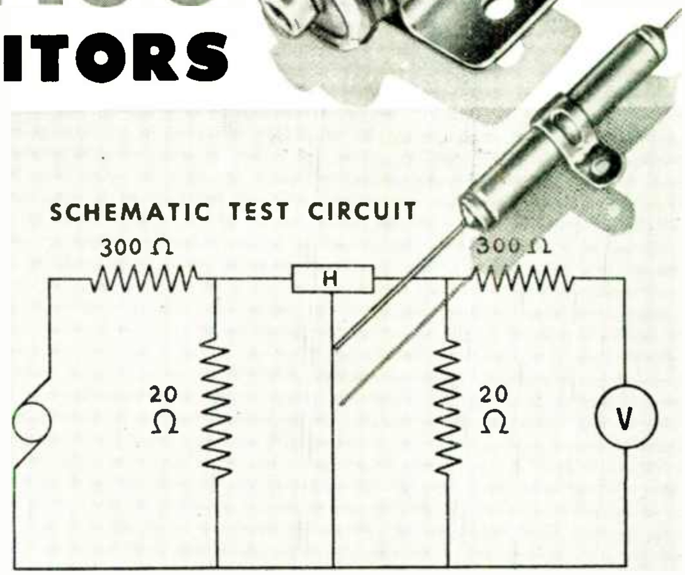
Abbott Instrument, Inc., 8 W. 18 St., N. Y. C. 3
Admiral Corp Chicago Ill
Air Associates, Inc., Los Angeles
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Aircraft Radio Corp., Boonton, N. J.
Aircraft Radio Equip. Corp., 6244 Lex. Ave., Hollywood, Calif.
Air Communications, Inc., 2233 Grant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

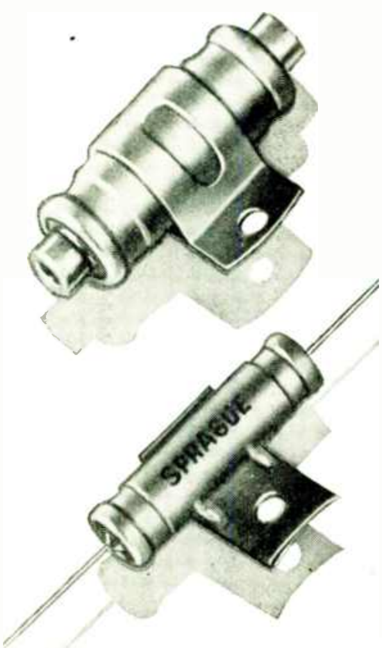
SPRAGUE HYPASS CAPACITORS





Curve showing insertion loss of a Sprague HYPASS Capacitor.





The Solution to "WHAT TO DO WITH ANTI-RESONANT FREQUENCIES?"

Conventional methods of getting rid of vibrator "hash" usually call for the use of a by-pass capacitor, shunted by a mica capacitor. This system, however, has at least one anti-resonant frequency. Of course the engineer juggles his constants so that this anti-resonant frequency comes where it causes the least trouble—BUT, in today's all-wave devices, there just isn't any such place!

The New Sprague Method is simply to utilize the Sprague HYPASS Capacitor. Technically, this is a 3-terminal network which, at low frequencies, "looks" like a capacitor in respect to its capacity, voltage rating, and size. At high frequencies—well, the above diagram tells the story. Although accurate measurements of their performance at the very high end of the spectrum are difficult to obtain as yet, qualitative indications show that HYPASS units do the job at 100 megacycles and more—so much so that, if you have a "hash" problem, we'd welcome an opportunity to stack them against it.

SPRAGUE ELECTRIC COMPANY, *North Adams, Mass.*

(Formerly Sprague Specialties Co.)

* T. M. REG. U. S. PAT. OFFICE

ARMY E NAVY

SPRAGUE

CAPACITORS — *KOOLOHM RESISTORS

Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles
Howard Radio Co., 1731 Belmont Ave. Chicago
Howard Pacific Corp 923 N Western Av Los Angeles
Hudson Amer Corp 25 W 43 St N Y C
Intl Detrola Corp Beard & Chatfield Sts Detroit 9
Jefferson, Inc., Ray, Freeport, N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 E 23 St., N. Y. C.
Karadio Corp., 1400 Harmon Pl., Minneapolis, Minn.
Kemlite Labs., 1809 N. Ashland Ave., Chicago
Lear Avia, Inc., Piqua, O.
Lewyt Corp., 60 B'way, B'klyn, N. Y.
Link, F. M., 125 W. 17 St., N. Y. C.
Machlett Labs., Inc., Springdale, Conn.
Magnavox Co., Indianapolis, Ind.
Majestic Radio & Tel. Corp., 2600 W. 50 St., Chicago
McElroy Mfg. Corp., Brookline Ave., Boston
Megard Corp., 381 W. 38 St., Los Angeles, Calif.
Meissner Mfg Co Mt Carmel Ill
Midwest Radio Corp., Cincinnati, O.
Millen Mfg. Co., Inc., Malden, Mass.
National Co., Inc., Malden, Mass.
Noblitt-Sparks Ind. Inc., Columbus, Ind.
North Amer. Philips Co., 100 E. 42 St., N. Y. C.
Operadio Mfg. Co., St. Charles, Ill.
Packard Bell Co 1115 S Oak St Los Angeles
Panoramic Radio Corp., 245 W. 55 St., N. Y. C. 19
Philco Corp., Tioga & C Sts., Phila.
Philharmonic Radio Corp., 216 Williams St., N. Y. C.
Pierson-DeLane, Inc., 2345 W. Washington Blvd., Los Angeles
Pilot Radio Corp., L. I. City, N. Y.
Powers Electronic & Communication Co., Glen Cove, N. Y.
Precision Tube Co., 3828 Terrace St., Phila. 28
Press Wireless, Inc 1475 B'way N Y C
Radiation Products, Inc., 1142 S. Wall, Los Angeles 15
Radio Corp. of Amer., Camden, N. J.
Radio Craftsmen, 1340 S. Mich. Ave., Chicago
Radio Engineering Labs L I City N Y
Radio Frequency Labs., Inc., Boonton, N. J.
Radio Mfg. Engineers, Inc., Peoria, Ill.
Radiomarine Corp. of Amer., 75 Varick St., N. Y. C.
Radio Receptor Co., Inc., 251 W. 17 St., N. Y. C.
Radio Transceiver Labs., 86-27 115th St., Richmond Hill, L. I.
Remler Co Ltd 2101 Bryant St San Francisco
Richardson-Allen Corp., 15 W. 20 St., N. Y. C.
Rosen Co., Raymond, 32 & Walnut Sts., Phila.
Rauland Corp., Chicago, Ill.
Sanborn Co., Cambridge 39, Mass.
Schuttig & Co., 9th & Kearny Sts., Washington, D. C.
Scott Radio Labs., Inc., 4450 Ravenswood Ave., Chicago
Seeburg Corp., J. P., 1500 N. Dayton St., Chicago
Sentinel Radio Corp., Evanston, Ill.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Calif.
Sonora Radio & Telev. Corp., 325 N. Hoyne Ave., Chicago
Sparks-Withington Co., Jackson, Mich.
Sperry Gyroscope Co Garden City N Y
Sperti, Inc., Cincinnati, O.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago
Stromberg-Carlson Co., Rochester, N. Y.
Tech. Radio Co 275 9th St San Francisco 3
Templetone Radio Co., Mystic, Conn.
Transmitter Equip. Mfg. Co., 345 Hudson St., N. Y. C.
Trav-Ler Karenola Corp 1030 W Van Buren St Chicago
United Cinephone Corp Torrington Conn
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Waugh Laboratories, 420 Lexington Ave., N. Y. C.
Western Electric Co 195 B'way N Y C
Westinghouse Elec. & Mfg. Co., Wilkens Ave., Baltimore, Md.
Wilcox Electric Co., 14th & Chestnut Sts., Kansas City, Mo.
Wilcox-Gay Corp Charlotte Mich
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECORD CHANGERS

