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FM RADIO-ELECTRONICS

FEBRUARY 1944

I. R. E. PRESIDENT

1944

FM & Television Products Directory

★ ★ Edited by Milton B. Sleeper ★ ★

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Motorola Radio

to the Men of the U. S. Army Signal Corps

It is no secret that our armed forces have the finest communications equipment in the world. What is even more important is the fact that this equipment—"the eyes and ears" of our fighting men—is in the hands of that even finer product of American Democracy . . . the men of the U. S. Army Signal Corps. *To them from Motorola Radio—a speedy Victory and a quick safe return!*

AFTER THE WAR . . . For the Signal Corps, Motorola Electronic Engineers pioneered in the development of the famous Guidon Set, the new Walkie-Talkie and the highly effective Handie Talkie—portable two-way communications systems. When Victory signals resumption of Civilian Radio production Motorola Engineers will add to their impressive list of "Firsts" in the development and production of Special Electronic devices and 2-Way F-M Communications Equipment.

Expect Big Things from Motorola—*THEY'RE IN THE MAKING!*

For the continued development and production of Radio Communications and other special Electronic equipment for our Armed Forces, the Motorola organization has been awarded two stars for their Army-Navy "E" Flag. Motorola is proud of the part it has been privileged to play in the speeding of Victory.

Motorola RADIO
FOR HOME & CAR

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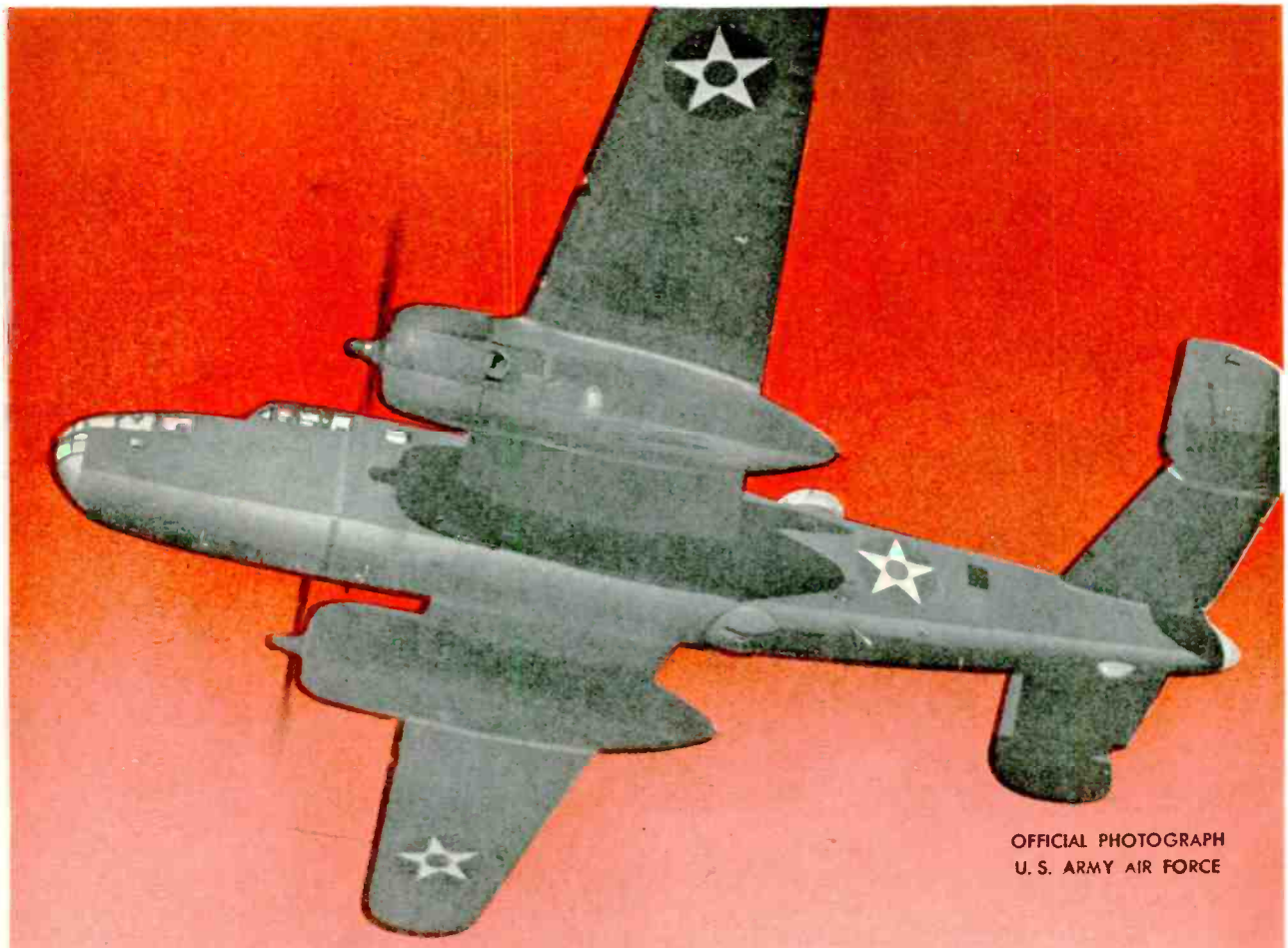

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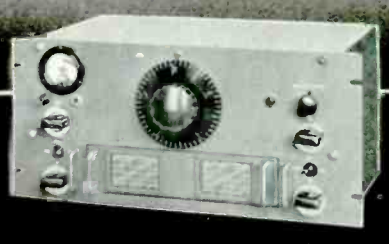
Ground stations around the world depend heavily on the HRO receiver for dependable communications with aircraft.



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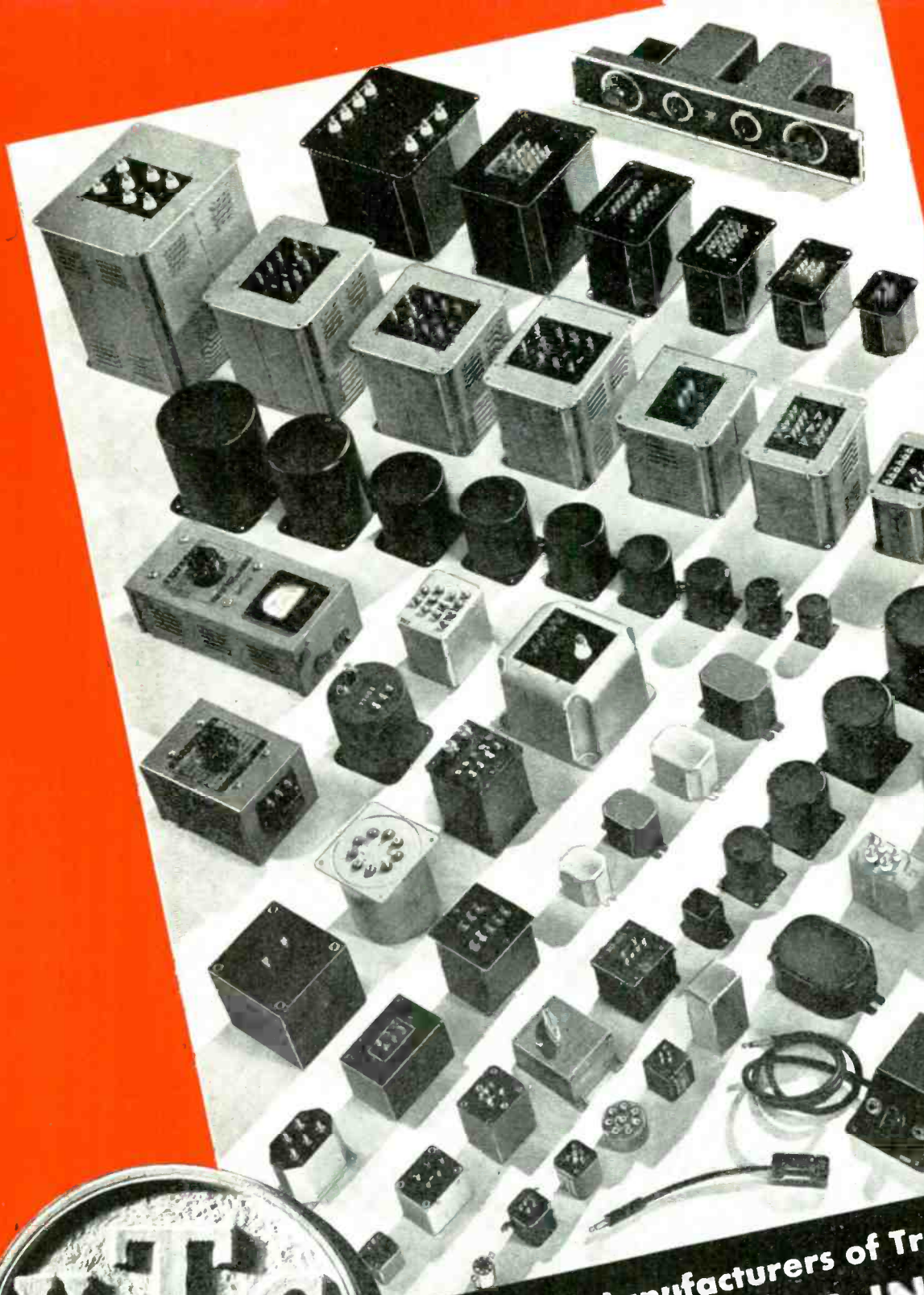
MALDEN, MASS.



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FM RADIO-ELECTRONICS

FORMERLY: FM RADIO-ELECTRONIC ENGINEERING & DESIGN
COMBINED WITH: APPLIED ELECTRONIC ENGINEERING

VOL. 4 FEBRUARY, 1944 NO. 2

CONTENTS

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MILTON B. SLEEPER, *Editor and Publisher*

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GORDON CROTHERS, *Circulation Manager*
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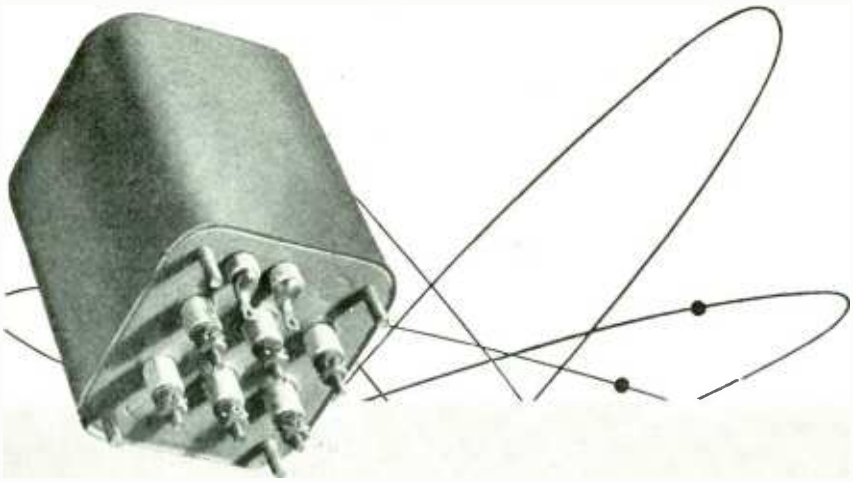
The publishers will be pleased to receive articles, particularly those well illustrated with photos and drawings, concerning radio-electronic developments. Manuscripts should be sent to the publication office, at New York City. Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will FM Magazine be responsible for their safe handling in its office or in transit. Payment for contributions are made upon acceptance of final manuscripts.

Advertising correspondence, copy, and cuts should be addressed to the advertising office at New York City.

THIS MONTH'S COVER

Prof. Hubert M. Turner, Associate Professor of Electrical Engineering at York University, is the 1944 President of the Institute of Radio Engineers. His election must be a source of great satisfaction to all members who are actively interested in the affairs of the I.R.E., and in carrying on the splendid wartime work of Arthur Van Dyck and Dr. Wheeler, who preceded Prof. Turner. The membership of the Institute has grown in step with the income of radio factory workers and junior engineers, bringing them into an association to which they could not aspire before the War. As an educator of the highest standing, Prof. Turner will undoubtedly contribute much to this new group through the expansion of the Institute's activities.



WHAT'S NEW THIS MONTH

1. Japanese Equipment
2. What, No Tubes?
3. Cancellations, Cutbacks
4. WPB's Next Headache

1. The Signal Corps' exhibit of captured Japanese radio equipment, shown at the A.I.E.E. and I.R.E. Conventions, gives to the radio engineer an illuminating picture of the people who have made themselves our enemies.

The stories about the Japs which come to us here at home are made comprehensible by a study of their radio apparatus because it shows that these people, while they have mastered the use of the *products* of science and engineering, have not achieved a knowledge of the *philosophy* of science and engineering.

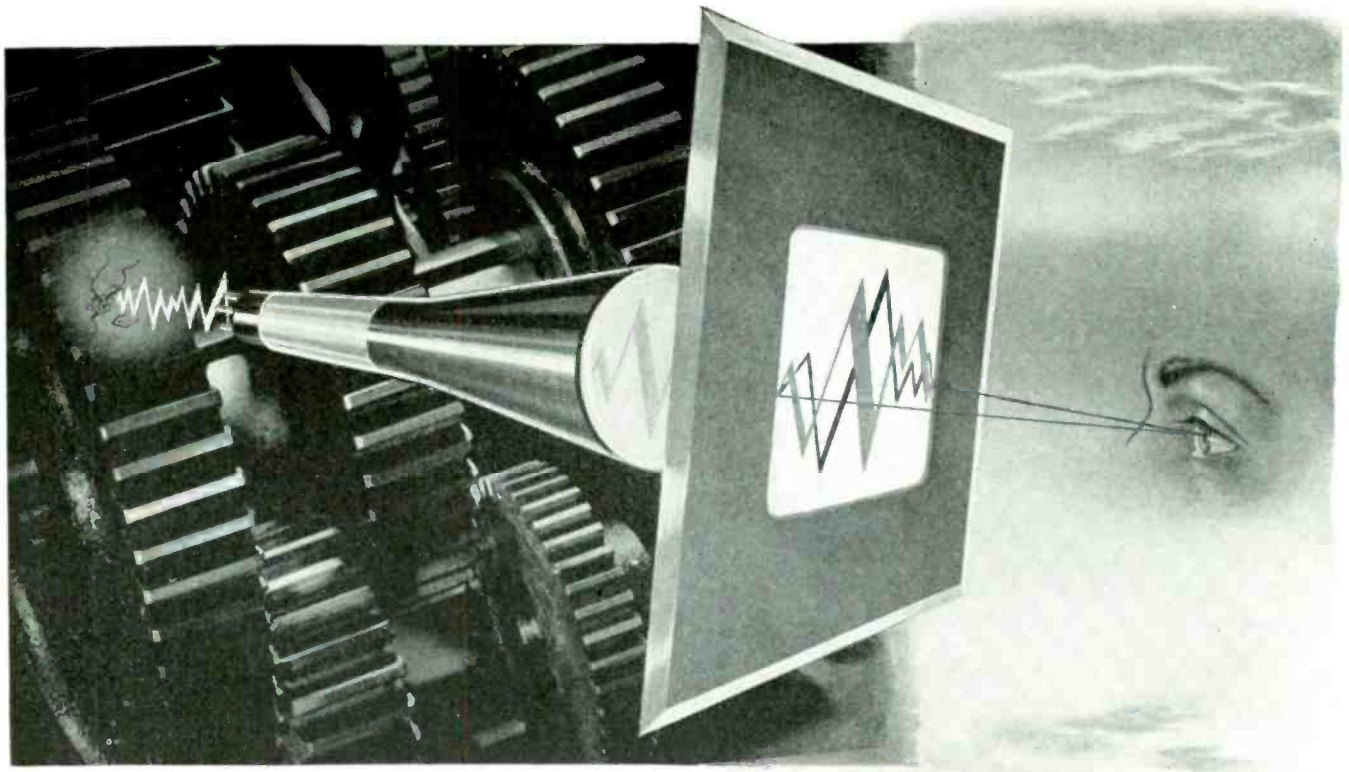
Their thinking and their methods, as evidenced in their equipment, seems to lack the confidence that comes only when science dispels superstition. That is, one might expect the manager of a Japanese tube factory to feel in his heart that a run of rejections was really an expression of disfavor visited upon him by the gods, rather than inadequate control of materials or processes.

These people seem to be a 20th century version of the American Indians. By theft or by trading with those who were willing to sell out the security of their countrymen, the Indians acquired rifles and powder and shot. They learned to shoot, and with great accuracy, too. That much they could do, but in their primitive savagery they could never master the chemistry of gun-powder.

Even though they possessed firearms, they could not prevail in battle, except in surprise attacks against unprepared or numerically inferior opponents, for their fighting was an expression of emotional and mystic willingness to die. But to scientific progress, as represented by successive improvements over the old flintlock, the Indians contributed nothing.

So history is repeated in Japanese radio apparatus. It is not designed by men who would qualify in this Country as engineers. One pictures them jabbering and squealing over 1935 editions of ARRL handbooks, and jumping around in gleeful astonishment when something works out as the text promises. But this would be a personal success, proving that the workers and their project had earned the special approbation of the gods, who had seen fit

(CONTINUED ON PAGE 60)



Key to a world within a world

To inspect metal, judge its inner worth with the aid of electronics, is to add a vital chapter to war industry's book of knowledge. More, it is to write a preface to the mightier book of the future.

This same science of electronics, which finds the structural flaw in war metal, holds great possibilities whose commercial use awaits only the welcome day of peace.

Infinite additions to the knowledge, the safety, the comfort of modern man continuously reveal themselves in the quick flutter of the electronic tubes.

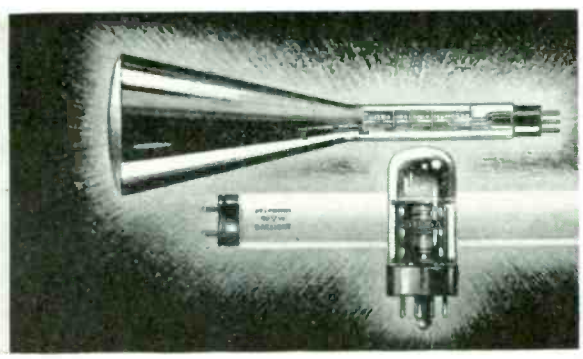
This is an inspiring reason why at Sylvania, in our work with electronics, as in everything else we do to widen the range of the eye and the ear, we set for ourselves a single goal — the highest standard known.

SYLVANIA ELECTRIC PRODUCTS INC. formerly Hygrade Sylvania Corporation

EXECUTIVE OFFICES: 500 FIFTH AVENUE, NEW YORK 18, N. Y.

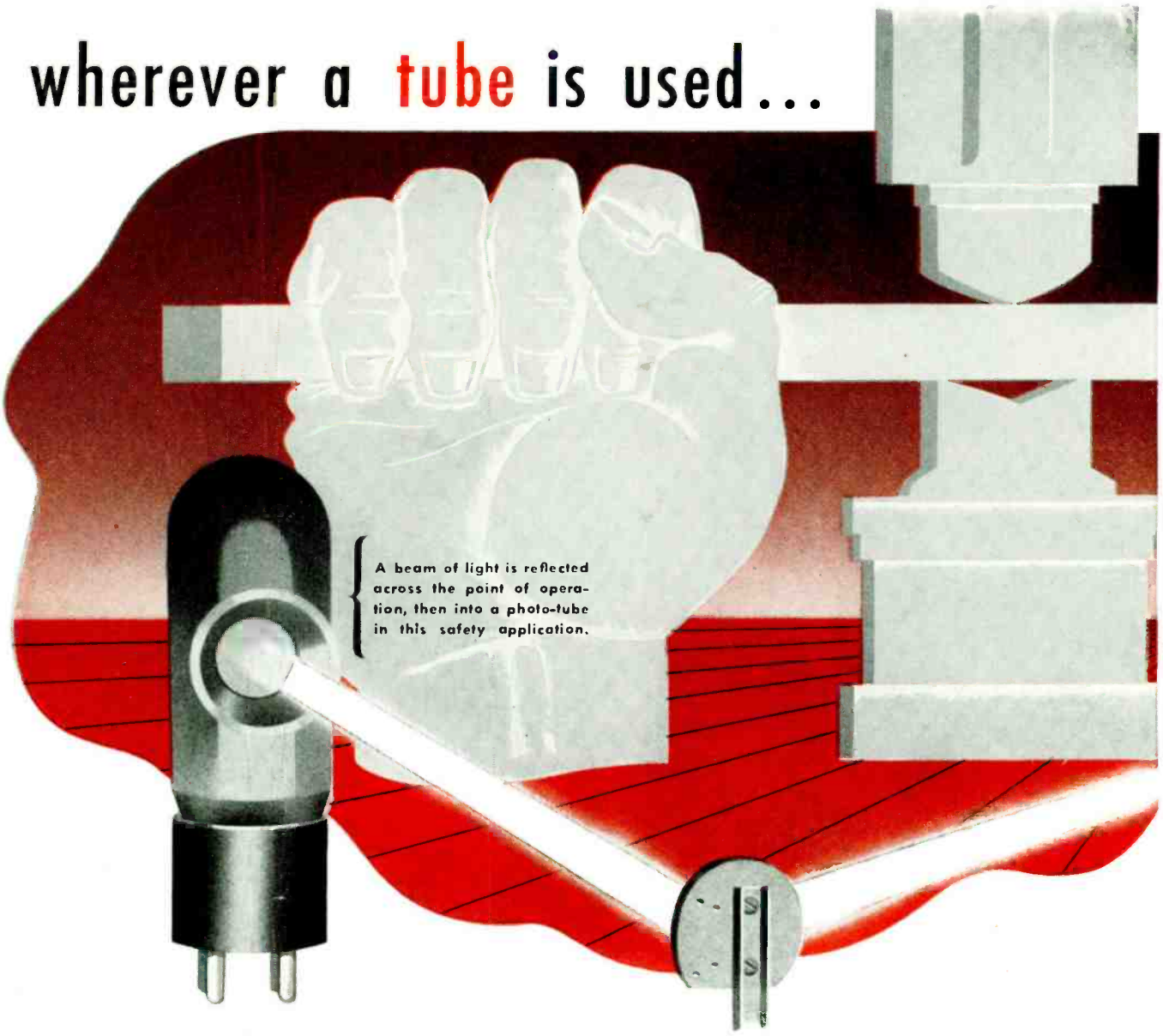
RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES, INCANDESCENT LAMPS, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES

AIDING THE HOME FRONTS "KNOW-HOW"—Sylvania Fluorescent Lamps and Fixtures give war workers the light they need to produce their armament miracles. Sylvania Radio Tubes bring the news of the world to the American family, keep our people mentally alert. Sylvania Incandescent Lamps economically protect the eyes of the American family. Indeed, the Sylvania name now, as always, means the ultimate in product performance.



ADVERTISERS INDEX

wherever a tube is used...



A beam of light is reflected across the point of operation, then into a photo-tube in this safety application.

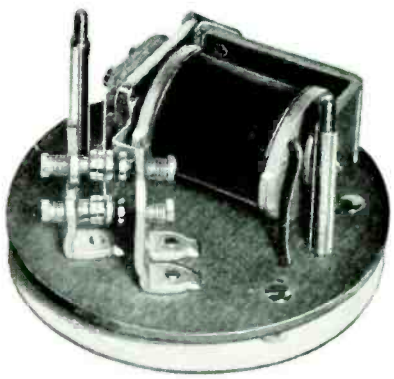
THERE'S A JOB FOR

Relays BY GUARDIAN*

Where makeshift mechanical devices rudely thrust your workers' hands and fingers away from punching and forming dies, the electron tube in combination with a relay offers definite advantages for safer power press operations.

Instantly responsive, dependable and simple—a beam of light, if broken or modulated, actuates the electron tube; the relay breaks the circuit and locks the controls in the "off" position until the full light beam is restored. Typical of relays which may be used in conjunction with such a photo-tube safety application, is the Series 5 D.C. Relay by Guardian. In hundreds of other ways—especially in your postwar developments—*wherever a tube is used there's usually a job for Relays by Guardian.*

* Not limited to tube applications but used wherever automatic control is desired for making, breaking, or changing the characteristics of electric circuits.



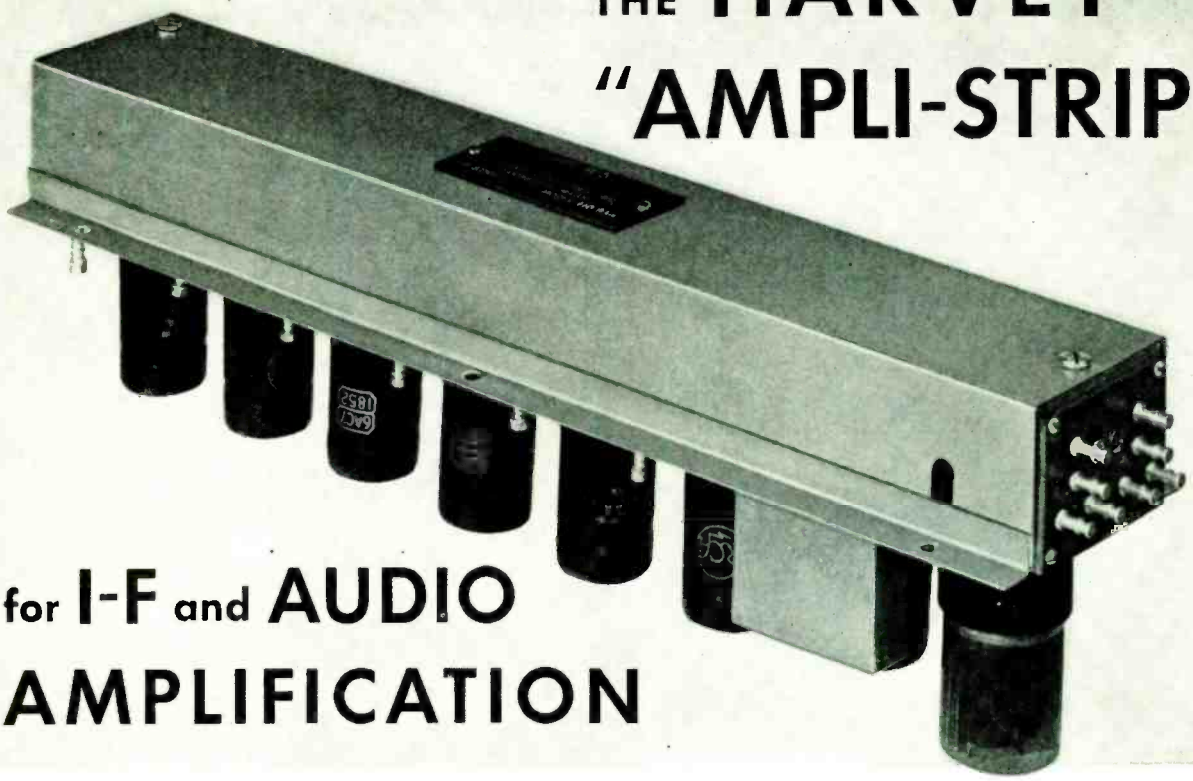
Series 5 D.C. Relay. Maximum switch capacity two normally open—two normally closed—or DPDT Contacts. Resistance range .01 up to 15,000 ohms. Send for bulletin 14.

GUARDIAN ELECTRIC

1637-R W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

THE HARVEY "AMPLI-STRIP"



for I-F and AUDIO AMPLIFICATION

Here is "something new under the sun" —a compact, thoroughly dependable I-F and AUDIO Amplifier in convenient, practical form, all ready to use.

The HARVEY AMPLI-STRIP is built to supply the electrical characteristics you want. Developed by Harvey engineers to meet exacting performance standards, it offers a superb example of the creative and production resources of the Harvey organization.

Whatever your needs in the way of radio or electronic instruments, components or assemblies, present or projected, you will find it to your advantage to get in touch with Harvey of Cambridge.

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OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.

443 CONCORD AVENUE · CAMBRIDGE 38, MASS.

HARVEY UHX-25

A 25-Watt General Purpose Radio Telephone Transmitter

Available for operation between 1.5 M.C. and 30 M.C.

HARVEY

106 PA REGULATED POWER SUPPLY

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What famous name in radio is identified with America's first crystal sets, first neutrodyne sets, first sets with self-contained speakers and first FM radio-phonographs produced exclusively?

Freed-Eisemann

Today this name is identified with the production of military communications equipment demanding highest engineering skill and precision.

Freed-Eisemann

Watch for this name after the war. It will appear on the finest FM radio-phonographs ever produced in this country.

Freed-Eisemann

● At every important stage of radio history and achievement, the Freed-Eisemann name has come to the fore. Synonymous with *quality leadership* in the world of radio, this famous name will continue to live up to the great tradition established in the past—in the wartime production of highly complex electronic instruments, and in the post-war production of the world's *finest* Frequency Modulation radio-phonographs.

FREED RADIO CORPORATION • 200 HUDSON STREET • NEW YORK, N. Y.

COMPLETE G-E EQUIPMENT

for wide-range, high-fidelity FM broadcasting

1. ***FM Broadcast Transmitter.*** G-E two-section 1000-watt transmitter, consisting of basic 250-watt exciter and 1000-watt radio frequency amplifier. Others from 250-watt to 50-kw ratings.

2. ***FM Broadcast Antenna.*** Circular type — an exclusive G-E development. Easy to tune and adjust — increased power gain.

3. ***FM S-T Relay Transmitter*** (25 watts) for relaying, *without* wires, local studio programs to remotely located broadcast transmitter station.

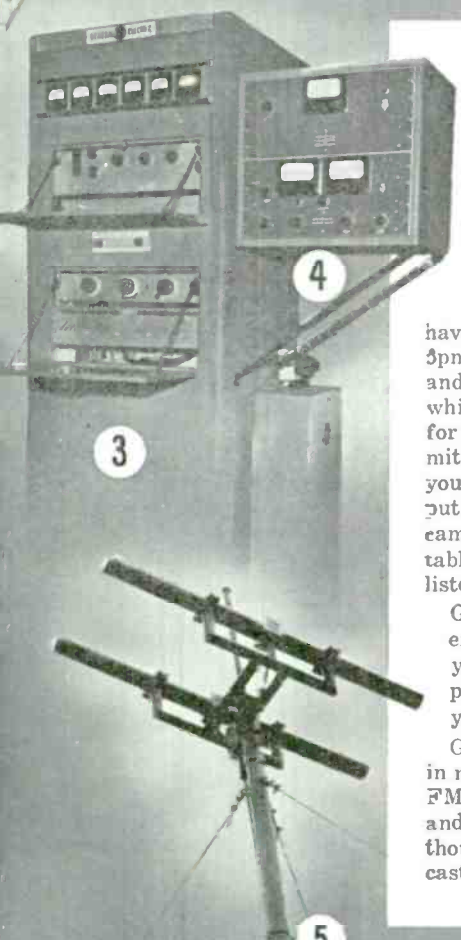
4. ***FM Station Monitor*** for checking center frequency, percentage modulation, and fidelity.

5. ***FM S-T (studio-to-transmitter) Directional Relay Antenna*** that provides a 100-fold power gain when used at both the studio and station transmitters.

6. ***FM Receiver.*** Full fidelity FM with noise levels as low as the circuits themselves and less than 2% distortion.

7. ***Transmitter Tubes.*** Developed from a long list of G-E basic electronic-tube "firsts," G-E transmitter tubes carry the definite assurance of maximum economy, efficiency and service life.

for FM



When you start planning your post-war FM station, make full use of General Electric's broad FM experience and "know how."

You can have the full benefit of the background and knowledge of the *only* manufacturer with experience in building the *complete* FM system . . . from transmitter right through to home receiver. You can have the full benefit of exclusive G-E developments such as the FM circular antenna, and the studio-to-transmitter relay system which enables you to establish your studio for maximum convenience and your transmitter for maximum coverage. And, when you install your G-E equipment, we will put on an aggressive FM receiver sales campaign in your area to help you establish your station and to broaden your listening audience.

General Electric's own FM broadcasting experience, which includes more than 3 years of programming through its own proving-ground station WGFM, will give you valuable programming information.

General Electric equipment is installed in more than a third of all the commercial FM broadcast stations now in operation; and six exclusive G-E *S-T* relays, with thousands of hours of continuous broadcast operation, are now serving their stations. These provide examples where practical operating and maintenance costs are a matter of record.

Thus does widespread *proof of performance* supplement the years of development and engineering that have made G. E. unquestionably the leader in FM radio equipment.

50 FM STATIONS ON THE AIR
80 APPLICATIONS PENDING

NOW IS THE TIME TO PLAN YOUR POST-WAR FM STATION

Write for "How to Plan an FM Station," along with other helpful booklets and bulletins on how other broadcasters established themselves: on FM transmitters, antennas, and associated equipment.

Reserve your post-war FM equipment now

General Electric offers you "The G-E Equipment-Reservation Plan." This plan will help you secure your place in radio broadcasting post-war. It will enable you to establish a *post-war priority* on a broadcast transmitter and associated equipment. It will enable us to plan definitely for quick post-war deliveries. Write for "The G-E Equipment-Reservation Plan"—address *Electronics Department, General Electric, Schenectady, N. Y.*

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

STATION AND STUDIO EQUIPMENT • TRANSMITTERS
ANTENNAS • ELECTRONIC TUBES • HOME RECEIVERS

GENERAL ELECTRIC FM television AM

See G.E. for all three!

COMMERCIAL TELEVISION AWAITS ONE ANSWER

When Engineers Solve One More Problem, We Can Have Television on a National Scale

BY MILTON B. SLEEPER

OF the thirteen panels comprising the Radio Technical Planning Board, Panel 6 has what is probably the toughest job, and at the same time the greatest responsibility. This is the panel charged with the "review and further development of standards with respect to television."

The primary purpose of this panel is to arrive at recommendations for expediting the commercial development of television in the postwar period. Therefore, these recommendations should represent the very best thinking of the industry, so that they will guide the FCC in formulating regulations under which television can expand most effectively as a public service.

The deliberations of Panel 6 will be followed closely and criticised freely, no doubt, by the entire industry. The reason is that television research and development is such a highly specialized field that the average radio engineer knows very little about it, and television engineers are concerned with dissecting and reconstructing images rather than with the problems of radio propagation and reception.

FM Reception on AM Circuits ★ That probably explains why the deliberations of Panel 6 seem to be hung up over matters pertaining to the sound channel. For example, they have had to ask the VHF Broadcasting Panel 5 for recommendations on the matter of the stability of FM receivers for the sound channel.

If television engineers are in trouble with FM receiver tuning, it is only because they are not using properly designed FM circuits.

However, there is reason to doubt that the "FM receivers" they complain about were ever designed for FM reception. All prewar television sets were equipped with AM sound channel receivers. When the sound transmission was changed to FM, the original AM receivers were simply readjusted to a point just off resonance, at which they will respond to FM signals. This is a critical and unstable adjustment, and the AM circuits were never intended to be used in that way.

I recall that one of the leading television-engineer-enthusiasts operated a set at his home in this manner, and he apologized for the poor audio reception, explaining that, although the sound transmission had been changed to FM, he was still using the original AM sound receiver.

Multipath Distortion ★ Panel 6 has also inquired of Panel 5 about multipath distortion of FM signals. To an FM engineer, it seems as if the television engineers think that there ought to be such an effect on the FM sound channel because there are reflections or ghosts on the pictures.

At least, it can't be a relevant matter because it has not been observed by FM engineers, nor is there any recorded complaint about it from the several hundred thousand owners of FM broadcast receivers in such metropolitan and suburban areas as New York, Chicago, Philadelphia, and Detroit.

Nor has there ever been a complaint recorded from the rural sections of New England where the FM stations at Paxton and Mt. Washington are giving many listeners their first reliable, enjoyable program reception.

The Real Problem ★ Actually, the choice between FM and AM for television sound is beside the point. The commercialization of television does not depend on that. If the Front Office hears that time is being wasted now on such minor matters, there are going to be remarks made about not entrusting engineers with such a practical matter as postwar planning. Panel 6 should dispose of its major problems first.

For example: It is nearly four years since the Worlds Fair inauguration of television broadcasting. At that time, the greatest difficulty facing the purchaser of a television set was 1) picking up video signals of sufficient strength to overcome static interference and 2) picking up signals free from reflections. This is still the major problem of television.

In four years time, no technical progress has been made in this direction!

Television's Greatest Need ★ Why hasn't anything been done about the television antenna problem? There are two reasons: First, television engineers have centered their interests and efforts on the video technique. Great strides have been made in cameras, lighting, and cathode-ray tubes, but not one television engineer knows any more about receiving antennas than he knew four years ago.

It is probably not reasonable to expect men who are specialists in the apparatus department of television to do the necessary work on antennas. But someone must. We must have antenna specialists at work on this problem. Until this is done, and until we have a method of video reception independent of the vagaries of buildings, trees, and high ground, we can not have practical, salable home television.

Second, manufacturers are reluctant to face the reality of the television antenna problem. They still hope that some other answer will be found to the elimination of ghosts caused by multipath transmission, so that television sets can be put in operation by merely plugging them into power sockets. But it can't be done with the present system.

C. M. Jansky, Jr., at the recent FMBI Conference, warned against looking at FM problems through AM spectacles. The warning is equally in order that every aspect of home television is distinctly different from convention "home radio".

A whole new philosophy of design, manufacture, sales, installation, and service, separate and apart from audio reception, must be worked out before home television can become a commercial reality. The laws of propagation which apply at standard broadcast frequencies do not apply at the ultra-high frequencies required for picture transmission.

The thinking of television engineers needs very definite reorientation. This is made clear by the fact that, while we have the television cameras and associated transmission equipment, and the video receivers, they cannot be used to full effectiveness because no one has perfected a receiving antenna system capable of 1) receiving desired signals and rejecting reflections, and 2) performing these functions for signals of different frequencies, arriving from different directions.

Television Frequencies ★ It has been proposed that the 44- to 50-mc. band be taken from the FM broadcasters and returned to television. The reason offered is that video signals are less affected by reflections in that band.

The truth is that television broadcasting began, during the Worlds Fair period, on 44 to 50 mc. That was when we started to learn about multipath transmission and ghosts. I can say from personal experience that more people returned television sets because of the unsatisfactory reception due to ghosts, than for any other reason.

(CONTINUED ON PAGE 56)

FMBI CONFERENCE FEATURES COÖRDINATED ACTION

Hearty Coöperation between Broadcasters and Equipment Manufacturers Assures Optimum Service to Public — New Spirit Evident among FM Enthusiasts

BOTH the radio manufacturers and broadcasters at the FMBI's Fifth Conference agreed that FM has become the magic word of this industry — magic the initials of Frequency Modulation also stand for *forward march*, and everyone knows that progress and profits have always gone hand in hand in the manufacture of home radios and transmitters, and in the operation of broadcasting stations.

Highly assuring was the fact that, while FM Broadcasters, Inc. is primarily an association of station operators, the equipment manufacturers took an active part in the Fifth Conference, held at the Commodore Hotel, New York City. Here, for the first time in radio history, executives of companies producing transmitters and home receivers joined with the broadcasters to plot a new course, and with the blessing of the FCC's Chairman Fly.

This recalls, by way of contrast, a meeting of dealers and manufacturers called in New York City just 24 years ago by AT&T, then operating WEAF on Walker Street. There was no broadcasting on the air at noontime then, although customers flocked into dealers' stores during lunch hour, mostly to buy parts for home-made receivers. The Telephone Company officials thought it would promote sales to have a program every day at noon, and they were willing to do this at WEAF if the dealers would chip in to defray the expense. The meeting was well attended, but barren of results. That was the last effort ever made, at least in the New York area, to establish coöperation between a broadcast station and the trade.

But somehow FM, even before the War, had cleared the way for instituting many improved practices. Chairman Fly[1] summed up the picture in this way: "I want to stress that today we have a golden opportunity. We are developing an ever-increasing efficiency in Frequency Modulation and in the radio art generally, but to prevent us from rushing pell-mell into production, perhaps injurious production, we have what might be called a beneficent stalemate. One of the incidental benefits that have resulted from a thing as gruesome as war is that we have today this opportunity to get right to the bottom of this situation, and to plan it in a thoroughgoing and orderly way for the development of an efficient, comprehensive public service."

And then, he made this comparison of his own between what many still call "the good old days" and the postwar opportunities ahead: "FM stands today on the threshold of as tremendous a development as did AM in the 1920's — perhaps a much greater development and a faster rate of growth."

The same conviction was shared by the nearly 700 engineers and executives who attended the Conference. The significance of this collective opinion is emphasized by the fact that the officers of FMBI, when they started their plans for this meeting, estimated that an attendance of 200 would assure its success. Actually, the paid registrations exceeded 650, a figure far beyond the most optimistic hopes of Walter Damm, FMBI president, or Theodore Steibert, chairman of the convention committee.

Convention Program ★ The two-day program was planned as a review of all aspects of FM, covering both the present status and the planning of postwar expansion.

President Walter J. Damm opened the first session with an account of the history of FMBI and the results accomplished by the association in bringing FM broadcasting up to the point at which the licensing of new stations was stopped by the FCC's freeze order.

He was followed by Philip Loucks, legal counsel for FMBI, who reviewed the legislative situation. Then came C. M. Jansky's splendid discussion of FM engineering problems, in which he warned against looking at FM through AM spectacles. The full text of his talk will be found on page 18 of this issue of *FM* Radio-Electronics.

Executives from some of the FM transmitter and receiver manufacturers told of their plans to make equipment available when production of civilian apparatus can be resumed. Representing the latter group were R. C. Cosgrove of Crosley Corporation, J. E. Brown of Zenith Radio, Lee McCanne of Stromberg Carlson, and Arthur Freed of Freed Radio. They were unanimous in their enthusiasm over the immediate postwar market for high-quality receivers and phonograph combinations offering the full advantages of FM quality. Moreover, they emphasized the effect which demand for these upper-bracket models will have in raising the total volume of radio set sales.

For the particular benefit of the broadcasters, the remarks concerning transmitting equipment, by representatives of General Electric, Radio Corporation, Radio Engineering Laboratories, and Western Electric are published here in full:

W. R. DAVID, Sales Manager of Broadcast Equipment, Electronics Department, General Electric Company: If you have seen one of General Electric's radio advertisements, or heard one of our radio programs, you must be aware of the Company's firm conviction regarding the future of FM in the broadcast industry and the home receiver fields. We think it will be an important postwar factor in your business of broadcasting and our business of manufacturing transmitting equipment.

I think I can say without exaggeration that General Electric played an important rôle in the introduction of FM to the broadcast industry. Coöperating with Major Armstrong, we demonstrated FM as a new and better system of broadcasting to representatives of the FCC, Army, Navy, Airlines and countless others. These demonstrations were preceded by exhaustive tests and measurements of both AM and FM, road tests in cars between Schenectady and Albany, and Albany and Alpine, N. J., and airplane tests over the same routes. Undoubtedly, this work contributed toward the adoption of FM by the FCC as a commercial broadcast service.

Following that, we developed and manufactured FM broadcast transmitters in ratings of 250 watts, 1 kw., 3 kw., 10 kw., and 50 kw., although none of the 50-kw. amplifiers was delivered because of the war situation. Other developments were the FM station monitor, the FM circular or "doughnut" type transmitting antenna, 350-mc. S-T transmitter-receiver and antenna, hermetically sealed crystal, and high frequency power tubes. Our transmitters are used in approximately one-third of the FM broadcast stations and in many government applications.

We knew, as did everyone else, that practically nothing could be done along commercial lines for the duration of the war. However, it seemed to us to be an

(CONTINUED ON PAGE 36)

[1] The complete text of Chairman Fly's speech was published in *FM* Radio Electronics, January, 1944.

GERMAN RADIO APPARATUS DESIGN

It Is Remarkable For Its Thorough and Devious Planning, but We Still Ask: Is It Good Design to Crowd Out All Room for Improvement?

THE highlight of the joint winter meeting of the A.I.E.E. and I.R.E. was the exhibit of captured enemy radio equipment. This was arranged under the direction of Maj. General Roger B. Colton, Chief, Engineering and Technical Service, U. S. Signal Corps.

At this meeting, General Colton delivered a paper in which he discussed the apparatus displayed. While he did not go deeply into the comparative merits of U. S. and enemy apparatus, he did make two significant statements.

Referring to the wartime accomplishments of American radio manufacturers, he said: "Another illustration of your accomplishments lies in the fact that, of the 200 principal items now being delivered to the Signal Corps, 115 were developed and standardized since July, 1941."

Then, summing up a description of German aircraft radio, he said: "In general, German airborne electrical design is sound, but not advanced."

How aptly these remarks apply becomes apparent from a thorough study of German design practices as shown in the accompanying illustrations, and comparing them with those employed in this country.

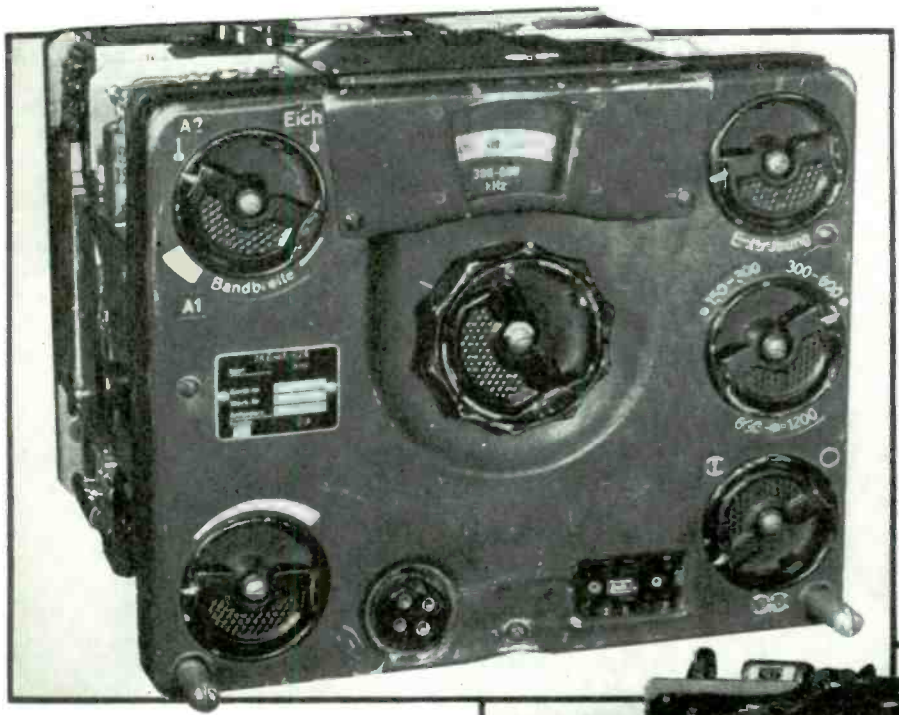


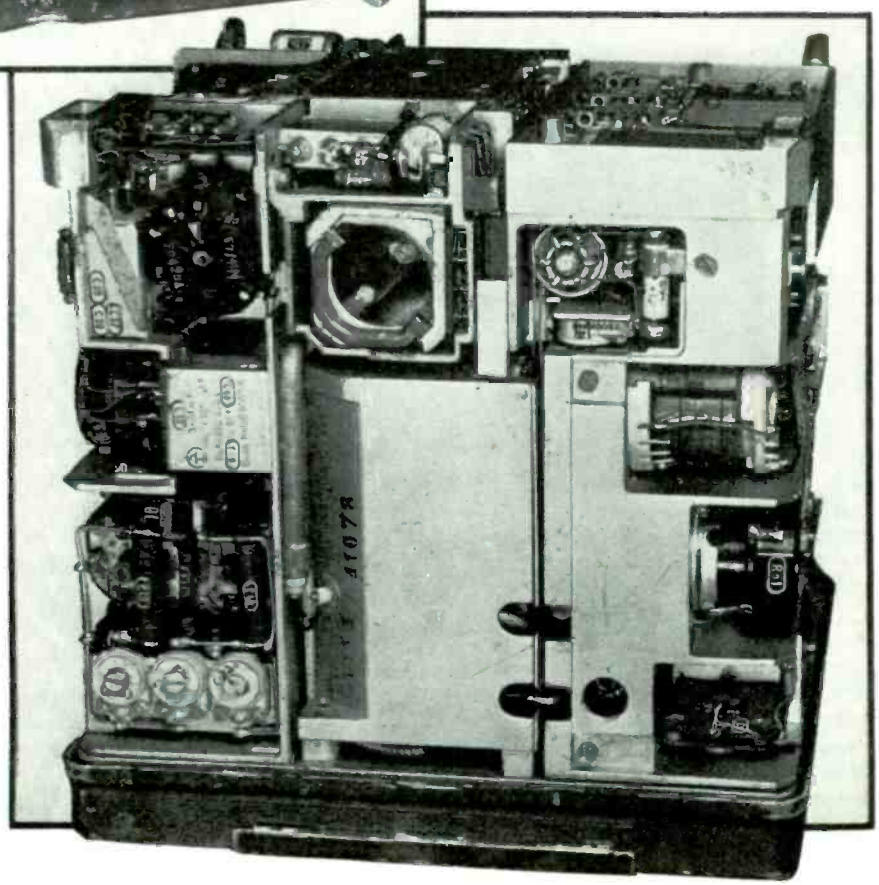
FIG. 1. CAPTURED GERMAN AIRCRAFT RECEIVER, WITH COVER REMOVED

Bearing in mind what General Colton said about the speed with which American equipment was produced, it is easy to imagine that the German engineers really believed they had the intellectual superiority that would prove them to be the Master Race. Certainly they lavished man-hours on the design of the components in terms of the composite assembly such as we never apply to our apparatus.

In the case of the aircraft receiver pictured here, it seems as if the engineer in charge must have been directed to build the perfect design within a certain, and minimum, amount of space, from which a predetermined minimum performance would be required.

No doubt there was a limit put on the time in which the receiver was to be finished. It must have been at least three years — possibly five. Probably it was nearer the latter figure, for there is not a

FIG. 2. TOP VIEW. TUNING CONDENSER IS BENEATH COVER AT FRONT CENTER



sign that any compromise was made in perfecting the last small detail.

A whole succession of models must have been made before the pre-production sample was finished. Then a year's time was surely required for the tools. They probably got into production in less time than it would take in most American plants because, again, the Germans, as a nation, have a greater capacity for working with that extremely deliberate, painstaking care than we do. Our workers would say: "Aw, nuts. That's not a radio. That's a catacomb, and I get lost in it!"

That is a literal description. So compact is the design that with anything less than minute precision in every detail, it would be impossible to assemble this set. Space is so limited that the wiring is done with fine solid wire covered only with synthetic insulation because there is no room to run the heavily insulated, stranded conductors we use on our receivers. In our equipment, a cable such as that at the upper right of Fig. 6 would be as big as a man's thumb.