See TURNTABLES, Record

RECORDS, Blank

See DISCS, Recording

RECTIFIERS, Metallic Current

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

RECTIFIERS, Metallic Instrument & Relay

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

REGULATORS, Temperature

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

REGULATORS, Voltage

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

RELAYS, Hermetically Sealed

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

RELAYS, Plug-in

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

RELAYS, Small Switching

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

RELAYS, Small Telephone Type

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

RELAYS, Stepping

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

RELAYS, Time Delay

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

RELAYS, Transmitter Switching and Keying

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

RELAYS, Vacuum

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

RELAY TESTERS, Vibration

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

RESISTORS, Fixed

Acme Elec. Heating Co., Boston, Mass.
Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., N. Y. C.
Carborundum Co., Niagara Falls, N. Y.
Centralab, Milwaukee, Wisconsin
Clarostat Mfg. Co., 130 Clinton St., Bklyn, N. Y.
Cont'l Carbon, Inc., Cleveland, O.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Jersey City, N. J.
Elco Resistors Co 114 W 18 St N Y C
Erie Resistor Corp., Erie, Pa.
Globar Div. Carborundum Co., Niagara Falls, N. Y.
Groves Corp Cape Girardeau Mo
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
Intern'l Resist. Co 429 N Broad St Phila 8
Lectrohm, Inc., Cicero, Ill.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy, Chicago
Sensitive Research Inst., Corp., 4545 Bronx Blvd., N. Y. C.
Shallcross Mfg. Co., Collingdale, Pa.
Speer Resistor Corp., St. Marys, Pa.
Sprague Specialties Co., N. Adams, Mass.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prod. Co., 842 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
White Dental Mfg. Co., 10 E. 40th St., N. Y. C.
Wirt Co., Germantown, Pa.

RESISTORS, Fixed Precision

General Radio Co Cambridge Mass
Inst. Resistors, Inc., Little Falls, N. J.
Intern'l Resist. Co 429 N Broad St Phila 8
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Presto Electric Co., Union City, N. J.
Shallcross Mfg. Co., Collingdale, Pa.

RESISTORS, Flexible

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

RESISTORS, Variable Laboratory Type

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

RESISTORS, Variable

Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Inst. Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
Biddle Co., James G., Arch St., Phila.
Centralab, Milwaukee, Wis.
Chicago Tel. Supply Co., Elkhart, Ind.
Cinema Eng. Co., Burbank, Cal.
Clarostat Mfg. Co., 130 Clinton, Bklyn, N. Y.
Cutler-Hammer, Inc., Milwaukee, Wis.
DeJur Amsco Corp., Shelton, Conn.
Electro Motive Mfg. Co., Willimantic, Conn.
General Radio Co., Cambridge, Mass.
G-M Labs., Inc., Chicago, Ill.
Inst. Resistors, Inc., Little Falls, N. J.
Intern'l Resist. Co 429 N Broad St Phila 8
Lectrohm, Inc., 5125 W. 25th, Cicero, Ill.
Mallory & Co., P. R., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Shallcross Mfg. Co., Collingdale, Pa.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prods. Co., 820 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
Wirt Co., Germantown, Pa.

RESISTORS, Variable, Ceramic Base

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

SCREW MACHINE PARTS, Brass, Steel

Chicago Aviation Co., 1200 N. Claremont, Chicago
Ward Products Corp., E. 45 St., Cleveland, O.

SCREW MACHINE PARTS, Non-Metallic

Continental-Diamond Fibre Co., Newark, Del.

SCREWS, Clutch Head

United Screw & Bolt Corp., 71 Murray St., N. Y. C.

SCREWS, Recessed Head

American Screw Co., Providence, R. I.
Bristol Co., The, Waterbury, Conn.
Chandler Prods. Co., Cleveland, O.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
International Screw Co., Detroit, Mich.
Lamson & Sessions, Cleveland, O.
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Nat. Screw & Mfg. Co., Cleveland, O.
New England Screw Co., Keene, N. H.
Parker Co., Charles, The, Meriden, Conn.
Parker-Kalon Corp., 198 Varick, N. Y. C.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Mfg. Co., Chicago
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
Shakeproof, Inc., 2501 N. Keeler Av., Chicago
Southington Hardw. Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

SCREWS, Self-Tapping

American Screw Co., Providence, R. I.
Central Screw Co., 3519 Shields Av., Chicago
Continental Screw Co., New Bedford, Mass.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Parker-Kalon Corp., 198 Varick, N. Y. C.
Shakeproof, Inc., 2501 N. Keeler, Chicago

SCREWS, Set and Cap

Allen Mfg. Co., Hartford, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Parker-Kalon Corp., 198 Varick, N. Y. C.
Republic Steel Corp., Cleveland, O.
Shakeproof, Inc., 2501 N. Keeler Av., Chicago

SCREWS, Hollow & Socket Head

Allen Mfg. Co., Hartford, Conn.
Central Screw Co., 3519 Shields, Chicago
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Parker-Kalon, 198 Varick, N. Y. C.
Stand. Pressed Steel Co., Jenkintown, Pa.

SELENIUM

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

SHAFTING, Flexible

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

SHEETS, Electrical

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

SHIELDS, Tube

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

SHOCK ABSORBERS

See MOUNTINGS Shock Absorbing

SIGNAL GENERATORS

See GENERATORS Standard Signal

SOCKETS, Cathode Ray Tube

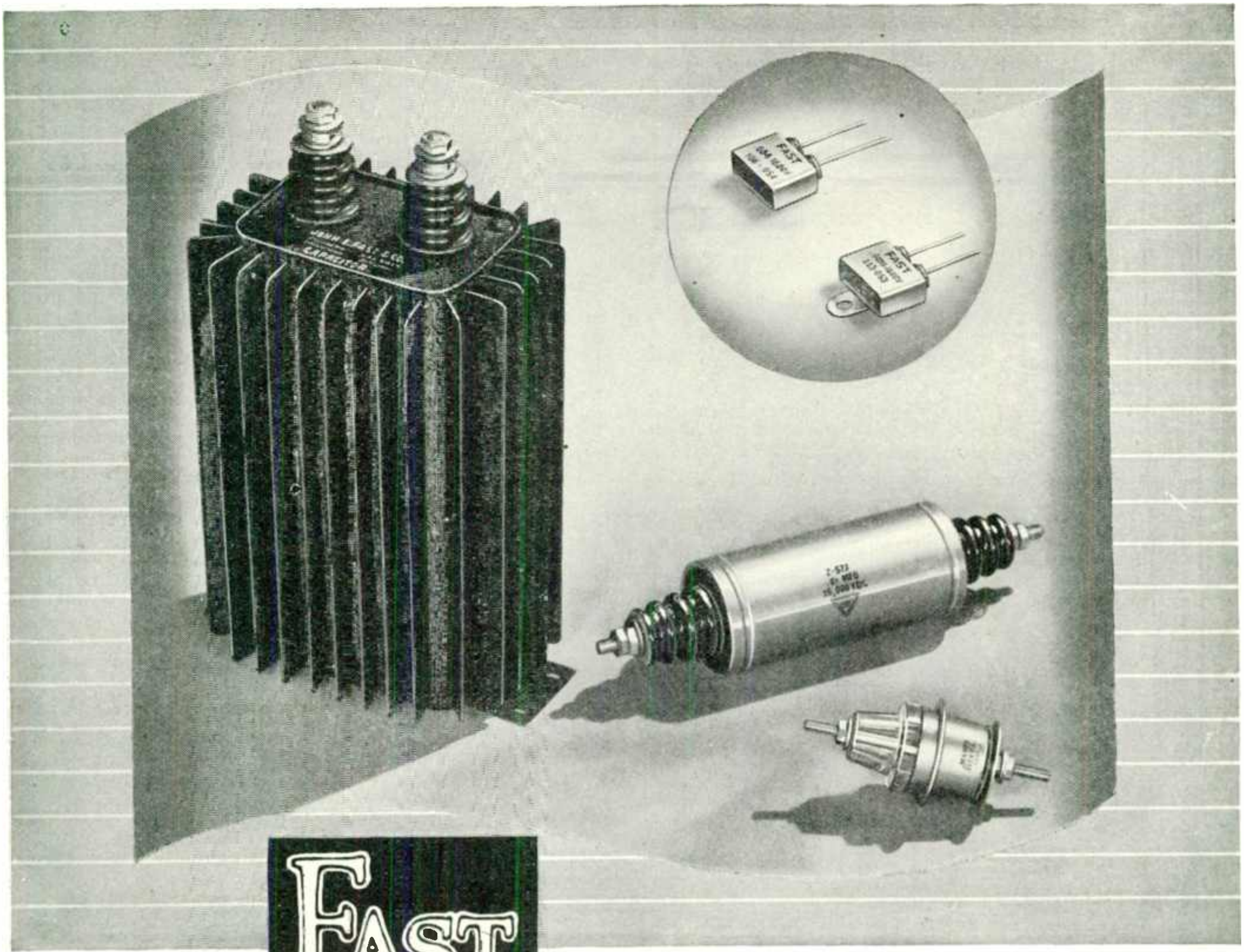
Franklin Mfg Corp 175 Varick St N Y C

SOCKETS, Tube

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

SOCKETS, Tube, Ceramic Base

Hammarlund Mfg Co Inc 460 W 34 St N Y C
Johnson Co E F Waseca Minn



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It may be of interest to note this is the first time in the history of the United States Navy that any industry has been selected for a citation of honor and achievement. The John E. Fast organization is a member of this group.

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Canadian Representatives: Beaupre Engineering Works Reg'd.
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J. R. Longstaffe, Ltd., 11 King Street, W., Toronto 1, for Special Applications

National Co Inc Malden Mass
Nat'l Fabricated Products W Belden Ave Chicago
Ucinite Co Newtonville Mass

SOLDER, Self-fluxing

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

SOLDER POTS

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

SPEAKERS, Cabinet Mounting

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

SPEAKERS, Outdoor Type

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

SPRINGS

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

STAMPINGS, Metal

Bud Radio Inc E 55 St Cleveland O
Goat Metal Stampings Inc 314 Dean St Brooklyn N Y
Hadley Co R M 707 E 61st Los Angeles
Insuline Corp of Amer Long Island City N Y
Par-Metal Prod Corp Long Island City N Y
Stewart Stamping Corp 621 E 216 St N Y C
Willor Mfg Corp 288-A Eastern Blvd N Y C

STEATITE, See Ceramics

SUPPRESSORS, Parasitic

Ohmite Mfg Co 4835 Flournoy St Chicago

SWITCHES, Aircraft Push

Square D Co Kollsman Inst Div Elmhurst N Y

SWITCHES, Key

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

SWITCHES, Midget Snap

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

SWITCHES, Rotary, Bakelite Wafer

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

SWITCHES, Rotary, Ceramic Wafer

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

SWITCHES, Time Delay

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

SYNTHETICS, Wood & Metal Finish

Sullivan Varnish Co 410 N Hart St Chicago 22

TERMINALS, Hermetically Sealed

See BUSHINGS Terminal Sealing

TERMINALS, Soldered or Solderless

See LUGS Soldering and Solderless

TERMINALS (Turret Lugs)

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

TERMINAL STRIPS

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

TEST CHAMBERS, Temperature, Humidity, Altitude, Salt Spray

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

THERMISTERS

Western Electric Co 195 Bway N Y C

TRACING PAPERS, CLOTH, CELLOPHANE

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

TRANSFORMERS, Constant-Voltage

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

TRANSFORMERS, IF, RF

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

TRANSFORMERS, Receiver Audio & Power

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

TRANSFORMERS, Variable Voltage

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

TUBE MANUFACTURING MACHINES

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

TUBES, Cathode Ray

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

TUBES, Current Regulating

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

TUBES, Photo-Electric

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

TUBES, Receiving

General Elec Co Schenectady N Y
Hytron Corp Salem Mass
Ken-Rad Tube & Lamp Corp Owensboro Ky
Nat'l Union Radio Corp Newark N J
Raytheon Prod Corp 420 Lexington Av N Y C
RCA Mfg Co Camden N J
Sylvania Elect Prod Inc Emporium Pa
Tung-Sol Lamp Works Newark N J

TUBES, Transmitting

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

TUBES, Voltage-Regulating

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

TUBES, X-Ray

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

TUBING, Laminated Phenolic

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

TUBING, Precision Metal

Superior Tube Co., Norristown, Pa.

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

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

TURNTABLES, Record

Fairchild Camera & Inst. Co., 475 Tenth Av N. Y. C.
General Industries Co., Elyria, O.
General Inst. Corp., Elizabeth 3, N. J.
Presto Recording Corp., 242 W. 55 St., N. Y. C.
R C A Mfg. Co., Camden, N. J.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago
Webster Products, 3825 Armitage Ave., Chicago
Western Electric Co., 125 B'way, N. Y. C.
Wilcox-Gay Corp Charlotte Mich

VARNISHES, Fungus Resistant

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

VARNISHES, Insulating, Air-Drying & Baking

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

VARNISHES, Wrinkle Finish

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

VIBRATION TEST EQUIPMENT

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

VIBRATORS, Power Supply

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

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Western Elec. Co., 195 B'dway, N. Y. C.
Zophar Mills, Inc., 112–26 St., Bklyn

WELDING, Gas, Aluminum & Steel

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

WIRE, Bare

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

WIRE, Glass Insulated

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

WIRE, HOOKUP

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

WIRE & CABLE

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

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Formica Insulation Co., Cincinnati, O.

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

NEXT DIRECTORY, TO APPEAR IN THE MAY ISSUE, WILL LIST THE MANUFACTURERS OF RADIO EQUIPMENT, COMPONENTS, AND MATERIALS, TOGETHER WITH THE NAMES OF THE GENERAL MANAGERS AND CHIEF ENGINEERS.

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

Triplett

STANDARDS ARE SET BY TRIPLETT

ELECTRICAL INSTRUMENT CO.

BLUFFTON, OHIO

(CONTINUED FROM PAGE 52)

ing methods of range extension in wide-band amplifiers; while others relate to impedance characteristics of various types of transmission lines, cut off frequencies in circular wave-guides, UHF paths and line-of-sight distances.

FIG. 9. NEW UNIVERSAL MICROPHONE

Microphone Design: Universal Microphone Company, Inglewood, Calif., has designed their wartime microphone experience into a new dynamic series illustrated in Fig. 9. The internal element is mechanically isolated from the case, to minimize transmission of noise from the cord and stand. Intended for recording, public address, or studio service, the frequency range is rated at 50 to 8,000 cycles at −54 db as referred to 1 volt per bar.