Those who are not familiar with German design practice will notice immediately that there are no tubes in evidence. The tubes are there, but only the bottoms can be seen. German tubes are made with pins extending radially around the bottom of the base. The tube is inserted *through* a ring-shaped socket carrying spring clips between which the contact pins are gripped. On the bottom of each tube, at the center of the molded base, is a threaded insert. This takes a short threaded rod molded into a small knob, or handle. Thus, by grasping the knob, the tube can be put into the socket or removed.

By mounting the tube pins in this manner, the tube can be arranged to extend *into* the assembly, while the socket connections are on the outside, readily accessible. The whole plan of this receiver design is made possible by this feature. However, according to a Philips engineer from Holland, who is familiar with the production of these tubes, this type of base is far more difficult and more expensive than the equivalent American types. It offers no advantage except that no means is required to prevent tubes from popping out of the sockets when they are subjected to vibration.

The Germans seem to have perfected the technique of die-casting magnesium to an extent not attained in this country. All the shields, partitions, and heavy metal

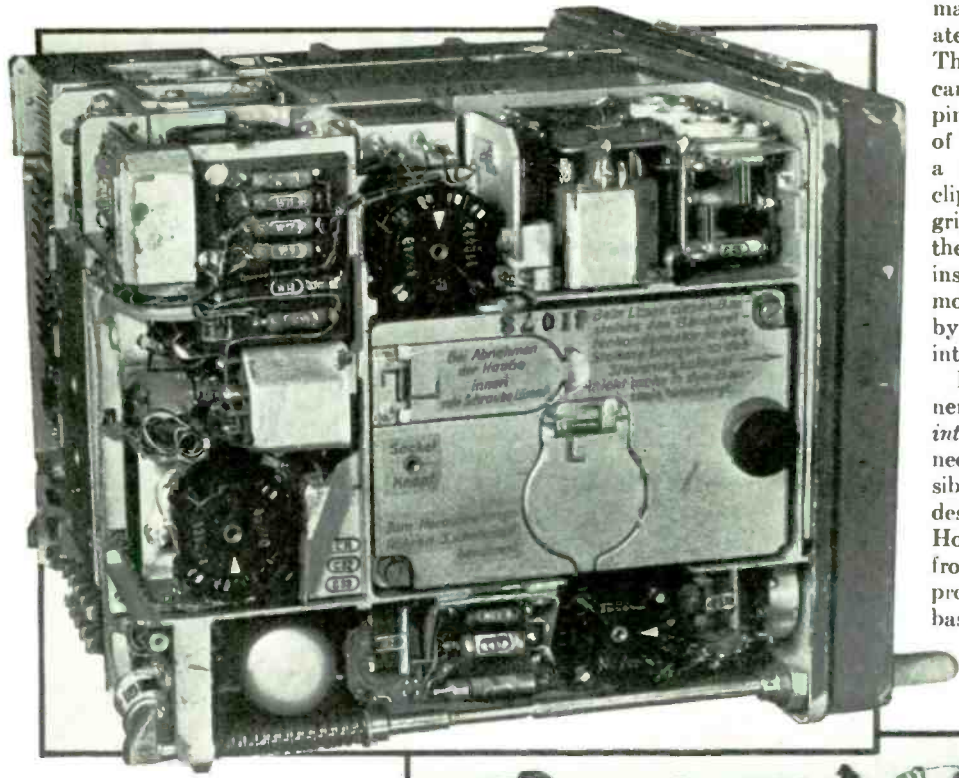


FIG. 3, ABOVE, IS LEFT SIDE. IT IS SURPRISING TO SEE SIMILARITY BETWEEN AMERICAN AND GERMAN COMPONENTS. NOTE THE CLOSE-FITTING COVERS ON THE LARGE SHIELD PLATE. BASES OF TWO TUBES CAN BE OBSERVED IN THIS PICTURE

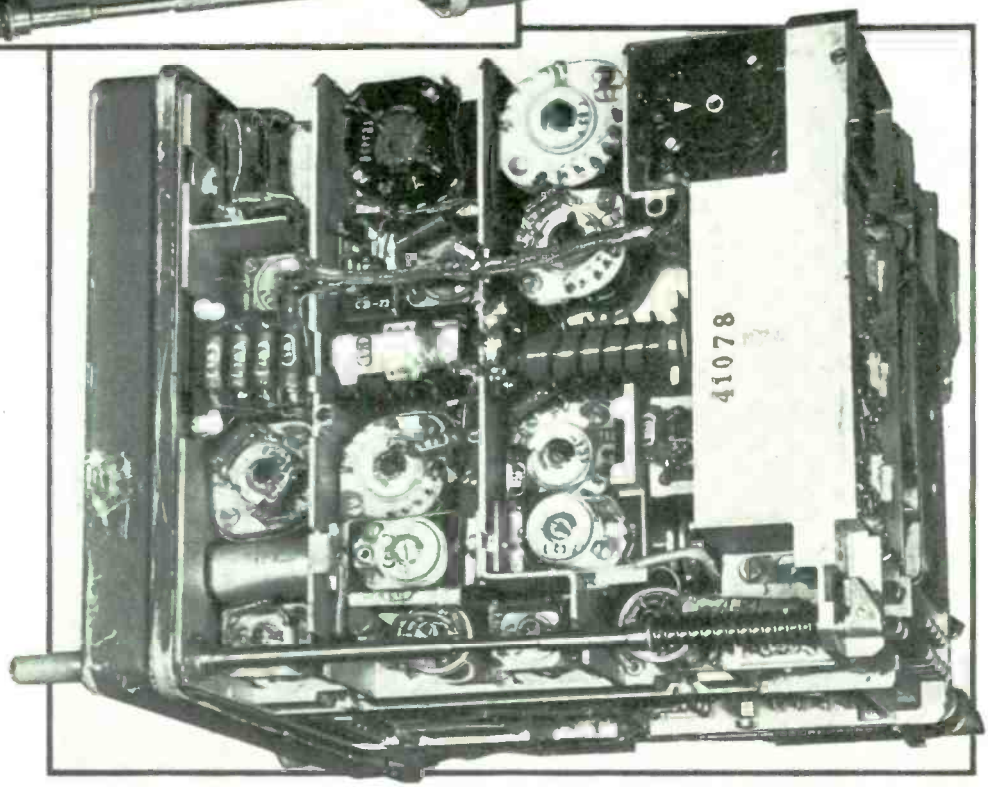
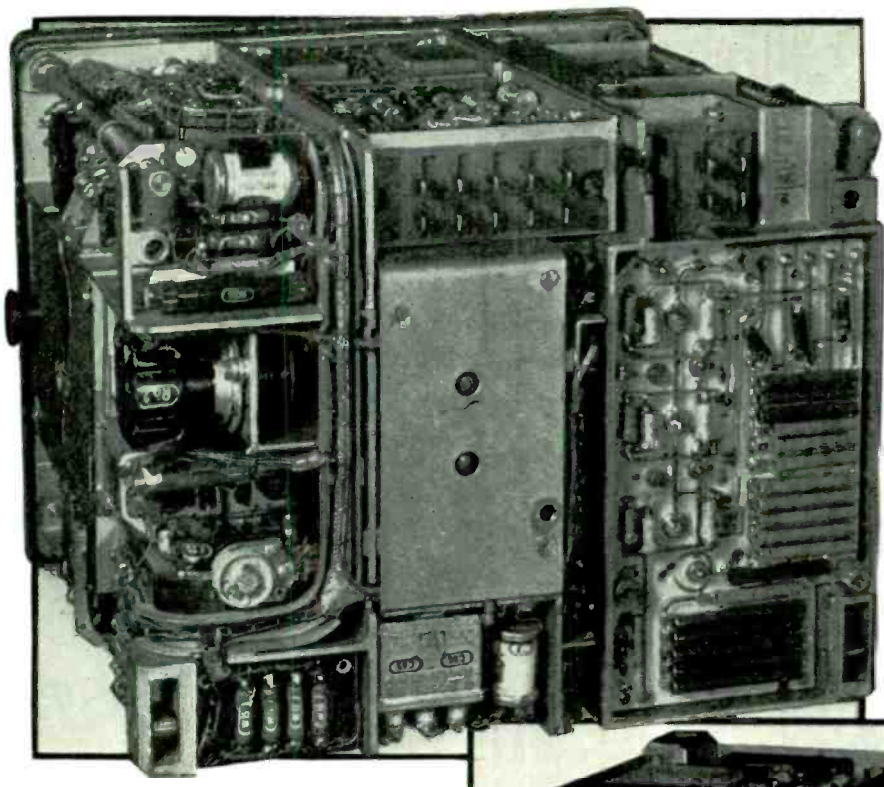


FIG. 4, RIGHT, IS RIGHT SIDE. THIS SHOWS THE ELABORATE DIE-CAST PARTITIONS. UNLIKE AMERICAN EQUIPMENT, THIS DESIGN COULD NOT WITHSTAND CONDITIONS IN THE TROPICS, AND NO TREATMENT IS USED TO PROTECT COMPONENTS AGAINST MOISTURE AND FUNGUS



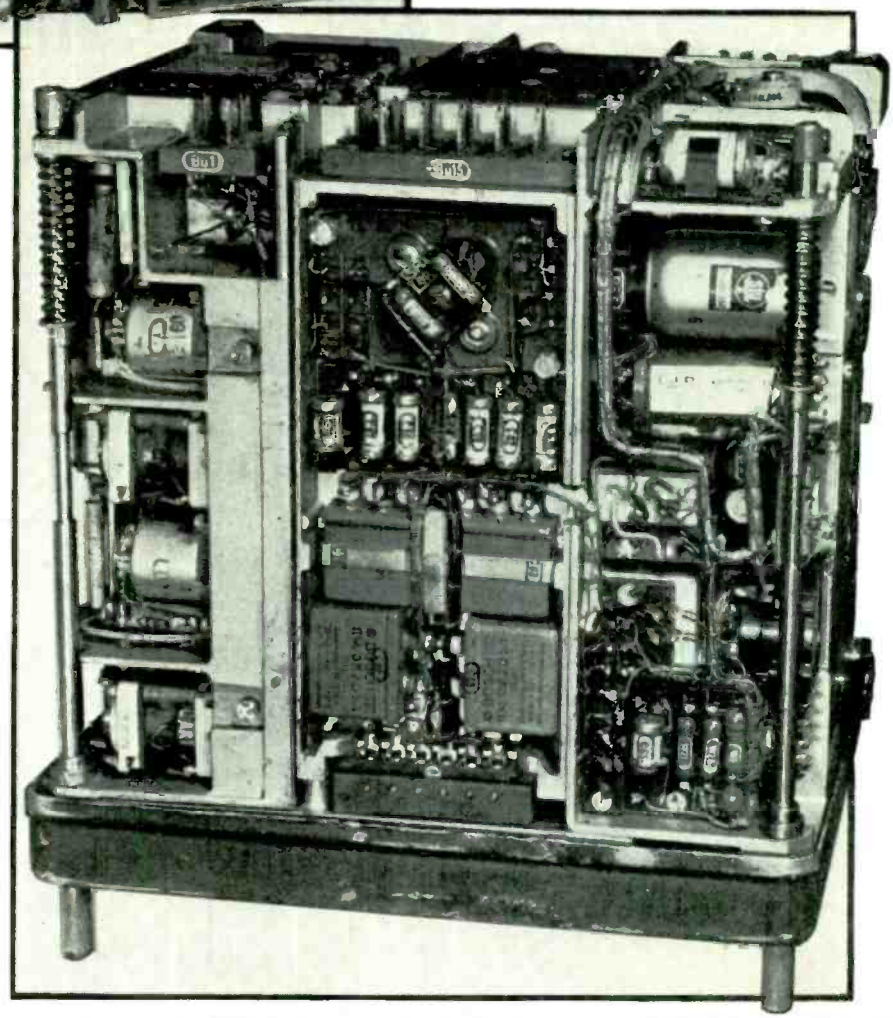


FIG. 5, ABOVE, IS REAR VIEW. CONNECTIONS ON CERAMIC PLATE ARE MADE BY RUNNING SOLDER IN GROOVES. FIG. 6, RIGHT, IS BOTTOM VIEW

parts in this equipment were made in that way except for the front of the set, which seems to be an aluminum stamping. The use of die-castings is another feature around which the assembly was designed. The castings are amazingly complicated, and some require draws in four directions. Just how intricate they are can be seen from the illustrations.

Component parts, such as the different types of condensers and resistors, are so like our own that it is difficult to tell whether they copied from us, or we from them. They have a trick in the ceramic plate at the left of Fig. 5 which is interesting. What appear to be connecting wires are actually little streams of solder run along grooves in the ceramic. It is very neat, but has no particular advantage.

In fact, it is all a part of the thinking which was apparently directed toward producing a "perfect" design. Indeed, it seems as if the engineers believed that there would be no need for further modification, for the elements are so closely inter-related and fixed, like the connections run in the grooves of the ceramic plate, that if one part should be altered, it would be necessary to redesign the set from start to finish!

This plan of designing apparatus intended to be so perfect that no lattitude for improvement is allowed, seems to illustrate the conceit which is the strength of the self-avowed Master Race. At the same time, it discloses the extreme weakness of the inflexibility resulting from such presumptuousness.

The men who planned the plan behind such designs must have scoffed at us indeed when our Armed Forces, equipped too late with too little, were being beaten back by an enemy so carefully outfitted and prepared.

Even today, they probably do not believe that equipment designed in the free-handed style of our American apparatus can be superior to theirs. They do not realize that our lack of conceit, which is behind our reluctance to freeze designs, is not lack of confidence, but an everlasting search for improvement.

So, today, we can imagine that German radio engineers have not discovered the truth of what General Colton said, that their designs are sound, but not advanced. And as we pour into the fight mounting quantities of arms of increasingly superior performance, we may look at the German equipment and say: "Too much in too little space. They have crowded out all room for improvement!" That seems to be the fundamental difference that distinguishes German from American apparatus.

ENGINEERING PLANS FOR FM PROGRESS

Explaining the Reasons Why FM Questions Should Not Be Looked at through AM Spectacles

BY C. M. JANSKY, JR.*

THE future destiny of FM will be largely determined by the following four considerations:

(1) The engineering potentialities of the system.

(2) The adequacy of the channel assignments provided by the regularly constituted government licensing authority.

(3) The guiding or restrictive effect as the case may be of the operating rules and standards imposed by that licensing authority.

(4) The value of the public service rendered by the broadcasters themselves.

Basic Engineering Potentialities of FM ★ Let us first direct our attention to the first of these, namely the engineering potentialities of an FM broadcasting system. Many broadcasters know intimately the engineering and commercial phases of AM broadcasting, in the standard band. Others approach FM with much less experience or with no broadcast experience at all. All of us, however, have one common bond. We desire to learn all we can about this new and greatly improved type of sound broadcasting, usually referred to as the Armstrong System of Wide-Band Frequency Modulation. Just what is this new system anyway? What can FM do that AM cannot? What are the basic differences between FM and AM and what are the social and economic implications of these differences?

The answers to these questions are not self-evident. Some of them can be deduced by due consideration of the fundamental engineering and allocation principles involved. Others will have to be solved by the trial and error method. However, since errors are costly and sometimes hard to rectify, we owe it to ourselves to carefully consider the implications of all available facts.

It has been my good fortune to be closely associated with American broadcasting for twenty-four years. I have grown up with its commercial, engineering, and allocation problems. Therefore, instinctively, every time I try to analyze a situation facing us in FM, I find myself looking back at our struggles with similar situations in the early days of AM.

Comparison of FM and AM Allocations ★ Now, serious mistakes can be made and wrong conclusions reached by merely looking at FM through a pair of AM spectacles. However, much can be learned from an impartial, comparative study which gives due consideration not only to similarities but also to the implications of the differences between FM and AM. Therefore, let us compare the potential future possibilities of:

(1) The AM allocation structure consisting of 106 channels occupying a band extending from 550 to 1,600 kilocycles.

(2) The FM allocation structure consisting of 40 channels occupying a band extending from 42 to 50 kc.

Each band is divided into channels. In each band each station is assigned to a specific channel. In both systems studios, transmitters and antenna systems are used, and in each the object is to deliver programs which may be received by radio receiving sets in the homes of listeners and at other points. Obviously, for AM reception an AM receiving set is required and for FM either an FM receiver or a converter designed for FM reception, the output of the converter being connected into the audio and speaker system of an AM receiving set.

The superior potentialities for sound broadcasting which FM possesses over AM all stem from two basic differences between the two systems, namely:

(1) Radio carrier frequencies in the FM band are approximately 40 times as high as those in the AM band. The laws of radio propagation are radically different at these higher frequencies and, as we shall see, better adapted to broadcasting.

(2) The use of Frequency Modulation rather than amplitude modulation greatly reduces the power necessary to overcome noise or interference at any given point of reception.

Propagation Characteristics in the AM Band ★ I do not believe that I need go too much into detail with respect to the idiosyncrasies of propagation in the AM band. Most broadcasters today are familiar with the fact that sky-waves exist at night but not in the daytime; that this dictates the classification of channels as cleared or shared; that shared channel stations have less coverage at night than in the daytime, and that cleared channel stations in addition to a primary service deliver an intermittent but useful secondary night service which up to a point grows better the farther you go away from the station.

To anyone familiar with the restrictions imposed upon broadcast service by the vagaries of interference and fading, it is plain that nature was none too kind to us when it wrote the laws of propagation for frequencies between 550 and 1,600 kc.

Propagation Characteristics in the FM Band ★ Around 50 mc. in the FM band, however, radio waves act more reasonably. In general they travel outward in all directions to distances two or three times line-of-sight, that is 20, 50, 100 miles and sometimes further.

While we cannot say that sky-wave transmission is entirely non-existent in the FM band, we do know that FM stations have substantially the same coverage areas day and night. So much for the radio propagation characteristics of the two bands.

Advantages of FM Over AM ★ Let us consider now the implications of the differences between FM and AM broadcasting which are due to the differences between frequency and amplitude modulation. We could establish a high frequency broadcasting system in the 42- to 50-mc. band using amplitude modulation. Why is it that instead we use Frequency Modulation in this band?

The best place to look for the answer to this question is at a point where a radio receiver is located. At this point there will be present a signal from the station it is desired to receive. This signal has an intensity, that is a signal intensity, which can be measured. There also will exist at the receiving antenna disturbing electrical intensities and possibly signals from broadcast stations other than the one we desire. These also can be measured.

With either AM or FM reception, it is not the absolute strength of the radio signal from the desired station which is important, but the ratio of the desired signal intensity to other potentially interfering noises or interfering radio signals. With AM broadcasting the desired signal

*Consulting Engineer for FM Broadcasters, Inc., Jansky & Bailey, National Press Bldg., Washington, D. C. A report delivered at the annual meeting of FMBI, New York City, Jan. 26, 1944.

must be of the order of 100 times as strong as the undesired disturbances or interference if completely clear and undistorted reception is to take place. However, with FM the desired signal need be only approximately twice as strong as the undesired noise and interference for clear reception. In other words, all other things being equal, for good clear reception conditions at a given location, an AM signal must be 50 times as strong at least, as an equivalent FM signal.

Expressed in terms of power, the comparison of the two types of modulation is even more startling. It takes approximately 2,500 times as much power at an AM station to deliver clear reception at a given receiving point as it would for an FM station operating on the same frequency at the same place. In so far as the ability to overcome noise and interference is concerned, a .2-kw. FM station is the equivalent of 500 kw. on an AM station on the same channel. The implications of this fundamental difference in the effects produced by the two types of modulation in determining the potential characteristics of an allocation structure and the number of stations which can be operated simultaneously upon a single channel is decidedly startling.

Comparative Potentialities of FM and AM ★ The idiosyncrasies of radio transmission in the AM band, plus the fact that a very weak interfering signal can disturb a very strong desired signal, seriously limits the number of stations which can operate in the AM band. The existence of sky-waves at night which do not exist in the daytime makes the limitations most severe at night when there is the greatest demand for broadcast service. Already the AM band is overcrowded, and even under the most favorable circumstances it cannot be expected that there will be any substantial increase in the number of AM stations licensed. If there is, it will be to the detriment of the service delivered by existing stations.

The more reasonable and localized propagation characteristics of the FM band, plus the fact that the desired signal need be only a little stronger than potentially interfering signals or disturbances, makes possible a broadcasting system where coverage areas will be the same day and night, and where many stations throughout the United States may be placed on a single broadcast channel. These same factors make for improved clarity of reception throughout the better defined, consistent coverage areas.

Need for Adequate FM Allocation Facilities ★ So much for the engineering potentialities of FM broadcasting as contrasted with the restrictive limitations inherent in AM. Consider next the adequacy of the channel assignments provided for FM broadcasting by the regularly authorized licensing body. We now have the use of 40 channels lying between 42 and 50 mc. There is available no tangible evidence to prove that this is not the best place in the spectrum for FM, and there is plenty to prove that it is. However, it is highly probable that a wider band than that at present available will be necessary to accommodate all legitimate applicants. This is evidenced by the fact that already in some parts of the United States there are more applications than can be granted in the existing band. FM Broadcasters, Inc. is already on record with a request that more FM channels adjacent to the existing band be provided.

FCC FM Regulations ★ In 1940, FMBI and those of us who firmly believe in the future of FM submitted evidence before the Federal Communications Commission in support of a recognition of this new broadcast service and for the allocation of a portion of the radio spectrum to it. The FCC not only acted favorably but followed with the promulgation of a complete and detailed set of rules, regulations and operating standards. Let us consider some of their general characteristics.

The rules emphasize and define such terms as Basic Trade Areas each of which includes a Principal City, Limited Trade Areas and other Cities, and finally Rural Areas. On the basis of these definitions, the FCC rules provide for 3 classes of stations and channels:

(a) Class A Stations intended to serve limited or basic trade areas and located in or near cities of less than 25,000 population. To stations of this class 6 FM channels are assigned.

(b) Class B Stations intended to serve limited or basic trade areas and located in or near cities of more than 25,000 population to which 22 channels have been assigned.

(c) Class C stations intended to serve large rural and special service area stations to which 7 channels have been assigned.

In addition, there are 5 channels in the band assigned exclusively to stations in the non-commercial, educational category.

Note, if you please, that the classification of channels as A, B, or C, that is (A) small city, (B) large city, and (C) rural area channels looks suspiciously like the local, regional and cleared channel classification in the AM band. Also, it is evident that a definite attempt has been made to closely relate the coverage areas of FM stations to economic areas of influence wherever that is possible. The philosophy in back of the Rules is obviously that upon which the American system of self-supporting broadcasting has been built. Idealistically, a close relationship between economic areas of influence and radio coverage areas would be a good thing. However, the extent to which this is possible will depend primarily upon the laws of radio propagation and not upon the laws of economics.

Further study of the Commission's Rules and Regulations shows emphasis upon one other basic philosophy and this is the thesis that, in general, all of the FM stations in or near a specific city should, for competitive purposes, serve substantially the same coverage area. I quote from the report of the Special Engineering Committee of FMBI on this point:

> "The provision establishing several classes of stations prevents the licensing of stations on such a basis that all of the stations in a given locality serve the same area. By setting up different classes of stations, the present rules in effect establish several widely different classes of stations, each of which competes with other stations in an area or even adjacent areas thereby intensifying competition in the matter of coverage between stations of different classes."

Obviously, either the Commission's philosophy with respect to equality of service from different stations in the same general locality or the Commission's rules must go by the board. The Rules and Regulations contradict the basic philosophy.

FMBI Comment On Use of Trade Areas ★ The Special Engineering Committee of FMBI has devoted a number of meetings to extended discussion of the present FM Rules and Regulations. Certain of this Committee's recommendations and comments have already been approved by the Board of Directors of FMBI. The following comments upon the use of trade areas as a basis for allocations are taken from the Committee's report:

> Trade areas do not represent a practical basis of allocation for FM stations because:
>
> (1) Trade areas are not one and the same for different commodities.
>
> (2) Authorities do not agree as to the boundaries of trade areas.
>
> (3) Trade areas are often irregularly shaped and the cities or principal city is often located in one corner or on one side of the area. In other words, there is no direct relationship between the laws of trade and the laws of propagation.
>
> (4) Trade areas change with time because of changing methods of transportation, road facilities and distribu-

(CONTINUED ON PAGE 23)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5 MEN ERECT 90-FT. MAST IN 1 HOUR

This Mast, of Light-Weight Steel Tubing, Is Ideal for FM or Television Antenna

BY HAROLD COHEN*

THE accompanying photographs tell, in a picture story, how easily a 90-ft. steel mast can be erected without the need of employing trained riggers.

Masts of the type illustrated are available in lengths of 25 to 200 ft. However, the 90-ft. mast is shown because it is particularly suited for a great many radio applications, either on the ground or on the roofs of buildings. It is ideal for carrying an FM or television receiving antenna, or the vertical radiator of an FM transmitter.

The 90-ft. mast is furnished complete with guy wires, anchors, base plate, boom, and winch, as well as all necessary hardware, weighing 750 lbs. complete. The mast comprises 10 sections ranging from 4½ to 3¼ ins. in diameter, and weighs 350 lbs. Anchors for the guy wires should be located 40 ft. from the base.