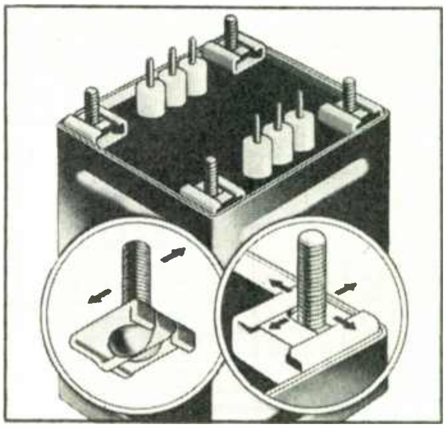

FIG. 10. IMPROVED MOUNTING STUDS

Self-Aligning Studs: A very interesting feature of transformer cases produced by Electronic Components Company, 423 N. Western Avenue, Los Angeles, is the use of self-aligning, detachable mounting studs. As shown in Fig. 10, the stud is a standard machine screw, held in the slot so that it cannot turn, yet the screw can move enough to permit a 1/4-in. tolerance in the location of the mounting holes. The clip is of heavy gauge steel, cadmium plated. Transformers fitted with these mountings are available in 15 case sizes, either hermetically or non-hermetically sealed.

RAYTHEON TUBES Chosen For PAN AMERICAN'S Postwar "Clipper"!

Feast your eyes on this mighty, 100-passenger airliner! When peace comes, a giant fleet of its sister ships will girdle the globe for Pan American World Airways. And in each of them will be the best electronic devices to come out of the war, equipped with famous Raytheon high-fidelity tubes!

Raytheon tubes have been used for years by Pan American, and it is because of their proven performance, fine reception and complete dependability that they were selected to play such a vital role in this great company's future operations. The assignment is but one of hundreds of postwar applications for which Raytheon tubes have been specified by America's radio and electronic industries.

When tubes are more readily available for civilian use, Raytheon will offer radio service dealers the *finest* tubes in its history . . . tubes combining long prewar experience with outstanding wartime development. And that's not all. They'll be backed by a Raytheon merchandising program that will be the most *beneficial* ever offered you. Keep your eye on Raytheon . . . for greater postwar profits!

Increased turnover and profits . . . easier stock control . . . better tubes at lower inventory cost . . . these are benefits which you may enjoy as a result of the Raytheon standardized tube program, which is part of our continued planning for the future.

Raytheon Manufacturing Company

RADIO RECEIVING TUBE DIVISION

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ELECTRONIC AND RADIO TUBES

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

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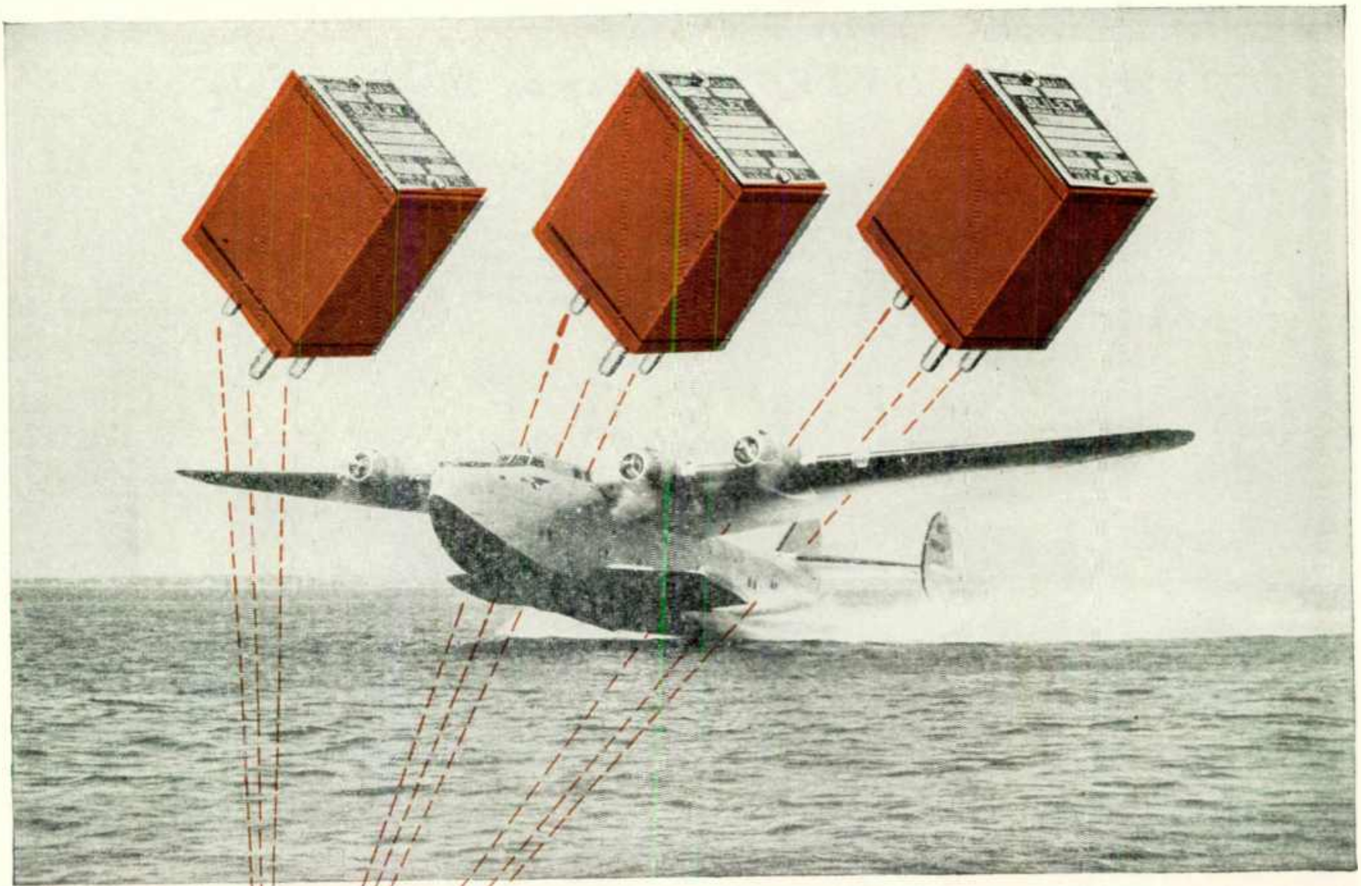
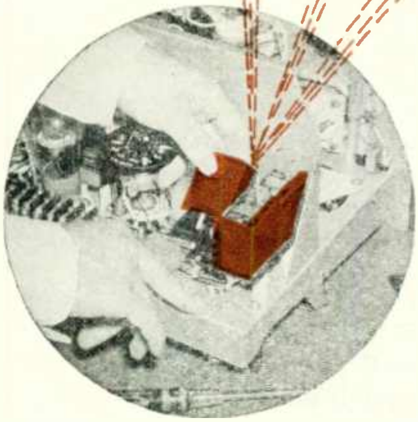


BLILEY CRYSTALS, of course, fly with Pan American



Bliley *acid etched** crystals persistently show up wherever there is an important communications job to be done such as the combination two-way telephone and telegraph and range finder systems of Pan American World Airways. In peace and in war Bliley crystals have flown millions of world-wide miles with their famous Clippers.

Bliley crystals are pre-conditioned for just such rugged assignments. In the Bliley Electric Company plant there is a large section where Bliley *acid etched** crystals receive their pedigree. Here each crystal gets "the works". Its activity and frequency are *proved* under tough laboratory created service conditions of altitude, humidity, temperature, immersion, shock and vibration.

But licking tough assignments is a tradition with Bliley engineers and craftsmen. This background of research and skill has been responsible for the distinguished record of Bliley Crystals in every field of radio communication. Whatever your crystal problem may be—specify Bliley.

✦ ✦ ✦

A new star has been added

ARMY NAVY

**Acid etching quartz crystals to frequency is a patented Bliley process. United States Patent No. 2,364,501*

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CRYSTALS

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Again it's HYTRON—Easy on the Battery!

HY1269 HY31Z HY65 HY69 HY1231Z

In mobile operation, the battery is the kingpin. Two-way police radio takes it out of the battery twenty-four hours a day. Conservation of battery power during stand-by periods is mandatory.

Instant-heating Hytron tubes with thoriated tungsten filaments came to the rescue of police radio. Only when on duty, does police radio equipment draw power when Hytron tubes are used. Filament and plate power go on together.

And that's not all. The Hytron HY31Z, HY65, HY69, HY1231Z, and HY1269 are rugged. HY65 performance in two-way motorcycle police radio has proved this. Including 12-volt filament tubes for marine applications, Hytron's instant-heating line is versatile. Concentration is on the R. F. beam tetrode — work horse of transmitting tubes — but also included is the HY31Z twin triode for Class B. One type can power a whole transmitter — R. F. and A. F. — thus simplifying the spares problem (e.g., Kaar Engineering transmitters built around the HY69).

Wartime uses are bringing additions to the Hytron instant-heating line. Watch for future announcements.

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CORNING GLASS GIVES YOU

Special Electrical Qualities
Thermal Endurance
Hermetic Sealing
Mechanical Strength
Corrosion Resistance
Precision
Permanence
Metallizing
Dimensional Stability

High dielectric strength — high resistivity—low power factor—wide range of dielectric constants—low losses at all frequencies.

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Commercial fabrication to the fine tolerances of precision metal working.

Corning's metallizing process produces metal areas of fixed and exact specification, permanently bonded to glass.

AS YOU plan post-war electronic products, give a thought to versatile glass. We really mean glasses, for Corning has, at its fingertips, 25,000 different glass formulae from which to select those especially suited to your electronic applications. Let us show what glass can do for you. We may already have a solution — or Corning Research can find the answer for you. Address Electronic Sales Dept., -4, Bulb and Tubing Division, Corning Glass Works, Corning, New York.

CORNING *means* **Research in Glass**

Electronic Glassware

VYCOR CORNING PYREX

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Warnings against unstable voltages are unnecessary on equipment protected with built-in CONSTANT VOLTAGE

Unstable voltage on commercial power lines is so prevalent that many manufacturers of electrical and electronic equipment have found it necessary to warn their customers of its existence and its possible effects on the operation and efficiency of the equipment.

There is an easy and inexpensive solution to this important problem —specify a SOLA CONSTANT VOLTAGE TRANSFORMER as a component part of your equipment. There are several types of SOLA CONSTANT VOLTAGE TRANSFORMERS specially designed for this purpose—small, compact units in capacities ranging from 10VA to several KVA. Other capacities and designs can be custom built to your specifications.

Once installed in your equipment they require no pampering or supervision. They are fully automatic, instantly correcting voltage fluctuations as great as ±15%. They are self-protecting against short circuit.

No sales manager will overlook the added salability of a product that features this guarantee of performance, low maintenance cost and satisfaction to the user.

SOLA engineers with wide experience in the application of the SOLA CONSTANT VOLTAGE principle are available for consultation on details of design specifications.

SOLA Constant Voltage Transformers

To Design Engineers:

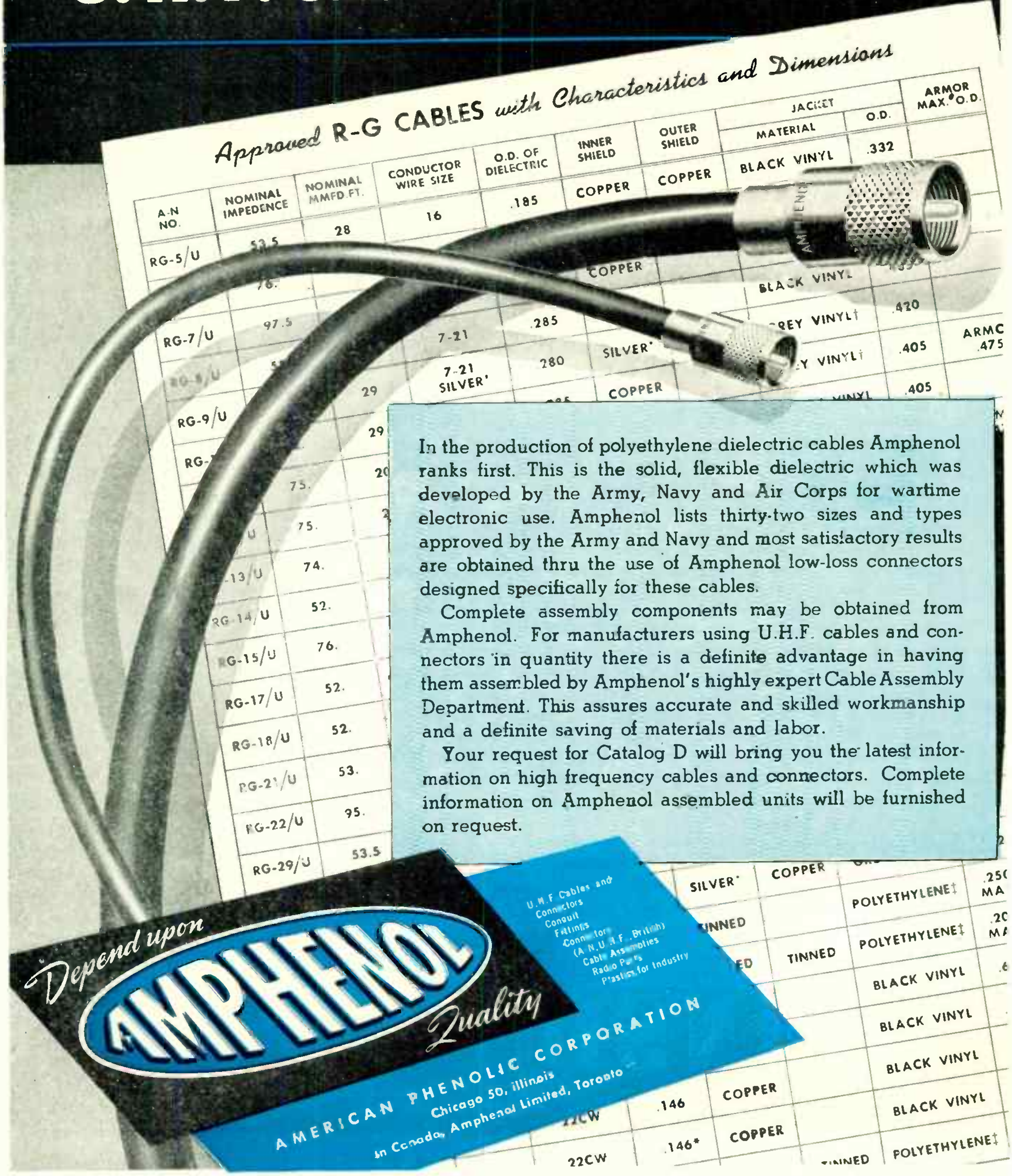
Complete, new hand-book of Constant Voltage Transformers available on request.