The first step in erecting the mast is to lay out the anchors with respect to the base. Each anchor carries a screw, by means of which the anchor is literally threaded into the ground, as shown in Fig. 1. The anchors are then fitted with chains to which the individual turnbuckles are secured, Fig. 2.

Two purposes are served by the base, Fig. 3. The part the workman is holding takes the bottom section of the mast, while the boom is fitted into the other tube. In addition, a hinge is provided to hold the mounting when the mast is swung up into position.

Only 8 of the 10 mast sections are assembled at first. The sections are telescoped together, making a 2-ft. joint. Then the tapered bars and wedges are inserted, as in Fig. 4. The pull of the guy wires on the wedges serves to make the joint permanently secure.

Fig. 5 shows how the winch is driven into the ground. This winch is furnished with the mast, and can be left in position in case it is necessary to lower the mast at any future time.

In preparation for raising the mast, the three sections of the boom are assembled with the base, and the two bottom mast sections are put in place, Fig. 6. At this point, guy wires are secured temporarily to the anchor opposite the boom and to the two anchors at the side. The fourth set of guys are fastened to the end of the boom, Fig. 7.

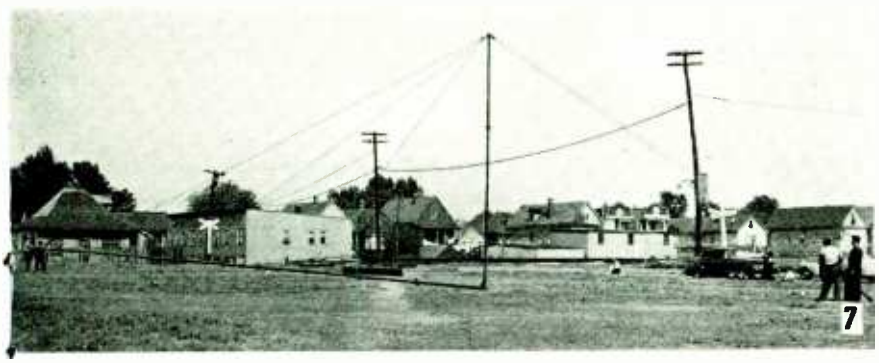
The latter guys must be adjusted carefully to keep the mast straight while the boom is drawn down by the winch, Fig. 8.

Fig. 9 shows the mast after the guys have been finally adjusted, and the installation made permanent. The boom can be left in place, against the possibility that there may be a reason for lowering the mast later, or it can be removed and stored away.

An important factor is the safety of construction, because of the danger to life or property in case of high winds. This factor was carefully considered in the original design. This mast can withstand wind velocities of 125 MPH, and up to 100 MPH with a ¾-in. coating of ice. Since 75 MPH is considered hurricane velocity, this is an ample factor of safety under all ordinary conditions.

The illustrations show a cross-arm at the top which is supplied with the mast.

*President, Harco Steel Construction Co., Inc., 1180 E. Broad St., Elizabeth, N. J.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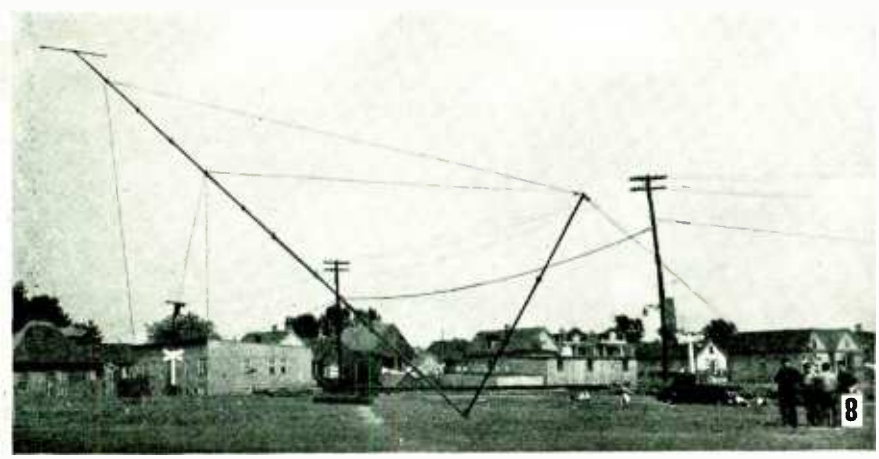
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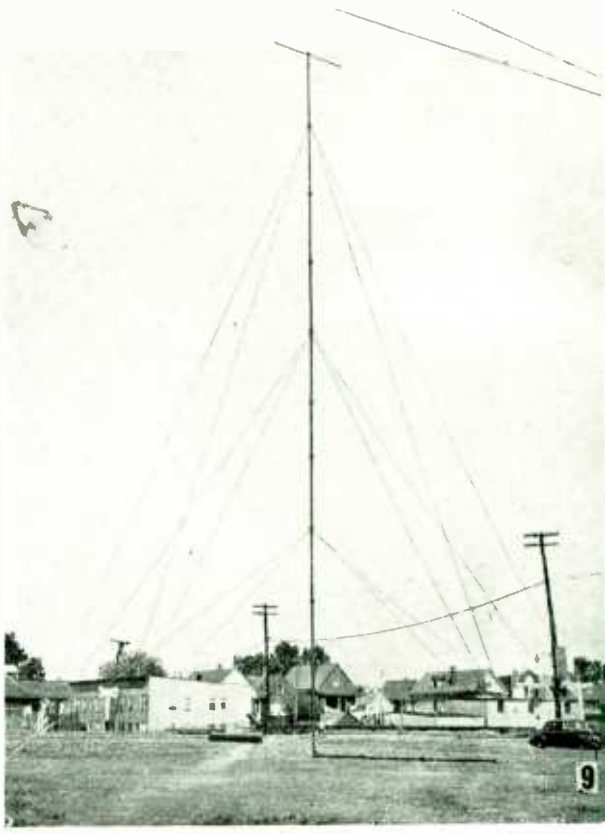
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RADIO HAS BECOME A TECHNICAL SERVICE

Manufacturers' Plans Must Recognize New Technical Problems Introduced by FM and Television

BY D. W. MAY*

NOT so many years ago, there were a few engineers who knew practically all there was to know about all the aspects of radio. At that time, there were also a few servicemen who knew enough about home radio sets to install and repair any type or model they encountered.

Conditions have changed during the last ten years, though, and at an accelerated rate. Engineers have become specialists, with great knowledge of one section of a complete instrument which may combine FM and AM radio reception, an automatic phonograph, and perhaps television reception also. Furthermore, many of our engineers today have little time and interest for other than their own sections of the equipment, and most all of them disregard entirely the problems of the men who must service the product of their composite efforts!

D. W. MAY, DEAN OF THE RADIO DISTRIBUTORS

The Forgotten Man ★ Thus, in the years immediately preceding Pearl Harbor, the work of the men who installed and serviced sets equipped with FM and television circuits and automatic phonographs was becoming more and more complex, and they were getting less and less consideration and assistance. *Yet upon these men rested the responsibility for the customers' satisfaction, particularly with the more expensive and elaborate models!*

And that is not all the story. Prewar discounts made ample allowance for the cost to dealers of handling installation and service work, and doing it in a way that would satisfy their customers. But they couldn't take care of this work because the average dealer's serviceman did not have a sufficiently broad knowledge of his own, nor was any opportunity afforded him to learn the electrical or mechanical details of new equipment. He didn't even have books from which he could dig out information for himself.

As a result, rather than take the responsibility for installation and service of expensive models, there was a growing tendency among dealers to offer a substantial discount in lieu of service. Then, if any serious trouble developed, the dealer passed the responsibility to the distributor.

Most distributors had factory-trained servicemen who were at least familiar with the models in their own line. They had to have such men, because conditions were getting so bad in many areas that the only way distributors could hold their dealers was to do much of this service work for them.

There'll Be Some Changes ★ Things are going to be different when civilian radio sales start again. In the first place, manufacturers have learned some important lessons from their military experience, and the wise ones are going to apply these lessons to their postwar plans.

In the second place, those distributors whose ability and experience as merchandisers will warrant their continuing to function in this capacity have known for a long time that a number of things in the radio picture needed correction, and they are going to take advantage of the fresh start to correct old abuses.

Lessons from Military Experience ★ Manufacturers have always recognized that installation and service instructions were necessary accompaniments to each model they produced. With certain notable exceptions, however, most of the instructions furnished were so sketchy and inadequate that they seemed intended to de-emphasize the subjects they were intended to cover. In fact, they might as well have stamped: "The less said about installation and maintenance, the better." Frequently models were modified but no corresponding changes were made in the instructions. Very often instructions were not available until months after new models were put on sale.

Upon conversion to military production, it was something of a disturbance to have contracting officers demand that instructions accompany all equipment going to the Armed Forces, and to have government inspectors refuse to release shipments before those instructions were produced! It was a new idea to be asked: "What good will the equipment be on the battlefront if our men don't know how to set it up, use it, and keep it in repair?"

Another kind of lesson has been taught the manufacturers by their war experiences. Efforts to cheapen civilian sets had resulted in the use of designs and production methods which made a great many models so difficult, and hence so expensive, to repair that dealers refused to try. If they charged a profit on their work, customers were indignant because the price of the repair was disproportionately high compared to the cost of the set itself. Yet they would willingly pay as much for a similar repair, which cost the dealer less to make, on more expensive models!

The Army, Air Corps, and Navy had different ideas about set designs in relation to service. They said: "No part shall be so mounted or positioned that it will be necessary to remove it in order to replace another part." What a difference from civilian construction. Some manufacturers are going to follow that policy in their new civilian designs, and it will help servicemen so much that they will be glad to modify their service charges accordingly.

Postwar Sales & Service ★ With the more complicated circuits and mechanical construction that are coming in FM, AM, and

* D. W. May, Inc., Far ısw ɔrth Distributor, 1 East 42nd Street, New York City.

television receivers and automatic phonographs, it is fortunate that the industry has had the war period to revise its methods and to work out new plans. I anticipate these changes in the factory-distributor-dealer-customer relationship:

1. The manufacturer will accept the responsibility for the satisfactory performance of his products when they reach consumers.

2. This will be accomplished by planned instructions for dealers' servicemen and for consumers in the form of

3. Instruction courses for servicemen, provided by the factory and arranged by the distributors, supplemented with complete and thorough instruction books covering installation, home demonstration, service, and replacement parts, and

4. Consumer instruction booklets, interestingly written and illustrated, that will help set owners to appreciate and enjoy the full quality of performance of which the new instruments will be capable.

POSTWAR MERCHANDISING

THERE'S a tremendous amount of food for thought in the ideas expressed by D. W. (Winnie) May. Former Philco distributor for New Jersey, New York, and New England, and with G.E. for the past eight years until he recently resigned his post as eastern regional manager of the Electronics Department, his ideas reflect a world of practical knowledge and experience in the distribution of radios, refrigerators, and household electrical appliances and equipment.

In his opinion: "The old methods served their purpose in their time, but the manufacturer or distributor who thinks they are still good will never survive the competition of postwar product ideas and the new concepts of service to consumers."

5. To assure the success of this plan, it will be the responsibility of the distributor to build his volume of sales not by selling the greatest number of units to the largest number of dealers possible, but to select dealers who are able to merchandise and service his line, and then to work with them in close coöperation to build their sales to maximum levels.

This does not apply, of course, to cracker box radios sold on wrap-'em-up-and-carry-'em-home-and-don't-ask-me-for-service basis. But it does apply to the new, high-quality FM, AM, phonograph combinations and television receivers at prices which will enable dealers to make attractive profits through the application of sound sales and service methods.

I don't know that all the postwar lines are going to be set up in this way, of course. But if the many years I have spent as a distributor of radios, refrigerators, and associated merchandise have qualified me to make a prediction, I am sure that no line will be able to meet competition unless the products are supported by a plan such as I have outlined, executed with great thoroughness in every detail.

ENGINEERING PLANS FOR FM PROGRESS

(CONTINUED FROM PAGE 19)

tion systems, and the changing influence of the cities themselves.

(5) In certain sections of the country trade areas are so large that to begin to cover them the FM stations must be of extremely high power with very high antennas, thereby involving a very large and prohibitive investment. In other densely populated areas, because of the proximity of two or more large cities, the individual trade areas become so small that to assign the available channels to cover only the restricted areas involved will not utilize radio facilities to their fullest extent.

Now, I think we must all recognize that it is not too difficult to criticize a tangible set of Rules and Regulations, but it is quite another and more difficult matter to make helpful suggestions for improvement.

Summary of FMBI Recommendations ★ The Board of Directors of FMBI has approved the following recommendations of its Special Engineering Committee:

I. It is recommended that the principle of allocation based upon assigning service areas to station applications be retained, but the rigid coupling of service areas to trade areas be abandoned.

II. It is recommended that new classification of channels if necessary be made on a regional, rather than a nation-wide, basis.

III. It is recommended that the use of the dual terminology "High Frequency Broadcast Stations" (as used by the FCC), and "FM Broadcast Stations" (as more commonly used by industry and public alike) be discontinued in favor of the use of only one such designation: "FM Broadcast Stations."

IV. It is recommended that in the granting of licenses to FM broadcast stations that the Commission take into account such factors as:

(1) The natural coverage area which the station would have been based upon the proposed location, power, antenna gain, and the laws of propagation for the territory to be served.

(2) The ability of the station to deliver adequate service to the community or communities the station is primarily intended to serve.

(3) That, in licensing a station, the Commission shall define the area throughout which that station shall be protected against interference from other stations on the same channel, even though the facilities to be originally installed do not provide for coverage of the ultimate area.

V. It is recommended that the Commission allow a period of commercial, program and engineering development to provide for normal growth before requiring installation of facilities to cover the ultimate area proposed, taking into consideration that growth in listener audience in different sections will be at different rates.

Summary ★ The engineering potentialities of FM broadcasting as you can see are practically unlimited. In contrast to the limited opportunities for expansion in the AM band, we can have a large number of FM stations with well defined coverage areas which will be the same day and night. When the original needs of FM broadcasting were presented to the Federal Communications Commission in 1940, adequate provision was made for it in the allocation structure in so far as it was possible to foresee the need at that time. We have before us continued evidence of the extent to which the Federal Communications Commission and the members of its Engineering Staff have worked and are continually working assiduously to guide the orderly development of FM.

The final factor which will determine the future of FM broadcasting will be the value of the public service rendered by the FM broadcasters themselves.

RAILWAY RADIO EXPERIMENTS

ACCORDING to an announcement from the Pennsylvania Railroad, tests have been started on two-way radio communication for use between trains and between the locomotive and rear of the same train.

The initial installation is being tried out on the Belvidere-Delaware Branch, a 67-mile stretch running along the eastern bank of the Delaware River from Trenton to Manunka Chunk, New Jersey. This is an important freight link because its lines serve New York and New England traffic.

No details of the equipment or the manufacturer were disclosed by Pennsylvania officials. The announcement merely stated that the apparatus is in the developmental stage, and that the use of the radio telephone will be extended to other parts of the system later.

SPOT NEWS NOTES

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

N. Y. Philharmonic on FM: Since CBS released network programs to FM stations, Columbia's own FM transmitter in New York City has gone all out to do a fine job. In fact, WABC-FM is now rated by some listeners in first place for both audio quality and program content among the Frequency Modulation stations in New York.

CBS is now giving listeners a special treat by broadcasting the Sunday Philharmonic Concerts from Carnegie Hall, and is thereby winning many warm friends. Switching from AM to FM, there is a marked improvement in tone quality. Going from FM to AM, some of the instruments actually disappear! We haven't inquired, so that we may be mistaken, but there is a definite impression at the receiving end that the same pickup and monitoring are used for FM and AM. There isn't the dynamic volume range that one would expect on FM reception. However, we are grateful for the decided improvement.

W. P. Hilliard: His appointment as general manager of the radio division of Bendix Aviation Corporation has been announced by Ernest R. Breech, president. Hilliard, whose own company in Chicago was bought by Bendix when the radio division was formed in 1936, has been director of sales and engineering since that time. As general manager, he succeeds Hugh Benet, who will now take up a special assignment. In the past eight years, radio personnel has been increased from 600 to the present complement of 7,800 workers at Red Bank, N. J., and Baltimore, Md.

Reorganization: At a recent meeting of the stockholders and directors of Universal Microphone Company, Ltd., it was decided to dissolve the corporation and to reorganize as a partnership, under the name Universal Microphone Company, taking over the assets and liabilities of the corporation. Management of the partnership will be under the direction of James L. Fouch, president; Cecil L. Sly, vice president and treasurer; Durwood D. Allen, secretary.

LT. FRED HERGESHEIMER WINS THE DFC

Lt. Fred Hergesheimer: FM engineer and former member of Major Armstrong's laboratory staff is flying P-38's on reconnaissance missions in the South West Pacific, taking photographs of Jap installations. To get pictures of the big Jap base at Kavieng, he set a record for over-water distance with a P-38. He was awarded the DFC for his successful completion of this mission, made after heavy planes, sent out for the purpose, had been badly shot up.

Radio Club of America: The oldest radio engineering association, founded in 1909, has announced the election of the following officers for 1944: President, F. A. Klingenschmitt, of Amy, Aceves & King, Inc.; Vice President, O. James Morelock, of Weston Electrical Instrument Corp.; Treasurer, Joseph J. Stantley, of Continental Sales Company; Corresponding Secretary, Milton B. Sleeper, publisher of *FM* Radio-Electronics; Recording Secretary, J. H. Bose, engineering assistant to Major Armstrong at Columbia University.

Membership of the Radio Club of America comprises many of the leading engineers in the radio and television field, and many new developments have been announced for the first time in papers delivered at its meetings. Inquiries concerning Club activities and membership should be addressed to 11 West 42nd Street, New York City.

Educational FM Applications: By North Michigan College of Education, State Board of Education, Lansing, Mich.; The State University of Iowa, Iowa City, Iowa; and the Board of Education of Newark, N. J.

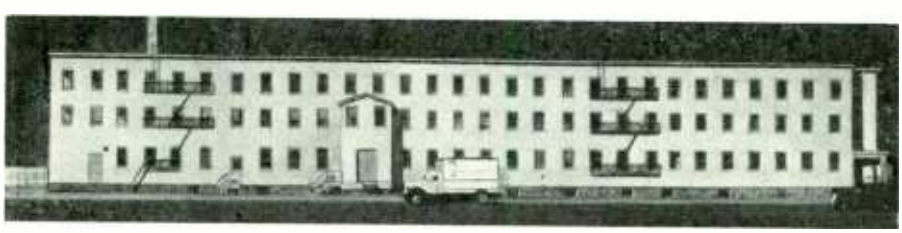
J. Kelly Johnson: Appointed executive engineer of Hammarlund Manufacturing Company. In this capacity, he will be in charge of all engineering activities, and will direct a program of expansion already under way. Johnson resigned recently as chief of Production Section, Office of Procurement and Material, Navy Department. He has previously served as engineer in charge of the Hazeltine Chicago Laboratory, and chief engineer at Wells Gardner. He received his degree in engineering at Columbia University in 1927.

Television Stations: William B. Still, of the Jamaica Radio & Television Company, Jamaica, Long Island, N. Y., has applied for a construction permit for a television transmitter to operate on 66-72 mc., with 250 watts power.

Allen B. du Mont Laboratories, Inc., New York City, have applied for a television construction permit for a transmitter to operate on 78-84 mc., with 1 kw. aural and 4 kw. visual.

Industrial Tool & Disc Works, Inc., Minneapolis, Minn. has applied for a television construction permit for a transmitter to operate on 78-84 mc. with 3 kw. for aural and 5 kw. for visual.

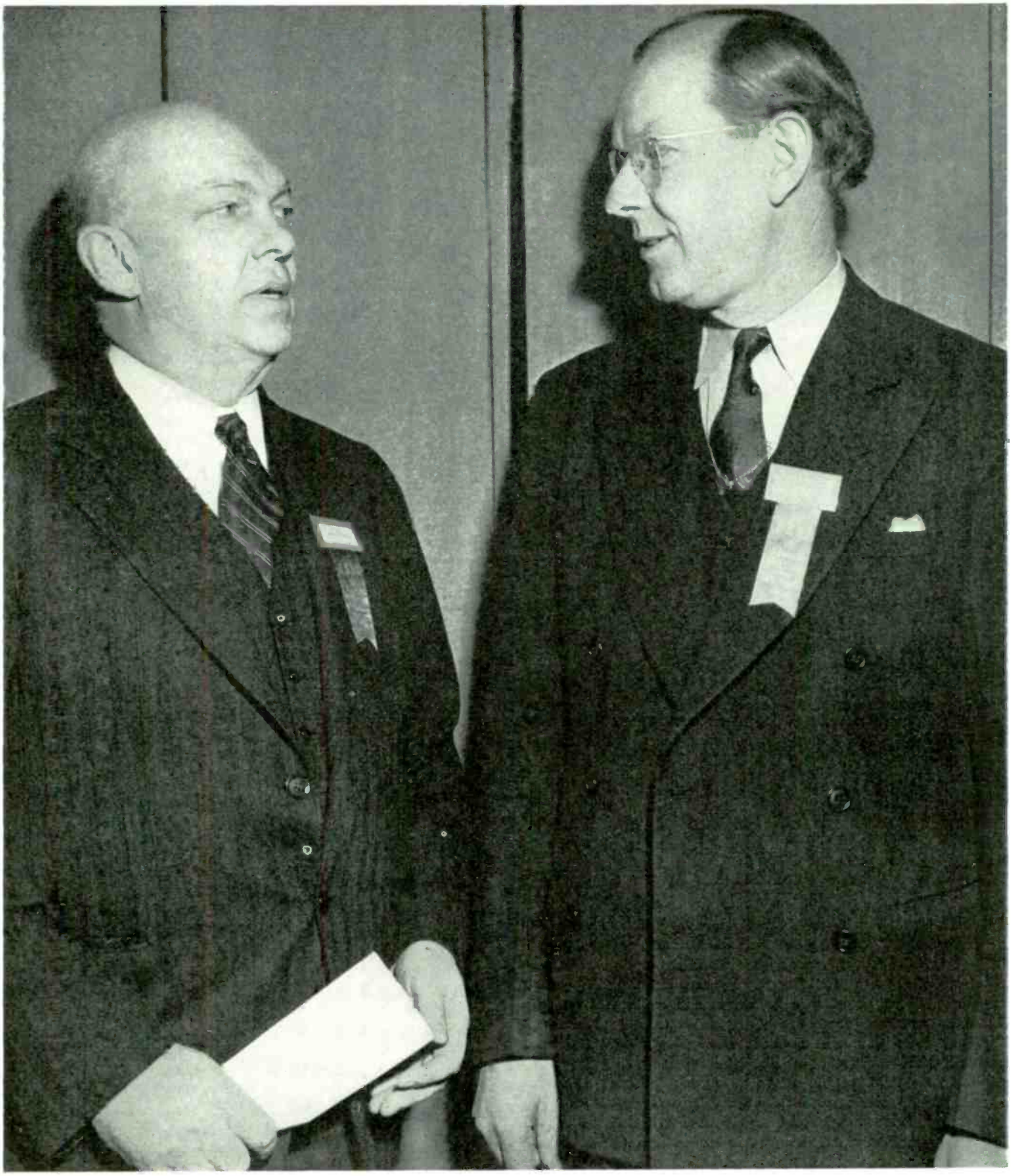
Albuquerque Broadcasting Company, Albuquerque, N. M., has applied for a television construction permit for a transmitter to operate on 50-56 mc.



PRODUCTION FACILITIES OF AMERICAN RADIO HARDWARE CO., INC. HAVE BEEN CONSOLIDATED IN THIS NEW PLANT OF 60,000 SQ. FT. AT MT. VERNON, N. Y.

Eau Claire, Wis.: Is the site of a new Western Electric plant being set up to augment the capacity of the Hawthorne Works in Chicago. The new factory will be located in Area 2 of the Eau Claire Ordnance Plant, located midway between the cities of Eau Claire and Chippewa Falls. Machinery is being installed, and production will start as soon as personnel can be trained.

(CONTINUED ON PAGE 57)



NEWS PICTURE

MAJOR EDWIN HOWARD ARMSTRONG and FCC Chairman James Lawrence Fly at the FMBI Conference. Said the Major: "No matter how many of his policies you agree or disagree with, he brought about the allocation of 1940, which permitted FM to get under way. This, I think, is the greatest service to the radio art that has ever come from the Commission, for it solves the problem of wavelengths for every city and town that can support a station."

Said the Chairman: "FM stands today on the threshold of as tremendous a development as did AM in the 1920's—perhaps a much greater development and a faster rate of growth. . . . Let us not manufacture the very transmitting and particularly receiving equipment which will destroy the great advantages of FM. Let's plan the optimum in terms of public service made possible by this great invention."