Ask for Bulletin 5CV-102

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-Ray Equipment • Luminous Tube Signs • Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago 14, Ill.**

AMPHENOL *Offers*

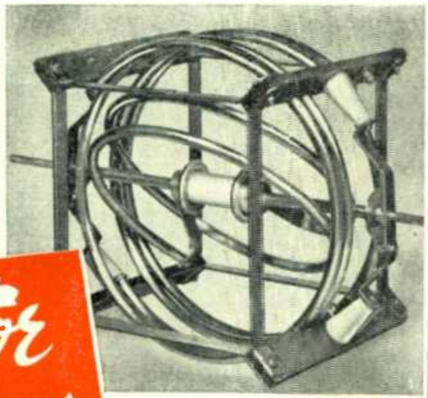
The Most Complete Line of U. H. F. Cables and Connectors.

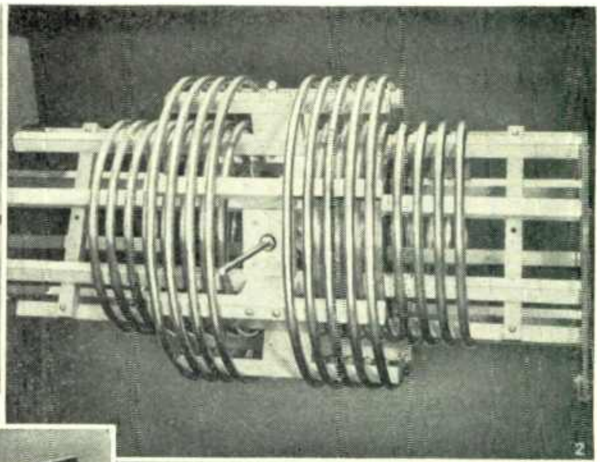


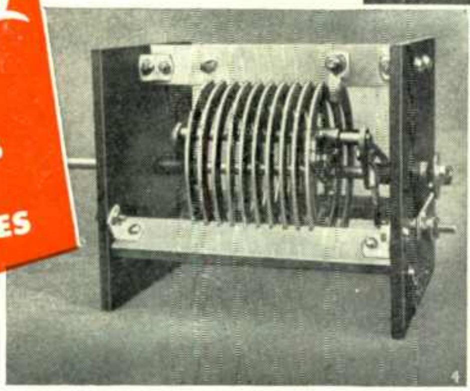
In the production of polyethylene dielectric cables Amphenol ranks first. This is the solid, flexible dielectric which was developed by the Army, Navy and Air Corps for wartime electronic use. Amphenol lists thirty-two sizes and types approved by the Army and Navy and most satisfactory results are obtained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

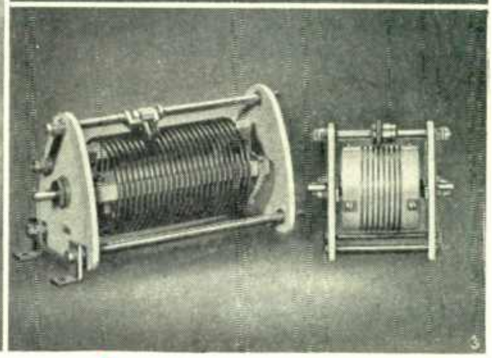
Complete assembly components may be obtained from Amphenol. For manufacturers using U.H.F. cables and connectors in quantity there is a definite advantage in having them assembled by Amphenol's highly expert Cable Assembly Department. This assures accurate and skilled workmanship and a definite saving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









ENGINEERING SALES

(CONTINUED FROM PAGE 8)

tributing Company, Little Rock, for Arkansas; Nelson Hardware Company, Roanoke, for western Virginia; Bond-Rider-Jackson, Charleston, for southern West Virginia and eastern counties in Kentucky and Ohio.

Leonard Truesdale, general sales manager for the radio line, has already started a series of jobber meetings at which plans, policies, and objectives are being outlined.

Charley Golenpaul: In May of this year, he will have completed 15 years service with Aerovox, during which time he has played a very active and highly useful rôle in the radio parts jobbing business.

Stewart-Warner: Thomas H. Maginniss Company, newly formed by Tom Maginniss, prewar manager of Stewart-Warner Distributors, will handle the Stewart-Warner line in Chicago as an independent distributor.

Another new concern, Fitzgerald & Company, Kansas City, Mo., will distribute this line in western Missouri and Kansas.

RCA Victor: Julius Haber, formerly director of publicity, has been appointed assistant director of advertising and sales promotion, under Charles B. Brown, director. Publicity will now be handled by Harold Desfor.

Dominion Electrical Mfg., Inc.: Of Mansfield, Ohio, has appointed Philco International Corporation, 230 Park Avenue, New York City, as exclusive export representatives in all countries except continental United States and Canada. The Dominion line includes all standard home appliances, from fans and irons to coffee brewers and infra-red lamps.

W. P. Laws: Has resigned from the RCA tube and equipment department to become sales manager of Thurow Radio Distributors, Tampa, Fla. This Company distributes RCA tubes and test equipment throughout the state of Florida.

SPOT NEWS NOTES

(CONTINUED FROM PAGE 32)

has been identified recently with development work on FM receivers.

Grand Rapids: Lear, Incorporated has acquired a 7-story building in Grand Rapids, Mich., to house the present and future production of its radio division. This space, totalling nearly 100,000 square feet, is now being altered in preparation for setting up production.

Railroad Radio: Construction permits have been granted to the Atchison, Topeka & Santa Fe for two experimental portable and portable stations to be used for obtaining radio engineering data.

FM HANDBOOK

(CONTINUED FROM PAGE 39)

When a 2-bay antenna is employed, the same transmitter output gives a field strength at a given receiving antenna that is 1.12 times greater, equivalent to a power gain of 1.27 times. When a 6-bay antenna is employed, the field strength is increased 2.04 times, equivalent to a power gain of 4.15 times.

The curves of Fig. 9 show the distance to the 50-microvolt contour for a 50-kw. transmitter when 2-bay, and 6-bay turnstile antennas of various heights are employed. For example, when the transmitting antenna is located at a height of 1,000 ft., the distance to the 50-microvolt contour is 84 miles when a 2-bay antenna is employed, but is increased to 93 miles with a 6-bay antenna.

At considerable distances, for example, well beyond the 50-microvolt contour of an FM broadcast station, signals at very high frequencies are subject to fluctuation of amplitude. So long as the least amplitude is sufficient to operate the limiter of the receiver, satisfactory reception can be obtained.

Several factors operate to cause variation of signal strength at great distances from the transmitter. For example, it has been mentioned that transmission of very high frequency signals beyond the line-of-sight is aided by the decrease in dielectric constant of the Troposphere with increase of altitude. The dielectric constant is not dependent upon altitude alone, however, but fluctuates with the weather, causing the range of the FM wave to increase and decrease.

Also, under certain conditions, a sharply defined region having an abnormal dielectric constant can be temporarily established at an altitude of 1 mile or more in the Troposphere. Such regions cause *Tropospheric reflections* of very high frequency waves back to earth. The strength of the tropospheric wave is variable, since it is related to the weather. Its general effect is to make it possible to detect signals from FM stations somewhat beyond their normal range at times, and to cause moderate variations of signal amplitude toward the outer limits of the normal range.

Another transmission vagary results from cloud-like areas of intense ionization floating within the *E* layer. These can cause sporadic skywave transmission to distant areas. Such sporadic-*E* transmission can occur at any time, but is more prevalent in the summer. Whether or not interference to local reception will be experienced in the distant areas will depend upon the ratio of the amplitudes of the desired signal from the local station and the interfering sporadic-*E* signal from the distant station. If the ratio is 2 to 1 or greater, the interference will not be noted. Sporadic-*E* transmissions of ap-

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FM HANDBOOK

(CONTINUED FROM PAGE 79)

preciable strength are experienced for such a small fraction of the total time, that this type of interference is not considered important to FM reception.