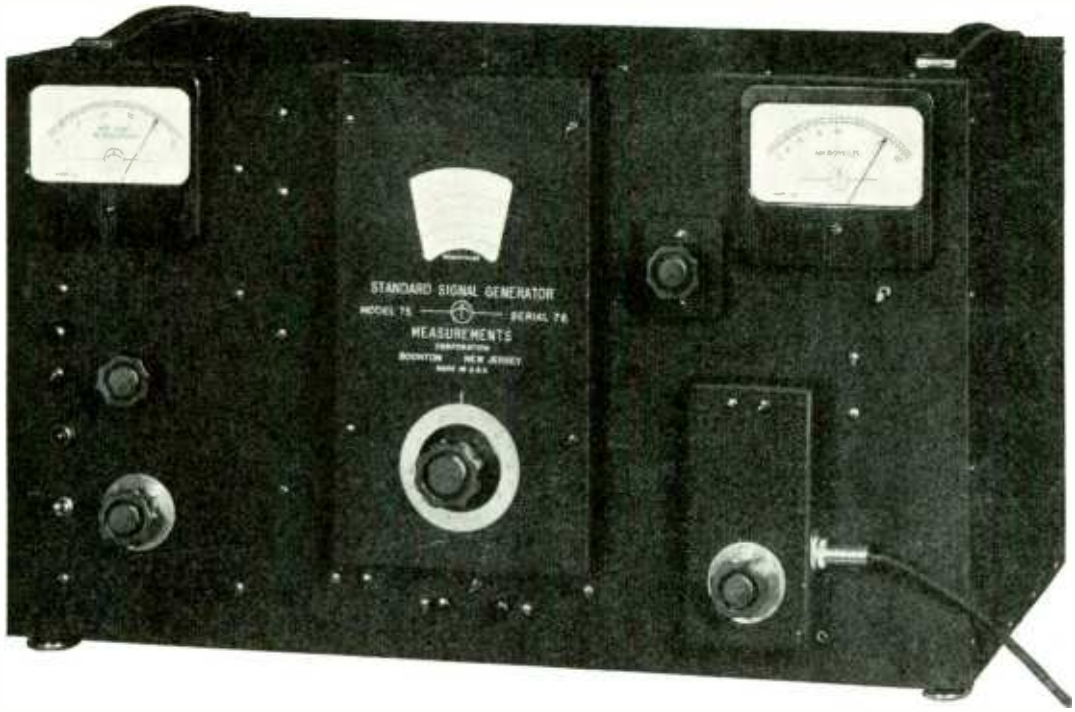


FIG. 16. PRODUCTION MODEL OF THE FINAL HIGH FREQUENCY SIGNAL GENERATOR DESIGN ANALYZED IN THIS PAPER

TAMING THE HIGH FREQUENCY SIGNAL GENERATOR

Analysis of Design Factors Involved in Generators of High Stability and Accuracy

BY JOHN M. VAN BEUREN and JERRY B. MINTER*

ANY signal generator consists basically of three units: 1) the oscillator which generates the RF carrier frequency, 2) the power supply and modulator which supply the necessary operating potential and modulation frequencies, and 3) the attenuator, which serves to reduce the output from the RF oscillator unit to the desired value.

In this discussion we will take up first the design considerations of the RF oscillator. The primary requirements of a good RF oscillator are: high stability of frequency, coverage of a wide range of frequencies, accuracy of frequency calibration, low backlash in the tuning system, and good amplitude modulation capabilities, all combined with a minimum of spurious frequency modulation.

Various difficulties arise in trying to obtain this combination of features, and there are various methods of overcoming some of them. It must be borne in mind, however, that all finished designs consist of a series of compromises between the ideal and what is possible to obtain.

*Chief Research Engineer and Chief Engineer, respectively, Measurements, Inc., Boonton, N. J. Reprinted from the Proceedings of the Radio Club of America.

Stability ★ Taking up the first of the considerations involved, that of high stability, good engineering practice dictates the use of a stable oscillator circuit, coil and condenser components that have extremely stable characteristics, rugged mechanical construction, and last but not least, tubes that give off a minimum of heat.

We are able to fulfill most of these requirements with the exception of the last, that of tube heating. While relatively little power is required from the RF oscillator, the dissipation of the tubes and resistors involved cannot be held much below 5 watts in average cases. While this amount of power seems small, it must be remembered that ventilating facilities are necessarily extremely limited, dut to the fact that the oscillator must be entirely enclosed in a metal shield to prevent leakage. Even 5 watts, under these conditions, can cause a considerable rise in temperature of the oscillator unit, with consequent expansion of component parts and frequency shift. The use of negative temperature coefficient compensating condensers naturally suggests itself, but in practice we usually find that due to different rates of heating of different parts and variations in tuning capacity, the ultimate result of trying to compensate usually turns out to be worse than the uncompensated generator.

Frequency Range ★ The second consideration of a wide frequency coverage adds further problems which necessitate still more compromises. Most conventional generators are tuned by means of varying the tank capacity. In order to cover a reasonable range on each tuning coil it is necessary to use a fairly large variable condenser. In a generator covering a total range of 100 kc. to 30 mc., the use of a condenser of around 350 mmfd. gives a reasonably good LC ratio in the neighborhood of the broadcast band. However, on the low frequency ranges, around 100 kc., the tuning condenser is considerably smaller than it should be for optimum operation, while at 30 mc. the LC ratio becomes considerably overbalanced on the capacity side.

The ideal situation would allow varying of both L and C in a fixed ratio, but unfortunately this would complicate the mechanical construction to a prohibitive degree.

Accuracy of Calibration ★ The third consideration, accuracy of calibration, brings in many of the difficulties experienced in obtaining high initial stability. The effects of tube aging, gradual changes in the size

and shape of component parts, all must be eliminated as far as possible. Special care must be taken in the selection of coil forms, impregnating compounds, and wire insulation to insure that age and constant heat cycling do not cause mechanical

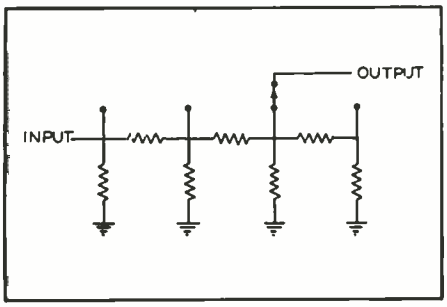


FIG. 1. CONVENTIONAL LADDER-TYPE ATTENUATOR DOES NOT REMAIN PURE RESISTANCE AT HIGH FREQUENCIES

changes in the coils. We have experienced considerable difficulty with low frequency coils in using silk insulated wire. Apparently the silk deteriorates and causes a change in the physical size of the coil which in turn affects its inductance. We have eliminated most of this trouble by the use of glass insulated wire in low frequency coils.

The elimination of backlash from the tuning system of the signal generator is a study in itself. Our experience has been that excellent results can be obtained without the use of prohibitively expensive component parts if care is taken to choose first of all a design which is inherently sturdy mechanically, and then to eliminate all sources of excess friction from the bearings and contact wipers of the variable condenser.

Modulation ★ The subject of modulation capability brings us first to the choice of

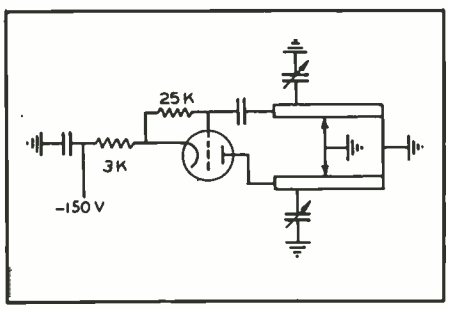


FIG. 4. PARALLEL RODS GANGED WITH VARIABLE CONDENSER FORM RESONANT CIRCUIT

the method of modulation. Grid modulation has been used on a modulated amplifier, but is generally characterized by relatively high envelope distortion. It is not feasible to grid-modulate an oscillator direct. Plate modulation has become generally the accepted method, as it produces the lowest distortion of any workable system. Plate modulation can be applied directly to an oscillator using amplitudes up to 50%.

In this case, of course, considerable spurious frequency modulation is produced as a result of the amplitude modulation. Where a master oscillator is used to drive a modulated power amplifier, the depth of modulation can be increased to 100%, while still maintaining low envelope distortion. Since the amplifier must track accurately with the oscillator over a wide frequency range, it is usually preferable to employ a screen grid type tube as a modulated amplifier to avoid neutralizing difficulties. Unfortunately screen grid tubes possess a characteristic "knee" on the modulation curve at the point where the plate voltage approaches zero. Consequently the envelope distortion rises somewhat between 90 and 100% modulation. Another difficulty arises when modulation at high audio frequencies is at-

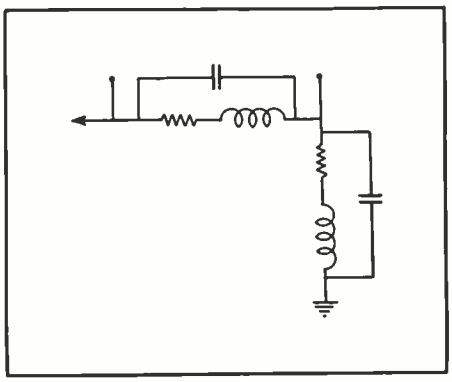


FIG. 2. ELECTRICAL EQUIVALENT OF ONE STEP OF CONVENTIONAL ATTENUATOR

tempted at low carrier frequencies. The fly-wheel effect of the tuned amplifier tank makes it impossible to obtain considerable depth of modulation at the higher audio frequencies, unless the tuned circuit is heavily loaded with resistance to spoil the *Q* of the circuit. When this is done heavier modulation may be employed, but in turn the RF harmonics rise to a considerable value.

The consideration of spurious frequency modulation is an important one. The direct modulation of an oscillator is ideal from the standpoint of simplicity, but very often it is necessary to modulate at depths greater than 50% and, in certain types of measurements, frequency modulation cannot be tolerated. This leads us to the use of a master oscillator and modulated power amplifier. The MOPA is certainly superior in practically all electrical characteristics but, unfortunately, is many times more complex and difficult to adjust than the simple oscillator. In the case of a UHF signal generator operating at hundreds of megacycles, this problem becomes even more difficult, and a really successful instrument has not yet been developed. The design of ultra-high frequency oscillators involves many different problems from that of medium frequency generator, and a typical example will be discussed later in this paper.

Power Supply ★ The power supply and modulation equipment of most generators are of conventional electrical and mechanical design, and present few unusual problems to the engineer. Consequently we will pass on to the discussion of the attenuator, which might be termed the heart of any signal generator.

Attenuator ★ The most commonly used type of attenuator consists of several resistance pads connected in a ladder arrangement as shown in Fig. 1. This is the conventional picture of an attenuator, with series and shunt resistors connected in the usual manner. If resistances would only remain pure resistances at high frequencies, everything would be well, and the design of attenuators would present no particular problem. Unfortunately, this is almost never the case at frequencies above a few megacycles.

The actual electrical equivalent circuit of a single step of a conventional attenuator is shown in Fig. 2. Here we see that each resistor contains a certain amount of distributed inductance as well as some shunting capacity. At high frequencies, the distributed inductance forms a substantial impedance and can seriously upset the attenuation ratio of the step. This can be corrected by adjusting the amount of inductance in each resistor. For example, if the resistance ratio at DC is 9 to 1, at high frequencies the inductance of the series arm would have to be 9 times that of the shunt arm in order to main-

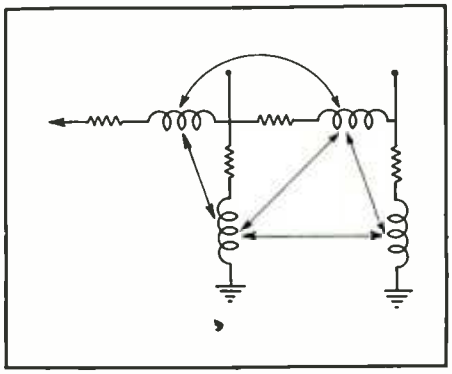


FIG. 3. ILLUSTRATING MUTUAL INDUCTANCE BETWEEN ELEMENTS OF ATTENUATOR

tain a correct ratio. This can be done but the process is clumsy, and due to the added inductance, the characteristic impedance of the attenuator will rise considerably. A much more satisfactory method is to eliminate as far as possible the inherent inductance of the resistors.

This can be done by using non-inductive carbon resistors and surrounding them by a close-fitting metal shell, which tends to

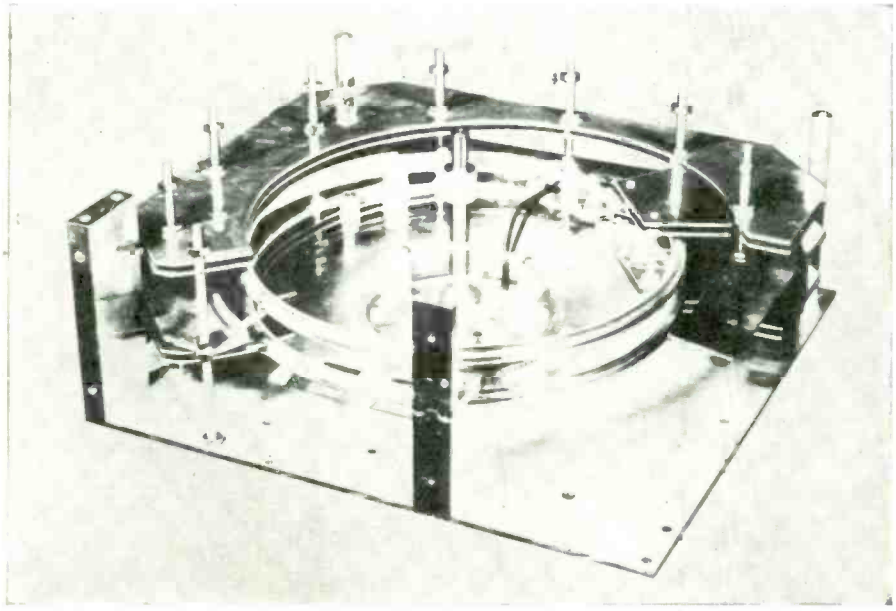


FIG. 6. THE COMPLETE OSCILLATOR ASSEMBLY, WITH ONE SIDE PLATE REMOVED. THE MAIN SHORTING CONTACTS ARE STATIONARY, WHILE THE UNIT IS ROTATED

short-circuit the inherent inductance of the resistor. Much the same situation applies to the shunting effect of the capacity of the resistors. This also can be compensated by adjusting the ratios of shunting capacity, but we have found that by using a low characteristic impedance attenuator, capacity effects even at several hundred megacycles are negligible.

Self-inductive and capacitative effects become a minor consideration, however, when compared to the real stumbling block of most attenuator design, the effect of mutual inductance between the various steps of the attenuator. This situation is shown in Fig. 3. The effect of this mutual coupling between steps of the attenuator can be so serious that at a frequency of 50 mc. an unshielded attenuator designed to give an overall attenuation of 120 db may actually give less than 20 db.

Therefore, the greatest care must be taken in the individual shielding of each step in order to prevent such interaction from taking place. It requires considerable study and experience to design an attenuator that is free from mutual inductance effects at frequencies above 100 mc. However, by careful design and placement of parts, it can be accomplished.

Design Details ★ Having discussed some of the basic problems of signal generator design, let us now follow the incorporation of these concepts into the actual design of a high frequency standard signal generator. We undertook the design of this instrument because a considerable need has been felt for an instrument to operate in the neighborhood of 400 mc. and also we were much interested in finding out what could be done toward attaining an accurate voltage source at these frequencies.

We recognized from the start that a great deal of conventional practice and design would probably have to be abandoned. However, we decided to see just what could or could not be retained, and just how much we would have to depart from what might be termed lower-frequency design. As it turned out, many of the things which we thought would present almost insuperable difficulties proved in practice to have very little to do with the successful operation of the instrument, and many things which we thought would present no difficulties formed the basis for most of the headaches.

However, the conclusion to be drawn from all this is that a great deal of conventional engineering design can be used at high frequency, provided that care is taken to think through the effect that higher frequencies have on the various circuit parameters.

Now to take up the design of the generator. The first thing was to set up desirable specifications. They were as follows:

FREQUENCY RANGE: 50 to 400 mc., greater if possible.

OUTPUT VOLTAGE: 1 microvolt to at least 100,000 microvolts.

OUTPUT IMPEDANCE: to be as low as possible.

ATTENUATOR: resistance type, balanced to ground.

The reason for some of these specifications may not be clear at first glance. Considerable discussion has arisen as to what is the optimum output impedance for a signal generator.

Since the ideal voltage source has zero impedance, we felt that the lower the output impedance, the better. While a great deal of work done is on 72-ohm transmission lines, it is extremely useful to be able to feed the output of the generator into the grid of a tube or other capacitative device. In the event that the output im-

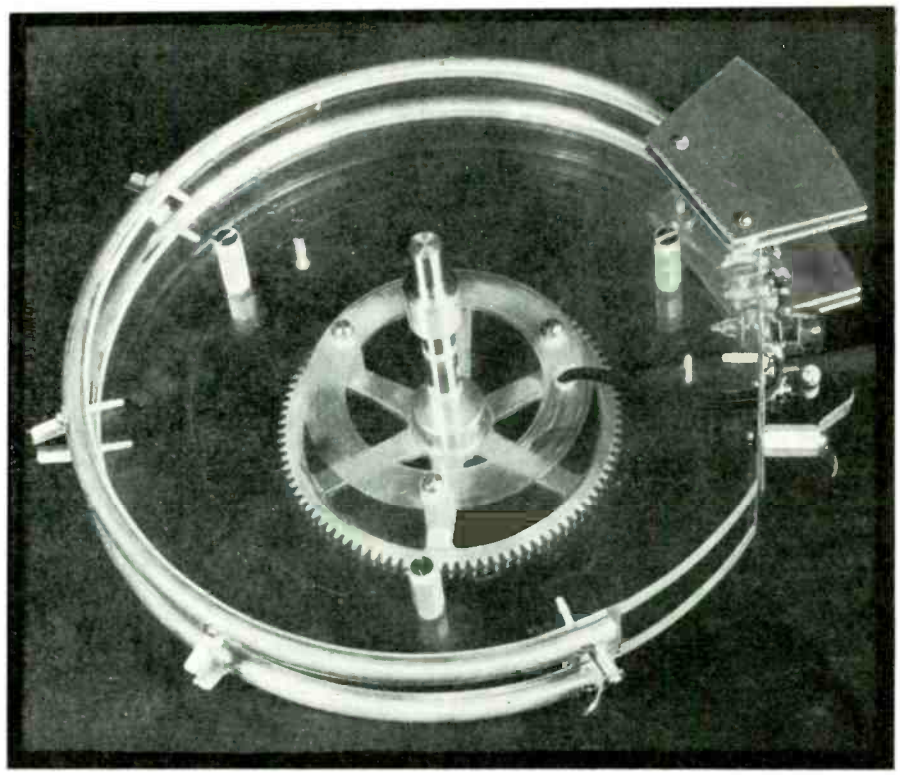


FIG. 5. RESONANT CIRCUIT COMPRISING PARALLEL RODS, CONDENSER PLATES, AND OSCILLATOR TUBE, AT RIGHT, DESIGNED AS A ROTATABLE MECHANICAL ASSEMBLY

pedance of the generator is 70 ohms or more, the capacitative reactance of the grid is often low enough at high frequencies to upset seriously the termination of the output line. As a low impedance output can be used quite readily into a 70-ohm line, we felt that for all-around use the low impedance is the most practical.

FIG. 7. VARIABLE COUPLING LOOP IS ADJUSTED BY MEANS OF CONTROL GEARED TO THE HOLLOW SHAFT

We chose the resistance type attenuator in preference to others mainly because it is the type with which we have had most experience and, also, we were curious to know whether such an attenuator would work at frequencies as high as 400 mc. As a great deal of work is done on balanced systems, we decided to make it of the balanced type.

Having set up a desirable set of specifications, the next step was to try to put them into an instrument. The first consideration was, of course, to generate the necessary radio frequencies. A number of circuits were considered with the idea of having as stable an oscillator as possible. This pretty much ruled out lump circuit constants, and indicated the use of a resonant transmission line of some sort for the frequency determining element. The first type considered was a coaxial line which has the advantages of a low radiated field and a high Q. An experimental oscillator was built along these lines. It seemed to operate quite well at the higher frequencies, but in order to reach a reasonable lower frequency limit, the physical size became relatively tremendous, unless capacity loading was added to reduce the low-frequency limit. A great deal of difficulty was experienced in trying to make a satisfactory co-axial type oscillator which could be loaded with capacity. So this type was finally abandoned in preference for the parallel rod (balanced line) type.

Upon further experimentation it was found that the parallel rod oscillator seemed to have many advantages for use in a signal generator. The oscillator could easily be loaded with capacity to reach a reasonably low frequency, while keeping physical size well within bounds. A pair of rods about 18 ins. long with approximately 50 mmfd. of capacity would give a low limit somewhere around 50 mc. In order to cover the complete range of 50 to 400 mc., either several ranges of capacity load would have to be employed or a variable condenser would have to be used. In order to maintain a fairly constant output and avoid difficulties in range changing, it was decided to try variable capacity plus a variable length line to cover the whole frequency range without a switching.

The fundamental circuit is shown in Fig. 4. The parallel rods which form the resonant circuit have a shorting slider whose position can be varied. A ganged variable condenser is connected at the open end of the line, which is varied in conjunction with the slider. The grid of the oscillator tube is connected through a blocking condenser to one of the rods. The grid leak is returned to the cathode. For the sake of simplicity it was decided to ground the B +, and connect the plate directly to the other rod. The resistor in the cathode lead was found to improve general operation.

Having determined on a suitable oscillator the next problem was to adapt it to a suitable mechanical design. There are two main actions to be accomplished in varying the frequency. The position of the shorting slider must be varied in combination with the variable loading capacity. It was also found necessary to short the unused portion of the parallel rods at high frequencies, as the section behind the slider would tend to resonate as a half-wave line, causing serious dead spots. The first design considered was a lead screw to vary the position of the slider, connected to a gear train which rotated the variable condenser. The difficulties involved in such a design were vast, as the mechanical complexity assumed nightmarish proportions when we tried to gang together the aforementioned lead screw and gear train to some means for shorting the unused portion of the line. In addition to the mechanical difficulties, the physical size was also rather large. So, in order to conserve space, we tried rolling up the parallel rods

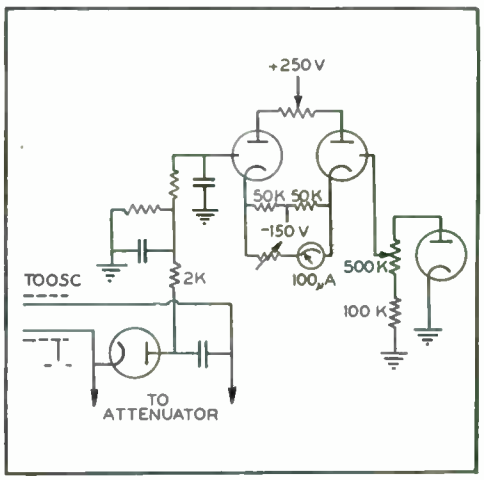


FIG. 8. VOLTMETER COMPRISING UHF DIODE ACROSS BALANCED TRANSMISSION LINE

in a circular shape and having the shorting slider, on an arm, travel around in an arc.

We finally found that if we used the circular-shaped rods, and moved the rods instead of the slider, all three operations of varying the length, the capacity, and shorting the unused portion of the line could be done very simply with only one moving part. The type of assembly which evolved from this idea is shown in Fig. 5. The parallel rods are bent into three-fourths of a circle and mounted on insulating discs. The oscillator tube is mounted on the discs and rotates with them. A set of condenser plates is attached to the open end of each rod for adding capacity. The clips spaced along the length of the line are used to short the unused portion.

Fig. 6 shows the complete oscillator as-

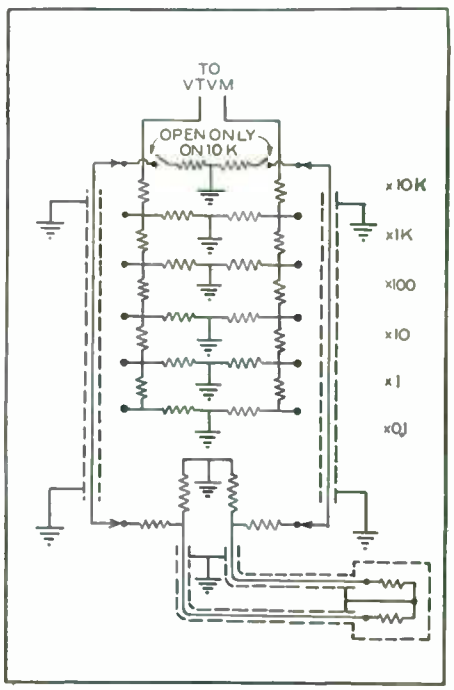


FIG. 9. DIAGRAM OF THE BALANCED LADDER-TYPE ATTENUATOR FINALLY SELECTED

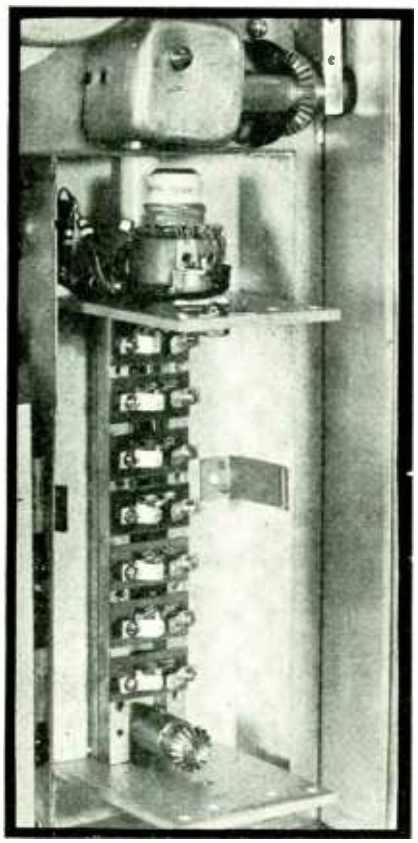


FIG. 10. CLOSE-UP OF ATTENUATOR MOUNTING, VT VOLTMETER, AND DC AMPLIFIER

sembly with one side plate removed. The rotor unit turns on its axle, and the main shorting contact, which controls the length of the line, is held stationary. Consequently, as the rotor revolves the length of the line is varied. As the length of the line increases, the condenser plates attached to the rotor mesh with the stator plates which are held on a series of studs. These stator plates are so shaped that, as the length of line increases, the rotor plates mesh deeper and deeper with them, thus adding considerable capacity loading. Now, if we turn the rotor counter-clockwise, the active length of the line decreases and the inactive length increases. As mentioned before, the inactive portion tends to resonate as a closed half-wave length of the line at the higher frequencies, and it is necessary to short it at frequent intervals to prevent dead spots. The clips which are spaced along the line perform this function by shorting on a stationary strip at the proper time. A pair of these clips can be seen just beginning to short in Fig. 5. These clips continue to slide along the stationary shorting strip, keeping the inactive portion broken up into short sections and preventing resonances in the working range. Thus the three operations of varying the length of the line, varying the capacity loading, and shorting the unused portion of the line are all accomplished with the single movement of the rotor. This proved very satisfactory.

Having designed the means for generating the required range of radio frequency, the next problem was to get it to the attenuator. This involved some sort of pick-up loop system and a means of controlling the voltage into the attenuator over a 10 to 1 range. A conventional pick-up loop and slide wire were tried and proved very unsatisfactory, because the relatively large inductance of the slide wire caused it to resonate in the working range. We assumed that in order to avoid excessive frequency reaction when the fine output control was varied, a relatively constant load would have to be presented to the oscillating circuit.

Various systems of slide wires, capacity and resistance devices were tried and found sadly wanting; and in desperation we turned to a simple variable coupling loop. Surprisingly enough, this worked very well, and caused less frequency reaction when varied than any of the systems previously tried. A mechanical design was then worked out as shown in Fig. 7. The coupling loop is mounted at the end of a T branch of a hollow copper tube. From the coupling loop leads run inside the tube, spaced by polystyrene beads, to form a balanced transmission line of approximately 150 ohms surge impedance. The beads are slightly smaller than the inside diameter of the copper tube, and the wires forming the transmission line are flexible so that the line can twist freely inside the tube. The tube is supported by mounting blocks, one of which can be seen in the picture, and can be rotated in its mounting. This causes the pick-up coil to approach or move away from the main shorting contact, which is the point of maximum current. In this way, the coupling is varied and the voltage at the end of the line is varied with a minimum of complexity. The coupling at the high frequencies between the tank circuit and the loop increased greatly and we found it necessary to supply a small copper shield for the loop to retire into. Without this shield only approximately a 3 to 1 maximum-to-minimum voltage was obtainable.

Upon leaving the RF unit, the transmission line from the loop enters the attenuator system proper where the vacuum tube voltmeter is located. The voltmeter consists of a special ultra-high frequency diode connected directly across the balanced transmission line as shown in Fig. 8. The maximum voltage that can be developed across the line over the whole frequency range is approximately 1 volt and, as we wished to vary this over a 10 to 1 range, it was necessary to be able to read accurately on a meter 1/10 volt across the line. If two diodes were used with one plate connected to each side of the line, and the cathodes grounded, this would give only .05 volts per diode at the minimum position, and this was found too small for satisfactory indication. Therefore, a special diode with low cathode-to-heater capacity was used and placed directly across the line. This gave very satisfactory indication with the 1/10 point occurring at approximately 4% of full scale on an expanded scale meter. In this case, the diode is used as an essential pure voltage source, the current to operate the meter being supplied by a balanced DC

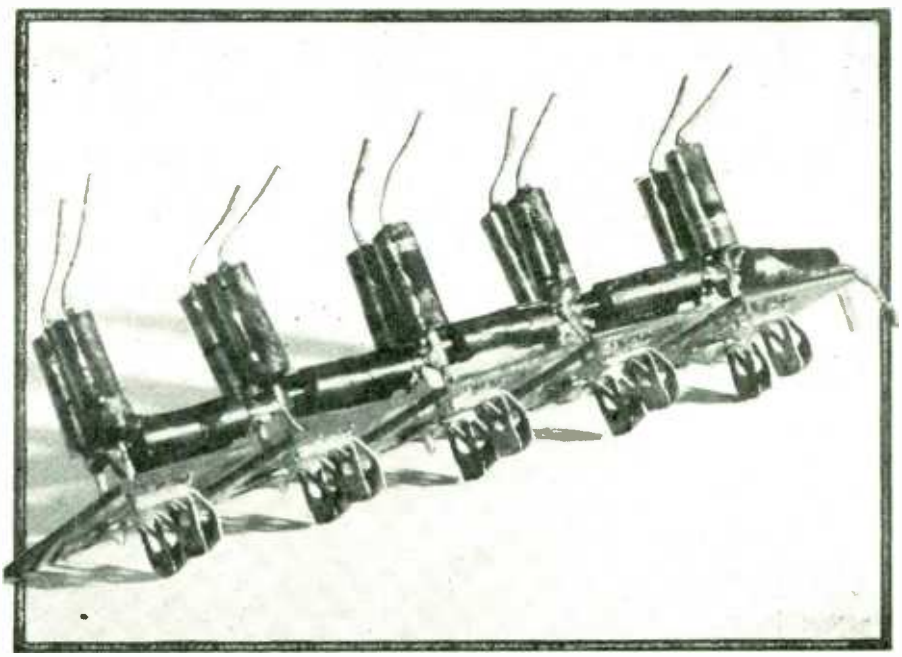


FIG. 11. COMPLETE SET OF SERIES AND SHUNT RESISTORS MOUNTED WITH THEIR SILVER LEAF SPRINGS FOR GROUNDING THE SWITCH DRUM ILLUSTRATED IN FIG. 12

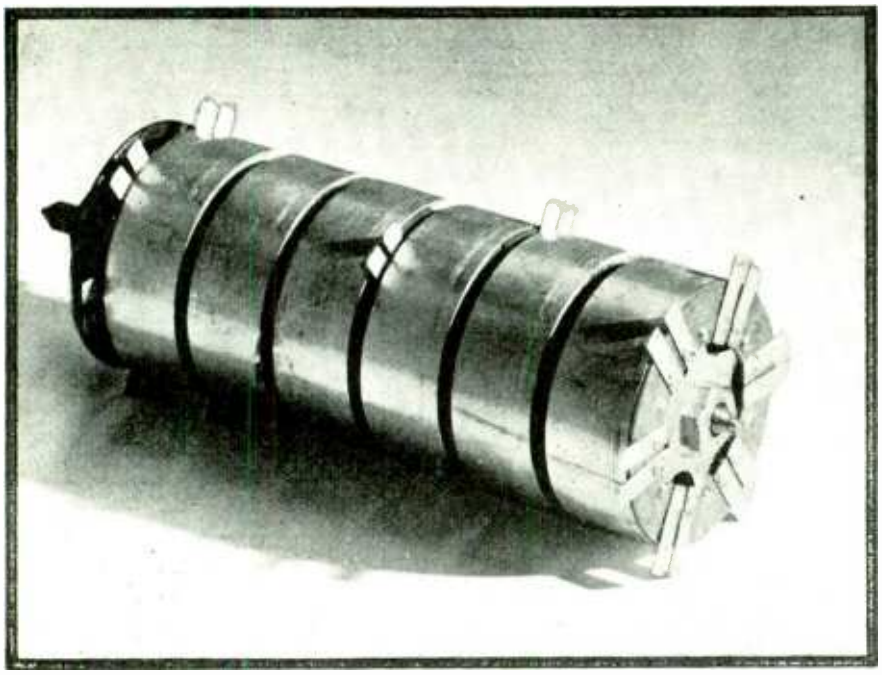


FIG. 12. DRUM SWITCH WITH BLADES WHICH ENGAGE THE ATTENUATOR CONTACTS. THE SWITCH HAS 6 SECTIONS OF BALANCED TRANSMISSION LINE OF DIFFERENT LENGTHS

amplifier of high stability. When used as a voltage source only, even these extremely non-uniform experimental diodes are quite satisfactory and follow a predetermined calibration curve very closely.

From the vacuum tube voltmeter the voltage continues into the attenuator, the diagram of which is shown in Fig. 9. The attenuator has six steps of 10-to-1 ratios and is of the balanced ladder type, having a characteristic impedance of 75 ohms per side. The voltage is picked off from the desired attenuator step and transferred to the output cables in a manner which will be described later. A view of the attenuator, vacuum tube voltmeter, and DC amplifier is shown in Fig. 10. The voltage from the RF unit emerges from the transmission line at the upper right hand side, goes through a junction box, and descends into the attenuator shield where it is measured by the diode.

Below the shelf on which the diode is located, the attenuator resistors themselves are arranged. The series resistors run vertically downwards between the two side bars, while the shunts extend through holes in the panel and terminate on the front of the panel. The junctions of the shunt and series arms are connected to the small silver plated clips which are mounted on the bakelite strips. The pairs of series and shunt resistors of the balanced system are placed close together so that stray inductive and capacitative effects tend to cancel out. The junctions of the six attenuator steps are brought out to the top six sets of contacts. The bottom set of contacts are connected to the output cable system on the front panel. The small silver leaf springs shown are for grounding the switching drum which will be described. Fig. 11 shows a complete set of series and shunt resistors soldered to their contact strips. In operation, the resistors are almost completely surrounded by metal which largely eliminates both self and mutual inductance effects, making it possible to operate the attenuator at high frequencies.

The problem of connecting the various attenuator steps to the output cable system proved very difficult. We felt that in order to avoid serious errors from voltage step-up and reflections, all RF voltages in the attenuator system must be carried in properly terminated lines. The difficulty to be overcome was the design of a transmission line of constant impedance so that when the bottom end was connected to the output cable system, the length of the line could be changed to contact the desired attenuator step. This was finally solved by the design of the drum switch shown in Fig. 12. The drum consists essentially of six sections of balanced transmission line of different lengths, arranged in cylindrical form, with the sections of line running parallel to the axis of the cylinder. One end of all the sections of line lies in a plane at the bottom of the drum, and connects to the output cable system in turn. The upper ends of the sections lie at various points along the drum, and by rotating the drum parallel to the attenuator, the various lengths of line are switched in between the output cable contact and the desired attenuator step contact.

In this way the voltage is transferred from each attenuator step to the output cable in a properly terminated line. The arrangement can be seen installed in place in Fig. 13. Upon leaving the attenuator, the output voltage enters a pair of 3-ft. flexible transmission lines. At the outer end of these lines is a terminal box containing the proper terminating resistors to avoid reflections in the output cable. As the entire attenuator and output system is of balanced design, both mechanically and electrically, the ground currents which are often a serious source of trouble in single-ended attenuators cancel. Since all voltages are carried in properly terminated lines, reflection difficulties are avoided and the attenuator system works with remarkable success at 400 mc.

The modulation and power supply unit is of conventional mechanical and electrical design. Both a positive and negative supply are needed, the positive to furnish plate voltage for the modulator and audio oscillator, and the negative to supply the necessary — 150 volts for the RF oscillator. A small rectifier and filter system provide 6 volts DC for the heater of the RF oscillator tube. This largely eliminates hum modulation at the high frequencies and makes for a clean note at 400 mc. A primary line voltage regulator maintains constant AC input voltage to the generator at all times.

In the design of the signal generator, leakage is an important factor, and filters must be provided to eliminate stray RF from the voltage supply leads. The com-

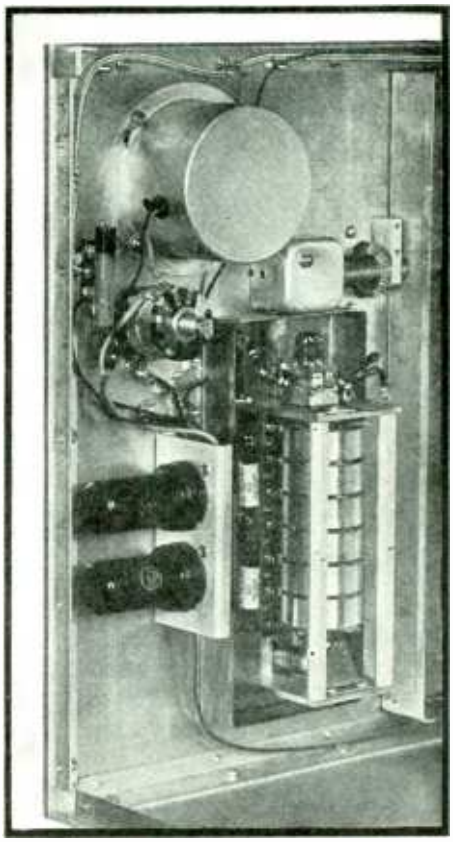


FIG. 13. ASSEMBLY OF ATTENUATOR AND SWITCH ELEMENTS SHOWN IN FIGS. 11 AND 12

IN TELEVISION BROADCASTING...

RCA pioneered the development of electronic television.

RCA engineers developed the Iconoscope, the Kinescope and the Orthicon, as well as circuits for their use.

NBC, a member of the RCA family, operates a commercial television station which has pioneered program development—a station whose programs are rebroadcast by other stations.

RCA had developed a full line of commercial television transmitting equipment before the war and had offered it to broadcasters.

RCA is now utilizing its engineering experience by building for the armed forces a large quantity of electronic equipment.

RCA will be prepared to offer for postwar service a full line of new and improved television equipment, including studio equipment, film equipment, portable equipment, relay equipment, studio-transmitter-link equipment, and, of course, audio and video transmitters.

BUY MORE WAR BONDS

RCA

RCA BROADCAST EQUIPMENT

RADIO CORPORATION OF AMERICA

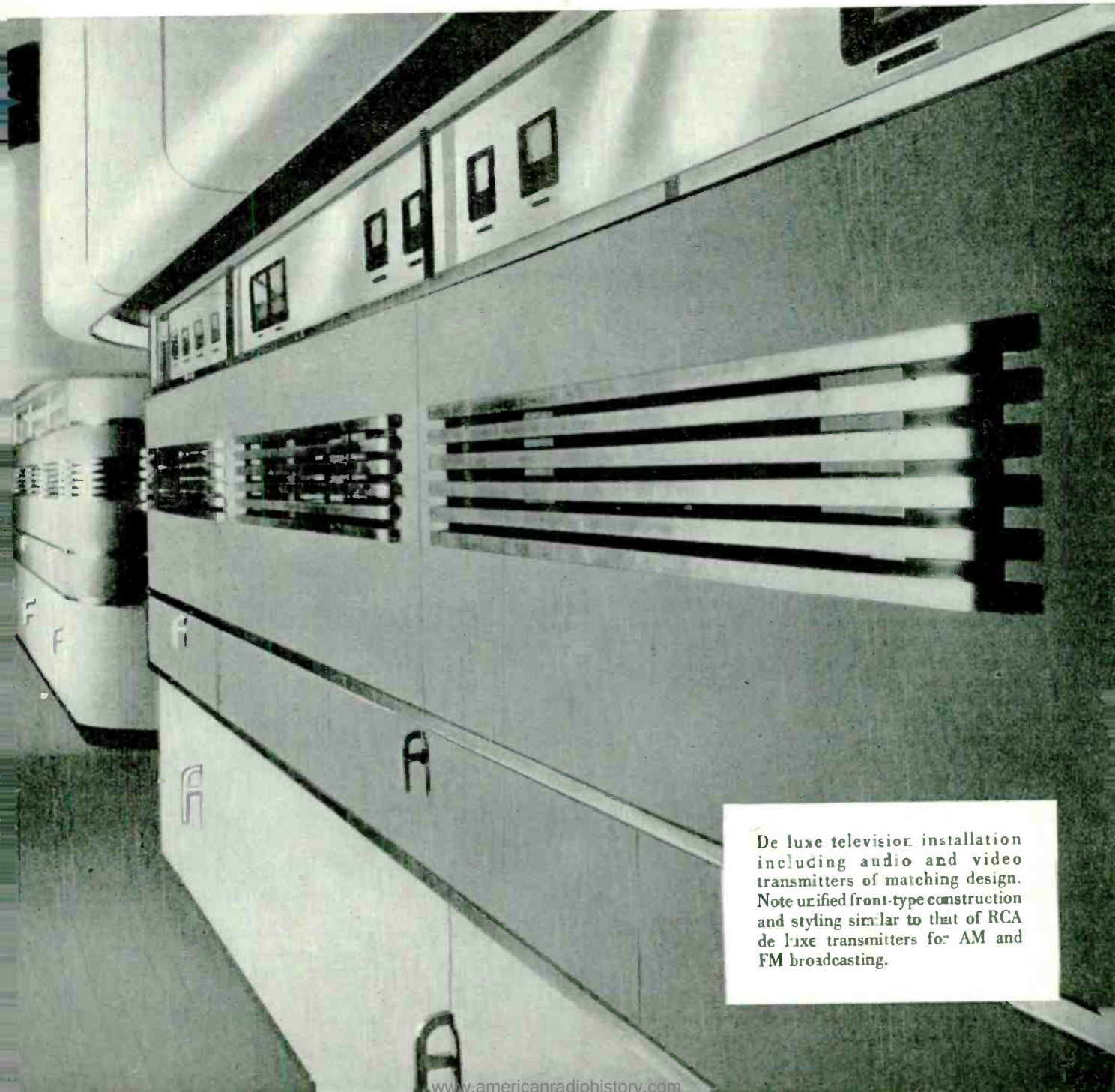
RCA installations now in operation

The de luxe-type installation shown below is one of several RCA Television Transmitters installed before the war.

All of these installations are standard transmitter models, designed and constructed to broadcast specifications and installed for regular television stations.

They are in addition to a number of experimental and relay-type television installations made by RCA as part of its own television development program.

RCA's experience in this field is unequaled.



De luxe television installation including audio and video transmitters of matching design. Note unified front-type construction and styling similar to that of RCA de luxe transmitters for AM and FM broadcasting.

ponent parts of the filter system are shown in Fig. 14. The choke is wound edgewise on a paper tube form. This construction was chosen to reduce capacity between the input and output leads. The associated condenser is of the strap type, having extremely low inductance to ground. In this condenser the "hot" plate runs directly through the surrounding grounded plate, making an extremely effective by-pass at high frequencies.

The oscillator unit and attenuator are carefully shielded by means of copper shields which completely surround the respective units. The overall shielding is accomplished by the metal case. Shafts exposed to RF fields are carefully insulated and grounded to prevent their carrying stray voltages outside the case.

A general back view of the experimental model of this generator is shown in Fig. 15. The power supply and modulation equipment are located on the right hand side and above them can be seen the back of the percentage modulation meter. Between the power supply and the RF unit are located the filters. The chokes are located in aluminum shield cans and the filter condensers are tied down directly on the front panel. The tuning motor is located on the side of the RF unit. Since the main tuning dial of the generator makes some 60 revolutions, the tuning motor saves a good deal of work for the

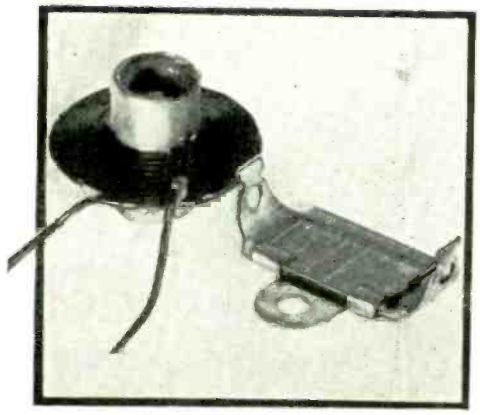


FIG. 14. ACTUAL SIZE OF THE RF FILTER CHOKE AND CONDENSER IN SUPPLY LEADS

operator. To the left of the RF unit can be seen the pick-up loop support, the tube which carries the RF from the oscillator to the attenuator. The bevel gear, controlling the position of the pick-up loop, is just to the left of the RF unit. The attenuator and DC amplifier have been described before. A shield is supplied around the output meter to prevent any stray leakage from it.

A front view of the instrument is shown in Fig. 16. The modulation controls, line switch, pilot light, and binding posts for external modulation are at the left. In the center is the main tuning dial and above it the calibration dial. The two push buttons below the dial cover control the tuning motor. To the right of the dial cover is the fine output adjustment knob. Control of this varies the reading of the output meter, the reading of which is multiplied by the indicated factor of the attenuator dial. The output cables plug into the side of the attenuator cover and can be removed for convenience.

A few words as to the methods of testing this instrument may be of interest. The attenuator ratios are, of course, one of the most important features of the generator. They are checked as follows: The output is turned up full and a vacuum tube voltmeter is placed across the output terminals and the calibration of the output meter adjusted until 1/10 volt appears from each output terminal to ground. Then a receiver whose second detector output voltage has been calibrated in a 10-to-1 ratio is attached to the generator. The attenuator multiplier is then reduced from × 10K to × 1K and the output of the latter voltage is checked. Then the gain of the receiver is increased until the second detector output voltage is again .1 volt, upon which the generator attenuator is moved down another step and the output voltage again checked. This procedure is followed for each step on each side of the attenuator at 50, 100, 200, 300, and 400 mc., to make sure that no

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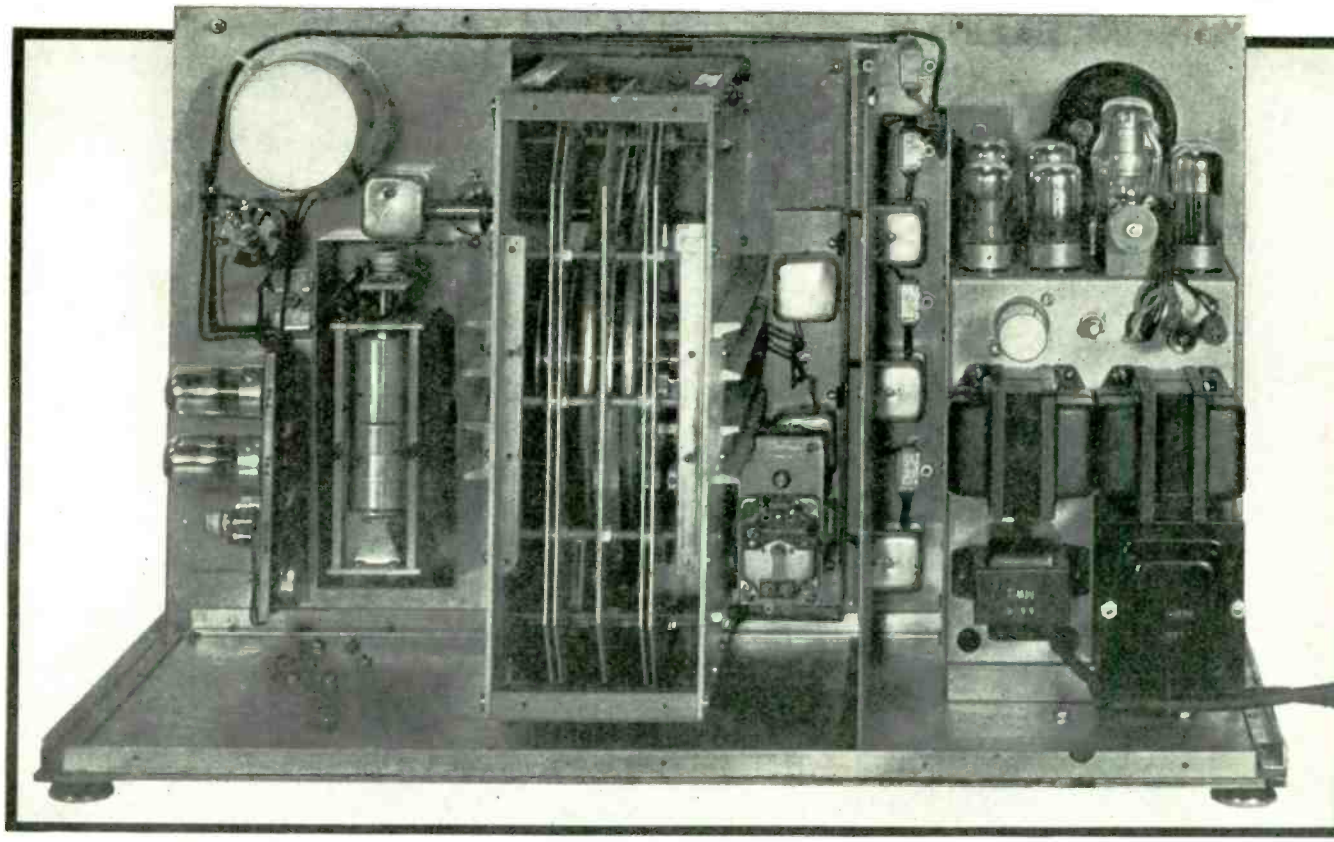
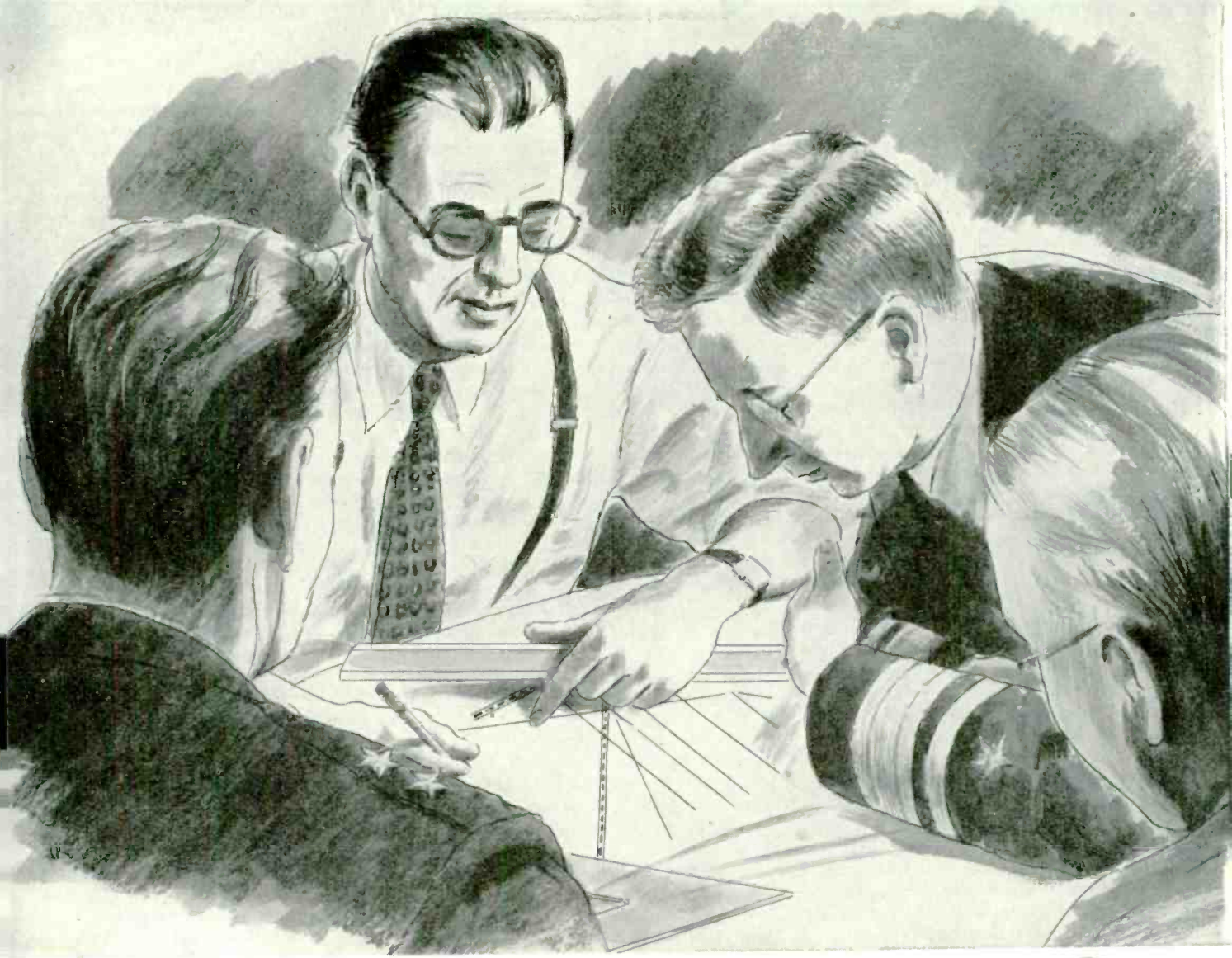


FIG. 15. REAR VIEW OF THE DEVELOPMENT MODEL. POWER SUPPLY AND MODULATOR ARE MOUNTED ON A SEPARATE CHASSIS AT THE RIGHT, WITH THE MODULATION METER ABOVE. MOTOR DRIVE FOR TUNING IS AT RIGHT OF THE ROTOR



Their *hobby* is radio too . . .