Bursts, which are sudden increases in the signal strength of a distant station, lasting from a fraction of a second to one or two seconds, appear to be related to sporadic-E transmission, and are likewise of little concern. The average owner of a well-designed FM receiver, incorporating a limiter, is entirely unaware of the existence of these vagaries of propagation.

Interference Considerations ★ In this discussion of the effects of the propagation characteristics upon coverage, the presence of signals from stations other than the desired station was not considered. However, satisfactory radio reception depends not only upon having a signal strength at receiving location sufficient to operate the receiver. It is also necessary that the strength of signals from other stations on the same frequency be of such low amplitude that they are not heard by the listener.

In the matter of such interference, the FM system possesses a considerable advantage over the AM system, as explained in the previous chapter. The ratio of the amplitude of the desired signal to that of the interfering signal must be 100 to 1 for good AM reception, whereas a ratio of 2 to 1 is adequate in a well-designed FM system.

Fig. 10 shows the area of daytime interference between two AM stations of the same power and the same frequency, located 140 miles apart, each having a distance of 60 miles to its 500-microvolt contour. In other words, within the shaded area of Fig. 10, the field strength of one station is less than 100 times the field strength of the other. The loss of primary coverage for each station caused by the presence of the other station is shown by the portion of each circle that is shaded.

In Fig. 11 is shown the area of interference between two FM stations located 140 miles apart, having the same coverage as the primary coverage of the AM stations represented by Fig. 10. The interference area, in which the field strength of one FM station is less than twice that of the other, lies entirely outside the 50-microvolt contours.

A comparison of Figs. 10 and 11 shows why, even if only daytime operation were to be considered, it would be possible to operate many more FM stations on the same frequency, with less geographical separation between stations, than in the case of AM.

With the advent of nightfall, the AM interference problem is vastly complicated by the presence of the sky wave, which causes the signals of AM stations

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FM HANDBOOK

(CONTINUED FROM PAGE 80)

to be heard for distances of hundreds of miles. On the other hand, the maximum range of the signals from an FM station is practically the same at night as during the daytime, so that no new source of interference is introduced. Every effort has been made to reduce the AM interference problem. Standard stations in the same locality have a frequency separation of at least four channels (40,000 cycles) to minimize adjacent channel interference; many local stations are required to reduce power after sunset; other stations are required to use directional antennas at night to minimize radiation in the direction of distant stations on the same frequency. In spite of these precautionary measures, the interference problem on the AM frequencies is serious, and a much stronger signal from the desired station is required at night to override interference than is necessary in the daytime. Since the power radiated from the desired station can not be increased, the area of satisfactory coverage of the station is reduced by the sky wave interference at night.

For example, the effects of night interference upon the typical local AM station operating with a power of 250 watts is shown at the left in Fig. 12. At night, a signal strength of at least 4,000 microvolts per meter is required to override the increased interference. This means that the effective range of service is reduced from 14 miles for the daytime limit of the 500-microvolt contour to about 5.4 miles for the nighttime limit of the 4,000-microvolt contour. An FM station operating on 100 watts with an antenna 70 ft. high can give essentially the same radius of coverage in the daytime, assuming flat terrain, with no reduction of coverage at night.

Fig. 13 shows the additional loss of coverage which occurs when a regional AM station is required to use a directional antenna after sunset. The 5-kw. AM station has a service range of about 35 miles in the daytime, but this range is severely curtailed after nightfall. An FM station of the same power with an antenna 100 ft. high gives the same radius of coverage in flat country by day or by night, and is less subject to the effects of interference from other stations.

Thus the use of FM at very high frequencies offers the solution for the interference problem encountered in AM broadcasting. With less than a thousand transmitters in operation, the present AM broadcast band in the United States is overloaded seriously. On the other hand, it is estimated that several thousand transmitters in continuous operation can be accommodated in the FM band, without requiring the range of any of the transmitters to be reduced during the night hours.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

the problem of F-layer interference. If the Commission feels that the facts in this regard are necessary before it can make a decision as to the proper place for FM in the radio spectrum, then I suggest that a closed session be held under the supervision of the military."

This proposition was promptly accepted by the Commissioners, although the errors in the basis of Mr. Norton's conclusions could have been discussed publicly, without involving the disclosure of any classified data. However, in a classified hearing, the record of any admission of error which Mr. Norton might be forced to make under cross-examination could be suppressed for an indefinite length of time.

And what took place at the star-chamber proceedings on March 12 and 13? Why, that's a military secret! However, it can be said that, as was expected, there was no justification for impounding the record as a matter of military security. In fact, C. M. Jansky, Jr., chairman of RTPB Panel 5, has called for immediate declassification of the record because "it is the opinion of a number who attended the two-day classified hearing that not only does the issue still remain, but the position taken by Panel 5, FM broadcasting, has

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 82)

been justified to even greater extent than previously."

At this time, no situation should be allowed to develop which will break down the industry's confidence in the FCC, for the closest coöperation is needed right now, not only to speed the expansion of new services in the higher frequencies, but in the interests of postwar economic recovery.

Even six months delay in conversion from civilian to military radio production will create unemployment and cost workers in radio plants and returning veterans millions of dollars in lost wages — far more than they can have saved in War Bonds. According to the best-informed estimates, a radical shift in FM frequencies will delay the major part of postwar radio production by six to eighteen months.

And to what end? Because Kenneth Norton thinks there will be too much cochannel interference on the lower band? And because some of the engineers employed by the larger AM station operators agree with him?

No, Mr. Norton's testimony and his yes-man chorus are discredited today. If the FCC finally rules that FM broadcasting must go to 84–102 mc., the industry will demand, and will ultimately determine the true reason for such a decision. Right now, the following statement, published in *The New York Times* on January 5, 1936, is of particular interest:

"The problems in connection with this (FM) system which have their origin in the forces of nature have been completely solved, and it will be possible to furnish a staticless, high-fidelity broadcasting service over greater distances than now considered the normal service range of the present high-power station, namely, seventy-five miles.

"The sole difficulties which remain to be overcome and that may retard but not prevent the introduction of this service are those intangible forces so frequently set in motion by men, the origin of which lies in vested interests, habits, customs, and legislation."

These prophetic words were written by Major Armstrong nearly ten years ago. If the Commissioners meet their obligation to serve public interest, convenience, and necessity, "those intangible forces so frequently set in motion by men" will not retard the progress of FM, and a decision on the new FM broadcast band will be reached that will command the respect and confidence of the entire industry in the Commission and its new Chairman.

2. Some time ago, this Column discussed the great need for adequate service personnel to maintain the still more complex radio equipment which will

(CONCLUDED ON PAGE 84)

WHAT'S NEW THIS MONTH

(CONCLUDED FROM PAGE 83)

be offered to the public after the war, and the great possibilities of this work as a source of employment, particularly for those who have had military radio and radar training.

In this connection, the following is of great significance: "Formation of Philco Service, a world-wide organization of appliance servicemen to establish new high standards in the profession, was announced today by Robert F. Herr, vice president in charge of service for Philco Corporation. A membership of 25,000 appliance servicemen qualified to repair all types of radio receivers, refrigerators, and air conditioners is expected by the organization within the next two years.

"Philco Service is the natural outgrowth of our ten years' experience with Radio Manufacturers' Service, which was organized by Philco in 1934. . . . Thousands of members of RMS are today serving the Army and Navy as radar and electronic technicians. All these and many new appliance servicemen are expected to join Philco Service, which will help them to become even better technicians and businessmen. . . . The users of Philco products will be benefited by their greater knowledge and ability. . . . An important phase of the program is the personal technical training and schooling from the local Philco Service Headquarters — the Philco distributor."

The real meaning of the announcement is packed into that last sentence! Before the war, most manufacturers felt that their service responsibilities were met by the publication of circuit diagrams in the Rider Manual.

Experience with military equipment has shown how inadequate a mere diagram can be, and how much careful thought is required to prepare information which provides quick and easy answers to service problems.

After the war, sales and service on radio equipment will be so closely related that the success of sales promotion on new lines will depend to a great extent upon the scope of related plans for service training. It won't be possible to ship out sets and then assume that dealers will handle the headaches from that point on. They won't be willing to try, for there will be enough lines available that they can select those which offer coördinated sales promotion and service plans. — *Milton B. Sleeper.*

LIST OF FM APPLICATIONS

When the final determination of the FM broadcast band is announced, the publication of the list of FM applicants, which appeared every other month in *FM and Television*, will be resumed. There has been a considerable increase in the number of applications filed since the last list was published in December, 1944.

FM LINKS WIRE SYSTEMS

(CONTINUED FROM PAGE 31)

trol and power cables, connect the wire lines to the radio equipment, start the portable gasoline driven generator, and the station is ready to go on the air.

Postwar Possibilities ★ The FM radio link is just one of many wartime developments that are expected to find considerable application after the war. When disasters strike and wire lines are down, link equipment will be transported into the stricken areas to provide communication to the outside. It will be possible to serve remote or isolated areas where it has been heretofore impractical or impossible to reach them with wire lines. When temporary construction or development projects create a sudden demand for additional telephone facilities, radio will be used to supplement existing wire lines until additional lines can be built or the traffic load dies down.

In all its phases, the design, development, and application of the radio link system have shown American ingenuity at work.

LOWER TELEVISION CHANNELS

(CONTINUED FROM PAGE 25)

receiving sets made under prewar standards should not be sold or that the present television should be closed down. In its proposal made in April, 1944 for the new and better television — a proposal that the interval of delay be minimized and the new and better television achieved as quickly as possible, Columbia said:

"If, on the other hand, the interval is shortened to the utmost by a concert of purpose and effort between Government and industry — if pictures on the new and higher standards can be demonstrated in a year — if receiving sets can roll off the line in another year — then the public should be told, and told fully.

"Under such a plan, present broadcasters could continue broadcasting on the low standards until the high standards are ready. They could close down the old transmitters when they open up the new. Families which can afford receiving sets which may be useless in a year or two could be *encouraged* to buy, *with full knowledge of the probably impending change*."

Columbia's position remains unchanged. If the public is to be encouraged to buy television sets made on the old standards, and if broadcasters are to be encouraged to invest in transmitters and studio equipment and to operate stations under the old standards — then, in each case, the public and the broadcasters should have full knowledge of the probable temporary nature of their investment.

As the need for keeping the public fully informed is self-evident, it may be appropriate to point out the problem from

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LOWER TELEVISION CHANNELS

(CONTINUED FROM PAGE 85)

the standpoint of broadcasters with limited financial resources. Such broadcasters may invest substantial sums in the construction and operation of low-definition television stations, without full knowledge of the probable change-over to the new system. If, at the time of such change-over, they desire to continue as television broadcasters they will be faced with the alternative of continuing with an outmoded system or of junking their investment and rebuilding their audiences after investing in new equipment. This additional burden will occur at a time when their television operating expenses will largely exceed their television income. From the standpoint of the advancement of a permanent television service, such a result — if these broadcasters are numbered in scores — can have as serious an effect as would the smaller individual losses of set purchasers — numbered in tens of thousands or even hundreds of thousands.

DETAILS OF STATION WRGB

(CONTINUED FROM PAGE 43)

tours for the WRGB transmitter using the antenna shown in Fig. 32, and a peak power of 40 kw. As can be seen from Fig. 33, the 5,000 microvolt-per-meter contour includes practically all of the metropolitan area of Schenectady, Albany and Troy. The 500 microvolt-per-meter contour includes such widely separated points as Hudson's Falls, N. Y., Bennington, Vt., and Williamstown, Mass. Field strength measurements of WRGB's coverage were started before the war, but pressure of war work has prevented completion of the survey. As soon as manpower can be made available, this survey will be completed. Spot checks of signal strength indicate that practically all of the metropolitan area in the capital district is adequately served.

The Audio System ★ Fig. 34 gives a block diagram of the audio transmitter system. The sound signals from the studio are picked up on a frequency of 167.75 mc. by a vertical coaxial dipole antenna mounted on a 60 ft. pole at the rear of the transmitter building. The radio-frequency energy is carried from the antenna to the receiver by means of a small coaxial transmission line. Here it is fed into a high-frequency converter unit shown in the lower right corner of the block diagram, Fig. 34. As the diagram shows, the high-frequency converter feeds directly into a GE type JFM-90 FM translator which has been modified for this use. The output of the translator is connected to a limiter-amplifier which feeds directly into the 50-watt FM exciter unit of the main audio transmitter.

(CONCLUDED ON PAGE 87)

DETAILS OF STATION WRGB

(CONTINUED FROM PAGE 86)

The 50-watt exciter is an adaptation of the standard exciter used with the GE line of FM transmitters, and is shown in the block diagram Fig. 34. The audio transmitter is straightforward in design, with four power-amplifier stages used to raise the 50-watt output of the exciter to 20 kw. at an operating frequency of 71.75 mc. The exciter, power-amplifier, and power supply of the audio transmitter are shown at the left of Fig. 29.

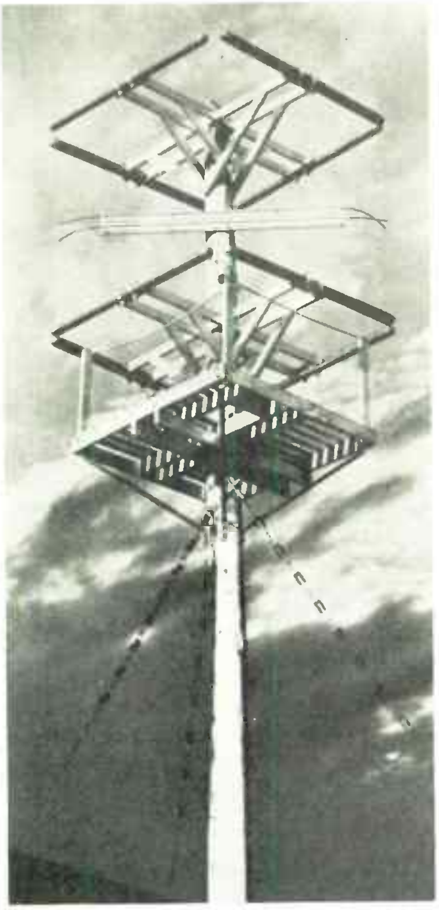

FIG. 35. TELEVISION SOUND TRANSMITTING ANTENNA AT MAIN STATION

A 60-ft. pole located adjacent to the transmitter building supports the television sound transmitting antenna. The antenna itself, Fig. 35, consists of 8 quarter-wave elements arranged in a cube and is designed to operate at a frequency of 71.75 mc. After the war, it is expected that this antenna will be replaced with a multiple — bay circular, or "do-nut" antenna mounted on a tower with the picture transmitting antenna.

The television transmitter at WRGB is the most powerful ever built, and has provided the practical experience which will be represented in commercial installations for various organizations now preparing to enter the television field in the immediate postwar period.

Another article in this series will appear in a forthcoming issue.


ALL CLEAR!
"All clear" is a welcome greeting
when returning from a sortie.
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