These are the leaders of science and communications. They are professionals in what has become a most vital element of modern civilization . . . radio communications and the science of electronics. Some of them wear the uniforms of top ranking military officers because we are engaged in war. Others remain civilians as doctors of science . . . the leaders of radio, electronic and electrical industries which are amazing the world through their achievements. Achievements which not only aid in war but which are creating the new era of industry to follow. They are the great men of today . . . they will be still greater tomorrow . . . and they are radio amateurs.

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opportunity to carry out a constructive program of institutional advertising on the subject of FM. That was done and is being continued in both transmitter and receiver advertising.

We produced a 16-mm. colored talking motion picture film explaining FM and comparing it to AM. The film, incidentally, was selected as one of the ten best industrial educational films that year. It is almost completely devoid of advertising and can be borrowed without charge by the broadcasters from the nearest General Electric district office.

We are sponsoring a news program on many of the AM stations and a high percentage of the announcements are devoted to FM. As a token of our continued interest in FM, we are sponsoring programs with practically all FM stations accepting commercial programs.

As far as we are concerned, this has not been a deliberate academic promotion of FM. In saying that, I refer to the recent statement by one of the broadcasters that FM has had one of the outstanding promotions of the decade. I believe it is one of the outstanding achievements of the decade and, in fact, the only major improvement since broadcasting began. Our publicity and radio programs have been sincere efforts on our part to prepare you, the public, and ourselves for the inevitable trend toward FM.

The transition period from wartime to peacetime production cannot be accomplished without shrinking pains. We, like many other manufacturers, must face that, but General Electric has taken steps to smooth out the transition insofar as possible. Here again, I believe we have been constructive. A few months ago, our publication *Radio Broadcasting Post War* and our *Equipment Reservation Plan* were announced, and copies mailed to all broadcast stations. We attempted in the book to forecast the three big changes in broadcasting:

1. Hundreds of FM stations will be built.

2. Many AM stations will modernize — others will switch to FM.

3. Television will grow into an important separate broadcasting enterprise.

Your presence here is an indication of the increasing interest in FM. With such impetus, continued rapid growth is assured. It seems reasonable that FM will eventually supplant all local, most of the regional, and some high-power AM stations. It would give the public FM and better AM reception. The present AM band would be cleaned up, making more clear channels available for more high-power stations. Possibly in the future we can have super power, 500-kw. AM stations for long range coverage. At this point I should say that a large master FM station with a group of satellite stations or locally owned affiliate stations has far greater coverage possibilities than any high power station in the eastern or western parts of the United States.

A few months ago, I stuck my neck out and predicted 500 FM stations and 750 AM stations five years after the war. To complete the prediction, 100 television stations and 50 international stations. True, this is only one prediction, but it is based upon our analysis of the trends and with some thought about the economics.

Our equipment reservation plan has been well received all over the country and it has created interest in Canada, Central and South America. Many stations have signed up and we expect many more. This information will permit intelligent planning of postwar production.

To give you some idea of our expanded facilities, we are now shipping each day in dollar volume of war goods, an amount equal to the total of reservations we expect to book. You will note that no vital statistics are disclosed in this statement!

Our plans for the future are very definite. We intend to manufacture and offer for sale a complete line of FM transmitting equipment from microphone to antenna and, in addition, medium and high-power AM transmitters both conventional and international. Work on these lines will be started as soon as our engineers are released from war work. Manufacturing will start as soon as we are authorized to produce transmitting equipment for commercial use.

In the meantime, we have a large amount of information which we believe will help you with your FM and AM postwar plans. We will furnish it gladly upon request. And you are welcome to visit us at Schenectady.

C. B. JOLLIFFE, Chief Engineer, RCA Victor Division, Radio Corporation of America: For many years, RCA has had a very considerable interest in the technical development of FM. Research has been carried forward in RCA Laboratories on specific FM circuits, propagation characteristics of very high frequencies used in FM, and on component elements required for FM broadcasting. Typical of the important contributions made by RCA engineers are the Seeley discriminator and the Crosby FM transmitter, which are extensively employed both by our company and by others. In addition, RCA antennas have enabled FM broadcasters to obtain highly efficient coverage of service areas. The wealth of data on wave propagation obtained by RCA and NBC has helped engineers of the government and industry to make predictions of the service areas of FM stations. RCA's research work on FM is continuing, but most of a confidential nature.

Prior to the war, RCA had developed and was ready to put into application some novel FM circuits. We expect to incorporate these circuits in apparatus produced in the postwar period. We manufactured and supplied FM broadcast transmitters prior to the war. Equipment was installed then and is now operating in such cities as New York, Philadelphia, Detroit and San Francisco. As soon as civilian production is resumed, we plan to offer for sale a complete line of FM transmitters. These transmitters will have the power ratings required by the industry and will follow the general trend of our previous models except for the inclusion of new circuit features and mechanical simplifications. These transmitters will meet all the technical requirements of the FCC for frequency stability, freedom from distortion, and other characteristics that insure good and reliable service. In the postwar period, all RCA standard broadcast audio equipment will meet the present standards of fidelity for FM and, consequently, all standard equipment will be suited for use with FM transmitters.

RCA has produced test and monitoring equipment required by FM stations and we expect to continue to offer this apparatus for sale. RCA plans also to supply FM antennas suitable for use on steel towers or existing structural supports. RCA will be able to furnish studio-transmitter link-circuit equipment and accessories. In fact, we plan to be in the same position as we have been in the AM broadcasting field; that is, we will offer a complete and coördinated line of studio, transmitter and accessory equipment. We expect to coöperate with stations and with their consulting engineers in equipment and installation problems.

With respect to the other portion of the FM system in which the public is interested — the receivers — as one of the larger producers of home radio sets, we expect to offer for sale to the public FM receivers of high quality design at reasonable prices. We expect that these sets will do full justice to the FM programs.

In summary, RCA's policy with regard to transmitting equipment and receiving sets is simple and clear. We intend to design, manufacture and sell the types of apparatus for which a need exists and which the public wants. As broadcasters, you are keenly aware of the importance of satisfying public demands. The success of the American broadcasting system is evidence of how well you have done this. We intend to use our background of

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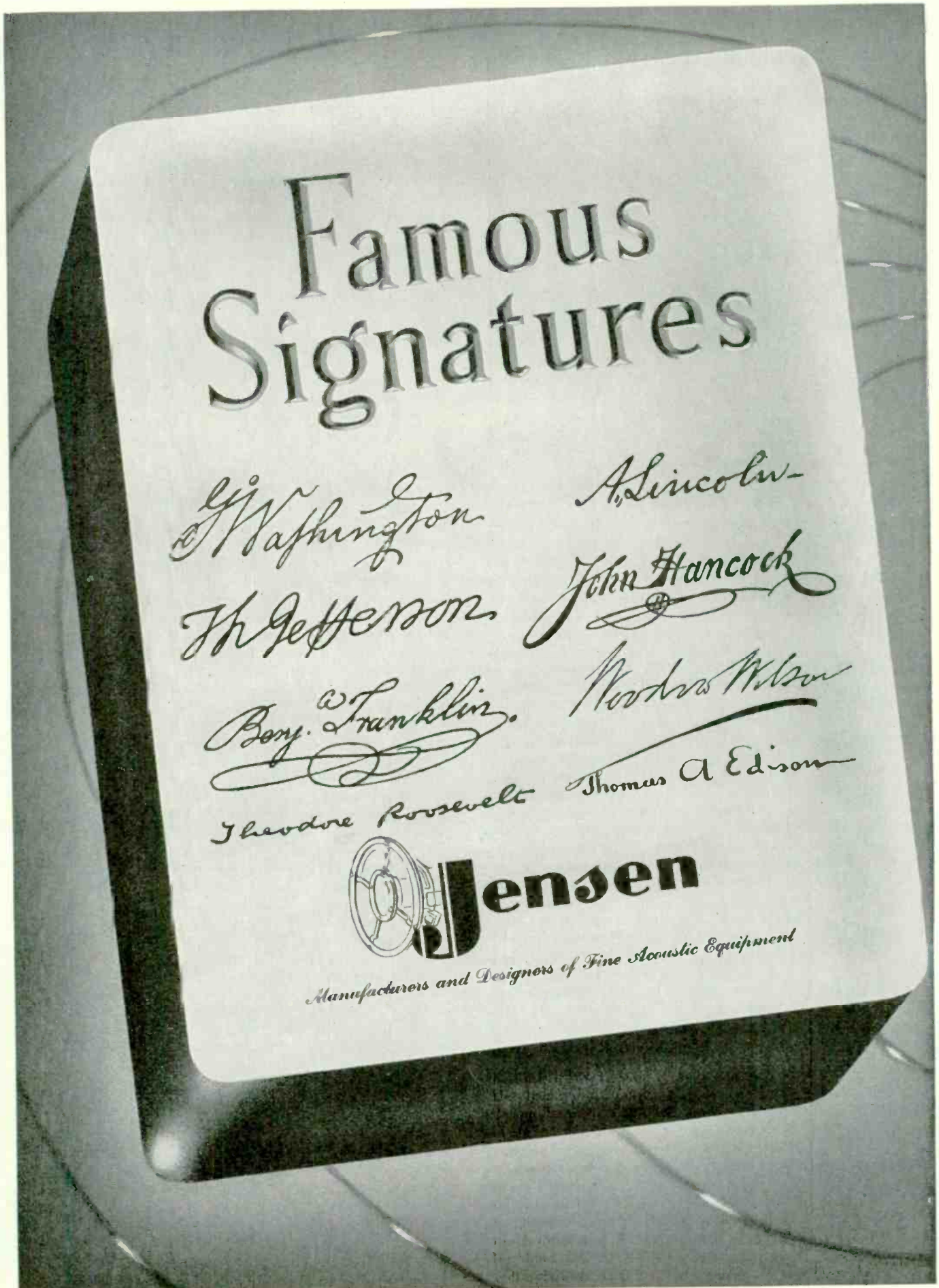

FMBI CONFERENCE FEATURES COÖRDINATED ACTION

(CONTINUED FROM PAGE 14)

experience in the broadcast transmitter and receiver fields, plus our engineering facilities, to provide the type of equipment the broadcasters need to satisfy the requirements of their listeners and the licensing authority.

CHARLES SREBROFF, President, Radio Engineering Laboratories, Inc.: REL is the pioneer manufacturer of FM broadcast transmitters, having closely collaborated with Major Edwin H. Armstrong in the construction of Radio Station W2XMN, Alpine, New Jersey. The total output of all the REL transmitters now in operation today is 242,000 watts. This represents the power fed to the antenna systems.

It is the intention of REL to maintain the fine traditions set up by these early stations. As soon as restrictions are lifted, we shall again supply FM broadcast stations complete with their necessary accessories and FM studio-to-transmitter links.

From the experience gained during this war period, we are in position to produce equipment of the finest construction and design. It is our definite intention to continue to employ the Armstrong phase-shift method of modulation. Field information and actual experience gained from the operations of the many REL FM stations now on the air more than substantiate the superiority of the Armstrong phase-shift method of modulation. We have manufactured two models of FM transmitters, both of which employed this method of modulation. The first of these has been performing consistently since 1938, and the second model has been in use since 1941. The transmitters range from 1 kw. to 50 kw.

Briefly, the advantages gained by the phase-shift method, as evidenced from the experience of the many stations using it, are:

1. The outstanding feature of the Armstrong method is its reliability. It is the only crystal-controlled method of producing frequency modulation, and it is therefore the only method which cannot get off frequency. Its frequency is directly controlled by a single crystal which maintains stability to within better than 100 cycles of the center frequency. Its fundamental principle is that frequency modulation is produced by phase-shifting a current derived from a relatively low-frequency, crystal-controlled oscillator. This phase-shift represents a very linear but very small frequency change which must be multiplied through a series of frequency doublers to produce the required frequency change in the radiated wave. The frequency stability is many times better than that required by the rules of the Federal Communications Commission.

2. It affords the least distortion without the use of any counter or audio feedback. It is simple and straightforward in its design and operation.

3. Audio frequency characteristics are essentially flat over the useful frequencies required for high fidelity broadcasting.

4. The placement of components and the overall design can be so arranged as to afford easy accessibility to all parts.

We feel that the postwar period will show a tremendous increase in the number of FM broadcast stations. Many of these new broadcasters will not come from the ranks of the present AM group, but will be the local bankers, grocers, newspaper owners, and others who are active and influential in their communities. This new group, lacking previous experience, will need guidance and close coöperation to get them off to a successful start. We are preparing to make this assistance available to them. We have accumulated the widest experience in this line from the REL installations now in use.

REL has set up a program whereby the new broadcaster entering the field can secure a complete "packaged" FM broadcast station, low in cost and easy to erect so that his community, which now lacks adequate, enjoyable, and static-free radio entertainment, will have the finest service. This FM radio package will comprise a 1-kw. transmitter, studio equipment, measuring equipment, and the material necessary for the erection of a suitable antenna. The prospective broadcaster will only need to supply the building or the space in which the installation is to be made, and the tower, roof or the mountain top on which to erect the antenna. Besides the apparatus, REL will be prepared to assist and guide in making arrangements to supply all of the engineering data required for the FCC construction permit filing. We will also make available information regarding programming, advertising, and operating costs. In short, we intend to make available for the package buyer all he wants to know. This means that at one source he will easily and quickly secure the necessary data to get on the air. In plain and straightforward language, the package will "provide everything from soup to nuts."

All 50-kw. FM installations now on the air are of REL manufacture. We plan to maintain our leadership in the field of high-power FM transmitters, also.

F. R. LACK, Vice President, Western Electric Company: What are Western's plans for FM? I am happy to say that we have nothing new to show you now and nothing new to talk about. I am happy because I do not have to tell a soldier named Joe, who needed a radio very badly last month, that we could not deliver it because we diverted some engineers and some shop people to building the model of a new super-dooper FM equipment to show you and thus strengthen our postwar position. I am sorry that I can't tell you when we will be able to talk. But then no one can tell me when the war will be over.

With the shortage of paper and manpower, we are concentrating all of our publicity efforts on our employees. Our latest effort in this regard is a booklet called "Battle Talk," which most of you will see. It is now being distributed to our employees — over ninety thousand of them — seven thousand in the Bell Laboratories and eighty-three thousand in the shops. Down at our shop, soldier Joe has a perpetual AAA and you will notice from "Battle Talk" that during the year 1943 we delivered to him nearly 575 million dollars' worth of radio, electronic and communication equipment. A large share of this was FM. In fact, during the years 1942 and 1943, with the assistance of our subcontractors, we delivered 129 million dollars' worth of FM to Joe. In this connection I should like to digress a moment and tell you a story that has not been told before.

When the Army came to us and asked for FM equipment, I went to Major Armstrong for a license. He said, "As you well know, I served in the last War, and they won't take me for this one, but I should like to do my bit. You can build all the FM you want for the Armed Services and the license fee will be one dollar." I take off my hat to him. I don't think anyone would have begrudged a reasonable license fee to the Major to help him pay for his continued experimental work and the operation of Alpine.

This huge FM program has taken all the time of our FM experts and a lot more, and a number of new projects are in the mill. While we have nothing to show you at this time, we are building up a great deal of experience not only in FM but in ultra-high frequencies and microwaves; experience in components, vacuum tubes, transmission lines, antennas, and all the new things necessary in this field.

When the war is over, all this experience will be available to you, your consulting engineers, and your own engineering staff, and when Uncle Sam says "Hold 'nuf" we hope we will have the privilege of going to work on your problems.

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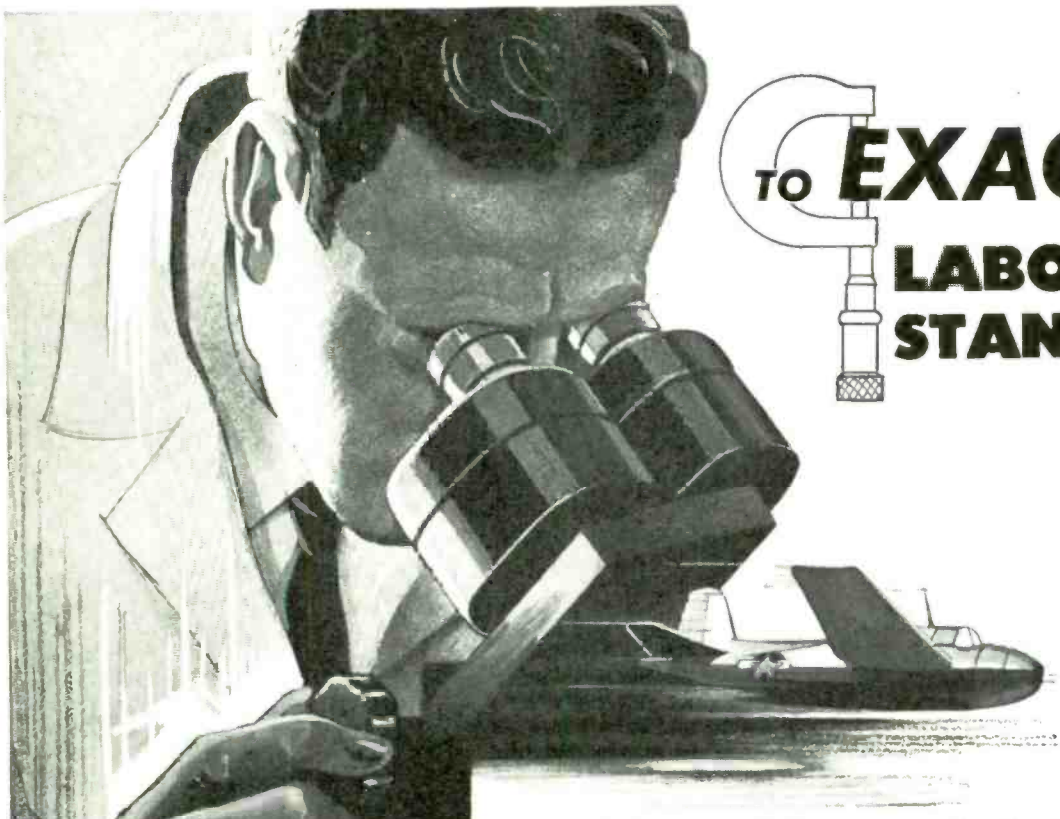

TO EXACTING LABORATORY STANDARDS . .

Over the long period of years separating the past from the present, ECA has been called upon to tackle the development and production of innumerable types of specialized radio and electronic equipment. Consequently, our facilities are geared to exacting laboratory standards. We can handle the most delicate assignments with understanding care and painstaking skill.

Typical of the apparatus produced by ECA is this Rectifier Power Unit for general laboratory operation. Operating from a 105-125 volt, 50-60 cycle line, it delivers a maximum of 150 ma at 300 volts DC and has an open circuit voltage of 450 volts DC and 45 watts power output from 6.3 volts AC centertapped terminals. The hum voltage is 0.1% at 150 ma for all voltages above 150 volts. Continuous panel control of the DC output voltage is provided through a variable autotransformer.

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TELEVISION BROADCASTERS ORGANIZE

Allen B. Du Mont Elected President of New Association of Television Broadcasters

IN order that the television broadcasters may express themselves as a group in matters pertaining to the future plans and the development of this field, the Television Broadcasters Association has been formed as a Delaware corporation. Charter members of T.B.A. include representatives of the leading interests in the television field.

At the first meeting, held in Chicago, Allen B. Du Mont was elected president of the Association, and Lewis Allen Weiss, vice president. The following are directors:

F. J. Bingley, Philco, Inc., Philadelphia
Robert L. Gibson, General Electric Company, Schenectady, N. Y.
O. B. Hanson, National Broadcasting Company, New York City
E. A. Hayes, Hughes Tool Company, Los Angeles, Calif.
Worthington Miner, Columbia Broadcasting System, New York City
Paul Raibourn, Television Productions, Inc., Hollywood, Calif.
Lewis Allen Weiss, Don Lee Network, Hollywood, Calif.
Allen B. Du Mont, Du Mont Laboratories, Inc., Passaic, N. J.

At the first meeting, the following committees were formed, and chairmen appointed:

Postwar Planning Committee, Paul Raibourn, chairman, to consider and analyze the problems facing the establishment of television on a commercial basis, and the potentialities of this field, not only in terms of telecasting and the production and distribution of equipment but also as an opportunity for employment in the period of reconstruction.

Program Committee, Worthington Miner, chairman, to exchange information on program technique and development in this essential activity, and to encourage the manufacture of equipment designed to improve programs.

Engineering Committee, E. J. Bingley, chairman. The scope of this committee's work has not been defined at this time of writing.

Membership Committee, Jack Poppelle, chairman. Inquiries concerning membership in the Television Broadcasters Association should be addressed to the chairman at Station WOR, 1440 Broadway, New York City.

Publicity Committee, Robert L. Gibson, chairman, and Paul Raibourn, co-chairman.

Television Manufacturing Committee: This committee will be appointed in the near future. Its membership will be comprised mainly of manufacturers who are planning to produce home television receivers when conditions permit.

Until the organization of T.B.A., there has been no association through which the television broadcasters could plan and express themselves. T.B.A. has a highly important and useful job ahead, and the calibre of its charter members indicates that its success is assured, now that it has begun to function.

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...with B & W "Air-Wound" Construction

Air-Wound coil construction—pioneered by B & W—holds many advantages:

Air-Wound coils weigh less because no conventional winding form is required.

Air-Wound coils are adaptable to almost any mounting arrangement.

Air-Wound coils are ideal for plug-in services. They are not likely to be damaged if dropped—but, even if bent completely out of shape, can easily be repaired. For rough service, they can be further protected with "bumper" rings.

Air-Wound coils have low dielectric loss, can be wound to uniform pitch, offer greater design adaptability (note tapping indents in illustration) and lend themselves to mechanical and electrical revisions in the circuit.

Thus, while not a panacea for all coil problems, B & W Air Inductors spell greater efficiency for most of them. For other applications where form-wound units prove preferable, B & W offers a variety of types.

HOW'S THIS FOR A "DROP" TEST!

There's nothing scientific about it, but when a B & W Inductor is dropped three stories (as illustrated) on to a cement sidewalk without being put out of commission, it at least proves the practical nature of Air-Wound construction. Actually, the only damage was a bent plug-in prong and a cracked ceramic support. The Coil was immediately "repaired" without tools of any kind, and operated perfectly!

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BARKER & WILLIAMSON
235 Fairfield Ave., Upper Darby, Pa.

FM & TELEVISION PRODUCTS DIRECTORY

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

★ Indicates advertiser in this issue of FM Radio-Electronics

AIRPORT RADIO Installations

Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Air Associates, Inc., Los Angeles, Calif.
Bendix Radio, Towson, Md.
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.

ANTENNAS, Mobile Whip & Collapsible

Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
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., Noble & Darien Sts., 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.
International Resistance Co., 429 Broad St., Phila.
Malbry & 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 Laboratories, 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.
Dunn, Inc., Struthers, 1321 Cherry, Phila., Pa.
Star Porcelain Co., Trenton, N. J.
Steward Mfg. Co., Chattanooga, Tenn.

BEARINGS, Glass Instrument

Bird, Richard H., Waltham, Mass.

BINDING POSTS, Plain

★ Amer. Hdware Co., 476 B'way, N. Y. C.
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
Radex Corp., 1308 Elston Ave., Chicago

BINDING POSTS, Push Type

★ Amer. Radio Hdware Co., 476 B'way, N. Y. C.
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.

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

AIRPORT RADIO Installations
Aircraft Accessories Corp.

ANTENNAS, Mobile Whip & Collapsible
Aircraft Accessories Corp.

BINDING POSTS
Franklin Mfg. Co.

CABINETS, Metal
Insuline Corp. of America
Par-Metal Products Corp.

CABINETS, Wood, for Home Radios
Churchill Cabinet Co.
Tillotson Furniture Co.

CABLE, Microphone, Speaker, Battery
Lenz Electrical Mfg. Co.

CERAMICS, Bushings, Washers, Special Shapes
Lenox, Inc.

CLOTH, Insulating
Mitchell Rand Insulation Co.

COIL FORMS, Glass
Corning Glass Works

CRYSTALS, Quartz
Quartz Laboratories

DIALS, Instrument
Barker & Williamson

GEARS & PINIONS
Crowe Name Plate & Mfg. Co.

INSTRUMENTS, Radio Laboratory
Boonton Radio Corp.
Ferris Instrument Corp.
General Electric Co.

KEYS, Telegraph
Telegraph Apparatus Co.

LABORATORIES, Electronic
Electronic Corp. of Amer.

METERS, Ammeters, Voltmeters, Small Panel
McClintock Co., O. B.

MICA
Mitchell-Rand Insulation Co.

OSCILLOSCOPES, Cathode Ray
Panoramic Radio Corp.
Reiner Electronics Co.

RADIO RECEIVERS & TRANSMITTERS
Aircraft Accessories Corp.
Aircraft Radio Equipment Corp.
Electronic Corp. of Amer.
Erco Radio Laboratories, Inc.
Harvey-Wells Communications, Inc.
Jefferson, Inc., Ray
Radio Craftsmen
Templetone Radio Co.

RECTIFIERS, Current
Selenium Corp. of America

RELAYS, Mercury Plunger
Adams & Westlake Co.
H-B Electric Co.

RELAYS, Small Telephone
Allied Control Co.

RELAYS, Time Delay
H-B Electric Co.

TEST EQUIPMENT, Service
Jackson Electrical Inst. Co.
Radio City Products Co., Inc.
Radio Corporation of America
Supreme Instrument Corp.
Weston Electrical Instrument Co.

TUBING & SLEEVING
Mitchell-Rand Insulation Co.

VARNISHES, Insulating
Mitchell-Rand Insulation Co.

WIRE & CABLE
Consolidated Wire Co.
Runzel Cord & Wire Co.
Western Insulated Wire, Inc.

BUSHINGS, Hermetic Sealing

Corning Glass Works, Corning, N. Y.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

BUSHINGS, Terminal Sealing

Corning Glass Works, Corning, N. Y.
Peerless Electrical Prod. Co., 6920 McKinley Ave., Los Angeles 1
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CABINETS, Metal

Par-Metal Prod. Corp., 32-49th St., L. I. City, N. Y.
Insuline Corp. of Amer., Long Island City, N. Y.

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., Victor J., 363 E. 75 St., Chicago
Belden Mfg. Co., 4673 W. Van Buren, Chicago
Boston Insulated Wire & Cable Co., Boston
Communications Prods. Co., Jersey City, N. J.
Cornish Wire Co., 15 Park Row, N. Y. C.
Doolittle Radio, Inc., 7521 S. Loomis Blvd., Chicago
General Cable Corp., 420 Lexington, N. Y. C.
General Insulated Wire Corp., 53 Park Pl., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Lenz Electrical Mfg. Co.
Radex Corp., 1308 Elston Ave., Chicago
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Coaxial, 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.
Gavett Mfg. Co., Brookfield, Mass.
Holyoke Wire & Cable Corp., Holyoke, Mass.

CABLES, Preformed

Belden Mfg. Co., 4633 W. Van Buren St., Chicago

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.
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.

CHASSIS, Metal

See STAMPINGS, Metal

CHOKES, RF

Aladdin Radio Industries, 501 W. 35th, Chicago
Alden Prods. Co., Brockton, Mass.
American Communications Corp., 306 B'way, N. Y. C.
★ Barker & Williamson, Upper Darby, Pa.
Coto-Coil Co., Providence, R. I.
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Gen. Winding Co., 420 W. 45 St., N. Y. C.
Guthman & Co., Edwin, 400 S. Peoria, 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., 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

Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
Corning Glass Works, Corning, N. Y.

COIL FORMS, Phenolic, Cast without Molds

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

COILS, Radio

See Transformers, IF, RF

CONDENSERS, Ceramic Case Mica Transmitting

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

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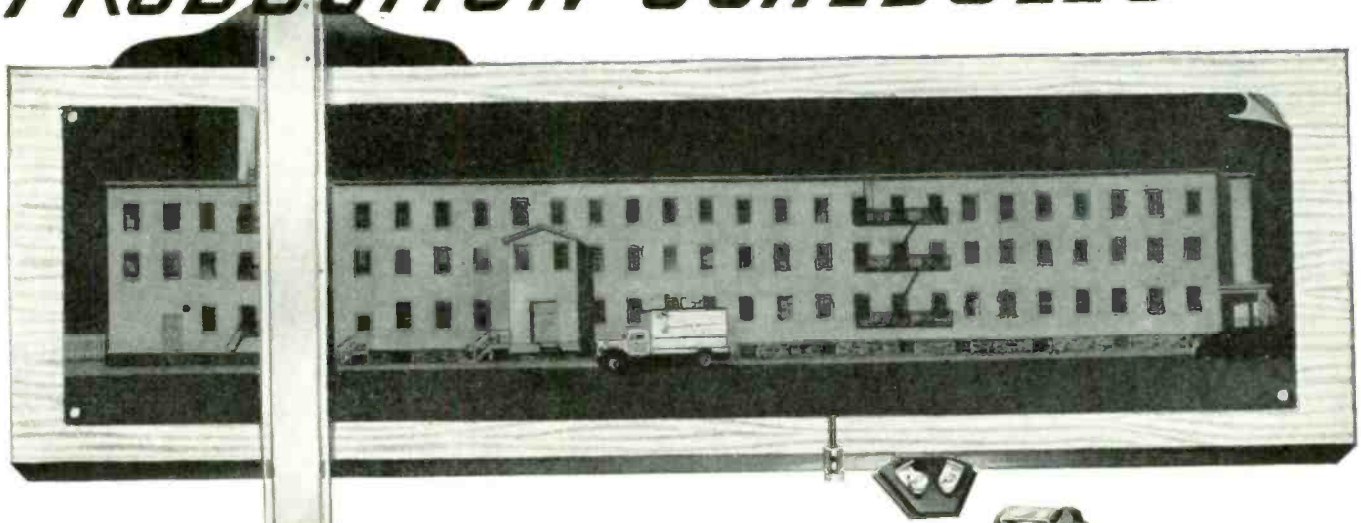

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ARHCO RADIO PRODUCTS

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MANUFACTURERS OF SHORT WAVE • TELEVISION • RADIO • SOUND EQUIPMENT

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.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
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., 3123 N. Crawford, Chicago
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.
Kellogg Switchb'd & Supply Co., 6650 Cicero, Chicago
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 Specialties Co., N. Adams, Mass.
Teleradio Engineering Corp., 484 Broome St., N. Y. C.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CONDENSERS, Gas-filled

Lapp Insulator Co., Inc., Leroy, N. Y.

CONDENSERS, High-Voltage Vacuum

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

CONDENSERS, Small Ceramic Tubular

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

CONDENSERS, 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.

CONDENSERS, Variable Trimmer

Alden Prods Co., Brockton, Mass.
American Steel Package Co., Defiance, O.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Brooklyn, N. Y.
Centralab, Milwaukee, Wis.
Fada Radio & Elec. Corp., Long Island City, N. Y.
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.

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
★ American Radio Hardware Co., 476 B'way, N. Y. C.
★ Andrew, Victor J., 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
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.
Harwood Co., 747 N. Highland Ave., Los Angeles
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
Mica Insul. Co., 198 Varick St., N. Y. C.
★ National Co., Inc., Malden, Mass.
★ Rogan Bros., 2003 S. Michigan Ave., Chicago

SCHEDULE OF DIRECTORIES

RADIO-ELECTRONIC PRODUCTS
February, April, June, August, October, December

CHIEF ENGINEERS OF BROADCAST STATIONS
March, September

POLICE RADIO COMMUNICATIONS OFFICERS
January, July

CHIEF ENGINEERS OF RADIO MANUFACTURERS
May, November

Under this schedule, FM RADIO-ELECTRONICS presents up-to-date listings, with complete corrections and additions, which are available in no other publication.

Insuline Corp. of Amer., L. I. City, N. Y.
Jones, Howard B., 2300 Wabansia, Chicago
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., 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.
Mallory & Co., Inc., P. R., Indianapolis, Ind.

COUPLINGS, flexible

Cardwell Mfg. Corp., Brooklyn, N. Y.
Johnson Co., E. F., Waseca, Minn.
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.

CRYSTALS, Quartz

Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Bausch & Lomb Optical Co., Rochester, N. Y.
Billey 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., W. Carroll Ave., 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

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.
Presto Recording Corp., 242 W. 55 St., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.

DYNAMOTORS — See Motor-Generators

ENAMELS, Wood & Metal Finish

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

ENGRAVING MACHINES

Auto-Engraver Co., 1776 B'way, N. Y. C.

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.

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

Avia Products Co., 737 N. Highland Ave., Los Angeles
Com. Equip. & Eng. Co., N. Parkside Ave., Chicago
★ Freed Radio Corp., 200 Hudson St., N. Y. C.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Miller Co., J. W., 5917 S. Main St., Los Angeles
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 METERS

Bendix Radio, Towson, Md.
★ Browning Labs., Inc., Winchester, Mass.
General Radio Co., Cambridge, Mass.
Lavoie 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.

FREQUENCY STANDARDS, Primary

General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Quartz Secondary

Garner Co., Fred E., 43 E. Ohio St., Chicago
Hewlett-Packard Co., Palo Alto, Calif.
Millen Mfg. Co., Inc., Malden, Mass.

FUSES, Enclosed

Dante Elec. Mfg. Co., Bantam, Conn.
Jefferson Elec. Co., Bellwood, Ill.
Littlefuse, Inc., 4753 Ravenswood Av., Chicago

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, 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., Elkart, 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.

These Facts We Know to be True . . .

Brush Spring for Aircraft Radio Dynamotor

"Micro-Processed" for best combination of strength, electrical conductivity, and resistance to heat

Design stress, 68,000 lb. per sq. in. for service at 270 deg. F.

Produced by the hundred thousand to tolerances of:

± .002 in. on outside or inside diameter
± 4% on brush pressure at specified compressed length.

Calibrated Spring for Aircraft Instrument

"Micro-processed" for minimum drift and maximum proportional limit.

Design stress, 65,000 lb. per sq. in.

Produced by the thousand to tolerances of:

± .004 in. on free length
± .001 in. on outside diameter
1 deg. on squareness of ends.
± 0.6% deviation from standard deflection curve
0.2% maximum drift, full load for 24 hours

Flexible Centering Ring

Punched and formed while soft and ductile, then hardened to a tensile strength of 200,000 lb. per sq. in. "Micro-processed" by the thousands to hold center in plane of rim to within .005 in.

Illustrations Approximately Twice Size

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These springs owe their success to "Micro-processing"—a precise technique by which the extraordinary spring qualities of beryllium copper are consistently predicted and controlled by I-S through every step of production, beginning with the spring wire itself.

Spring users are rapidly learning that they can expect more of their springs. As a result, many manufacturers are designing more service life into springs; are setting up and are obtaining closer tolerances and improved electrical qualities; are making steady use of our ability to control drift performance when necessary.

These are statements of fact which we can back up to the hilt. There is no better test of micro-processing than on your own springs—those now in use or on your drawing boards. Whether your requirements are as rigid as those illustrated or not, you can expect and will obtain, improved performance and greater freedom of design when you use "Micro-processed" beryllium copper springs. You can prove these statements to your own satisfaction without obligation by sending samples or drawings to our engineering department.

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DEPT. B. LITTLE FALLS, NEW JERSEY

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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.
Trimm Radio Mfg. Co., 1770 W. Berteau, Chicago
★ Universal Microphone Co., Inglewood, Cal.
Utah Radio Prod. Co., 842 Orleans St., Chicago

HORNS, Outdoor

Graybar Elect. Co., Lexington Ave. at 43 St., N. Y. C.
★ Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago
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.

INDUCTORS, Variable Tuning

★ Barker & Williamson, Upper Darby, Pa.

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.
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.
★ National Co., Inc., Malden, Mass.

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.
Geni. Aniline Wks., 435 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.
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.
★ Universal Microphone Co., Inglewood, Calif.
Utah Radio Prod. Co., Orleans St., Chicago

KEYS, Telegraph

★ Amer. Radio Hardware Co., Inc., 476 Broadway, N. Y. C.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Mossman, Inc., Donald P., 6133 N. Northwest Hy., Chicago
Remler 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
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.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
★ Rogan Bros., 2001 S. Michigan, Chicago

LABELS, Removable

Avery Adhesives, 451 3rd St., Los Angeles

LABELS, Stick-to-Metal

Ever Ready Label Corp., E. 25th St., N. Y. C.
Tablet & Ticket Co., 1021 W. Adams St., Chicago

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, 848 N. Noble St., Chicago, 22

LACQUERS, Wood & Metal Finish

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

LOCKWASHERS, Spring Type

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

LUGS, Soldering

Burndy Engineering Co., 459 E. 133rd St., N. Y. C.
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 Av., 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.

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

Allied Radio Corp., 901 W. Jackson Blvd., Chicago
★ Burstein-Applebee Co., Kansas City, Mo.
Harrison Radio Corp., 12 W. B'way, N. Y. C.
★ Lafayette Radio Corp., 901 W. Jackson Blvd., Chicago
Radio Wire Television Co., 100 Sixth Ave., N. Y. C.
Sun Radio Co., 212 Fulton St., N. Y. C.

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.
Meglintock Co., O. B., Minneapolis, Minn.
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, Q

Boonton Radio Corp., Boonton, N. J.

METERS, Vacuum Tube Volt

Ballantine Laboratories, Inc., Boonton, N. J.
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
Radio Speakers, Inc., 221 E. Cullerton, Chicago
Philmore Mfg. Co., 113 University Pl., N. Y. C.
Permoflux Corp., 4916 W. Grand Av., 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

★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
★ RCA Mfg. Co., Camden, N. J.

MOTOR-GENERATORS, Dynamotors, Rotary Converters

Alliance Mfg. Co., Alliance, O.
Air-Way Mfg. Co., Toledo, O.
Bendix, Red Bank, N. J.
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

MOTOR-GENERATORS

★ 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

Kollsman Instrument Div., Elmhurst, Long Island, N. Y.
Utah Radio Prod. Co., 842 Orleans St., Chicago

MOUNTINGS, Shock Absorbing

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.
Mycalex Corp. of Amer., Clifton, N. J.
Precision Fabricators, 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

NICKEL, Sheet, Rod, Tubes

Eagle Metals Co., Seattle, Wash.
Pacific Metals Co., Ltd., San Francisco, Calif.
Steel Sales Corp., 129 S. Jefferson St., Chicago
Tull Metal & Supply Co., J. M., Atlanta, Ga.
Whitehead Metal Prod. Co., 303 W. 10th St., N. Y. C.
Williams and Co., Inc., Pittsburgh, Pa.

NUTS, Self-locking

Boots Aircraft Nut Corp., New Canaan, Conn.
Elastic Stop Nut Corp., Union, N. J.
Palaut 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.
See TUBES, Photo-Electric

PILOT LIGHTS

Alden Prods. Co., Brockton, Mass.
★ Amer. Radio Hardware Co., Inc., 467 B'way, N. Y. C.
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

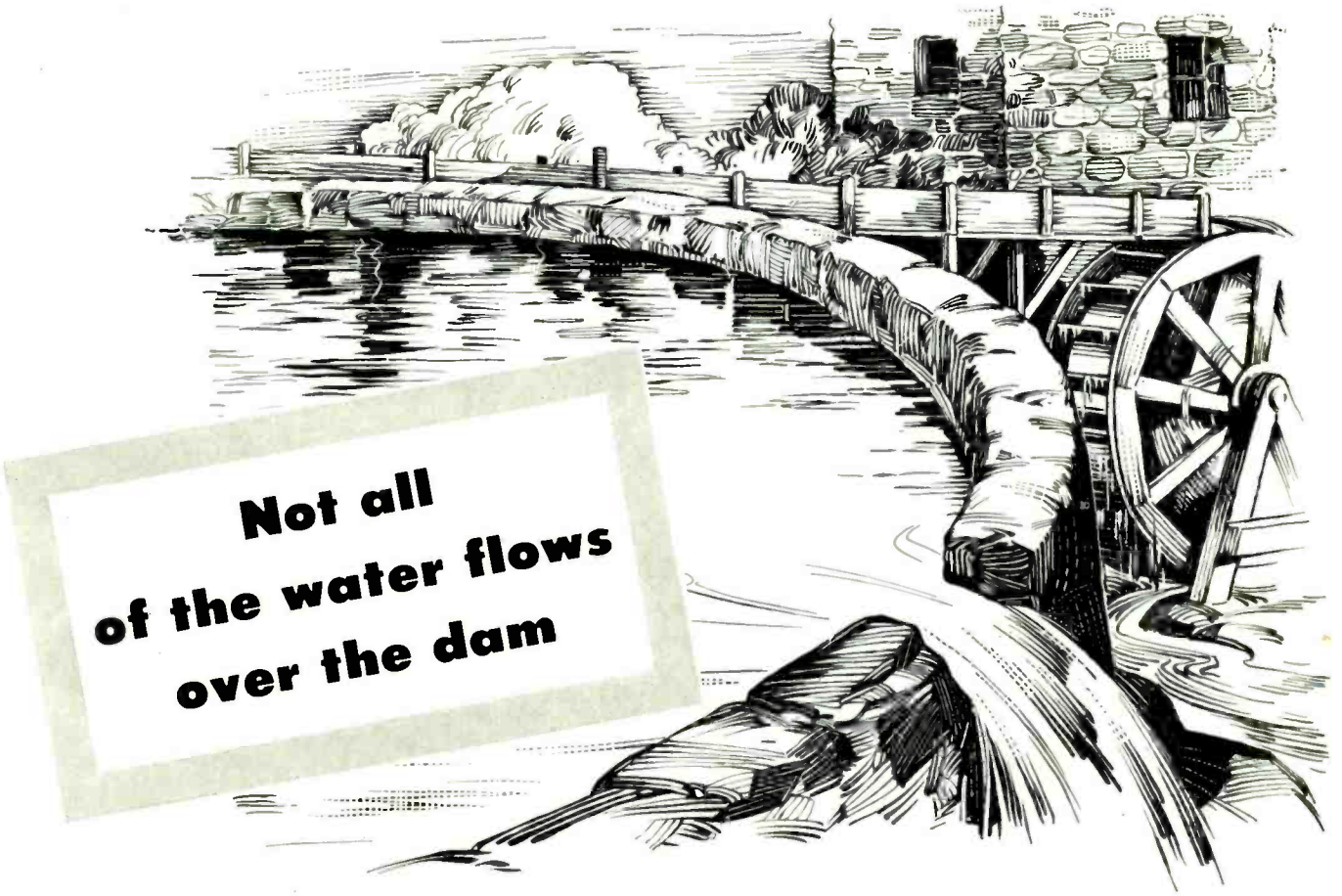
American Brass Co., Waterbury, Conn.
Bunting Brass & Bronze Co., Toledo, O.
Driver-Harris Co., Harrison, N. J.
Phosphor Bronze Smelting Co., Philadelphia
Revere Copper & Brass, 230 Park Av., N. Y. C.
Seymour Mfg. Co., Seymour, Conn.

PLASTICS, Cast without Molds

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

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.



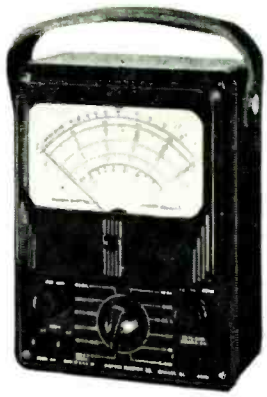
Not all of the water flows over the dam

BEFORE it becomes just "water over the dam", every working hour, every problem solved, contributes in some measure to the reservoir of practical knowledge we call experience.

There is a wealth of such experience behind Simpson instruments and testing equipment. Into their making has gone all the knowledge acquired during the more than 30 years which Ray Simpson has devoted to the design and manufacture of electrical instruments—all the experience and know-how of a group of men who have long been associated with him.

The important thing today, of course, is that this enables Simpson to build instruments of proven accuracy and stamina, at a rapid rate. Each one has a full bridge type movement with soft iron pole pieces. For the first time this admittedly finer design has been made a matter of mass production —with all the resulting economies and speed.

When it comes time to apply the many things learned under the impetus of war, remember that true progress has its roots in the past. For the utmost in lasting accuracy, and value, look to Simpson.



SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie St., Chicago 44, Illinois

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory

PLASTIC SHEET, for Name Plates

Mica Insulator Co. 200 Varick St., N. Y. C.

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.
Macalloy 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 & Haas 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

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 & Haas Co., Washington Sq., Philadelphia

PLATING, Metal on Molded Parts

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

PLUGS (Banana), Spring Type

★ Amer. Radio H'dw're Co., 476 B'way, N. Y. C.
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, 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
★ Universal Microphone Co., Ltd., Inglewood, Calif.
Utah Radio Prod., Orleans St., Chicago.

PLYWOOD, Metal Faced

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

RACKS, Standard Aircraft Types

Delco Radio, Kokomo, Ind.

RACKS & PANELS, Metal

See STAMPINGS, Metal

RADIO RECEIVERS & TRANSMITTERS

Abbott Instrument, Inc., 8 W. 18 St., N. Y. C. 3
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.
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 Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Berger Electronics, 109-01 72nd Rd., Forrest Hills, N. Y.
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.
Colonial Radio Corp., Rano St., Buffalo, N. Y.
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.
Detroit Radio Corp., 1501 Beard Ave., Detroit, Mich.
De Wald Radio Mfg. Corp., 436 Lafayette St., N. Y. C.
Dictaphone Radio Co., 420 Lexington Ave., N. Y. C.
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., 305 E. 63 St., N. Y. C.
Fada Radio & Elec. Corp. 30-20 Thomson Ave., Long Island City, N. Y.
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.
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.
Greeby Mfg. Co., Plainville, Conn.
Guided Radio Corp., 161 6th Ave., N. Y. C.
Hadley Co., R. M., 707 E. 61 St., Los Angeles
★ Hallicrafters Co., 2611 Indiana Ave., Chicago
Halstead Trafic 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 & Rodeman Co., 522 Market St., Phila.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles
Horni Signal Mfg. Co., 310 Hudson St., N. Y. C.
Howard Radio Co., 1731 Belmont Ave., Chicago
Hudson American Corp., 62 W. 47 St., N. Y. C.
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.
Midwest Radio Corp., Cincinnati, O.
Millen Mfg. Co., Inc., Malden, Mass.
★ National Co., Inc., Malden, Mass.
Nobilitt-Sparks Ind. Inc., Columbus, Ind.
North Amer. Philips Co., 100 E. 42 St., N. Y. C.
Operadio Mfg. Co., St. Charles, Ill.
Panoramic Radio Corp., 245 W. 55 St., N. Y. C. 19
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 Williams St., N. Y. C.
Pierson-DeLane, Inc., 2345 W. Washington Blvd., Los Angeles
Pilot Radio Corp., Long Island 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.
★ Radio Corp. of Amer., Camden, N. J.
Radio Craftsmen, 1340 S. Mich. Ave., Chicago
★ Radio Engineering Labs., Long Island 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.
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.
Templetone Radio Co., Mystic, Conn.
Transmitter Equip. Mfg. Co., 345 Hudson St., N. Y. C.
Trebor Radio Co., Pasadena, Calif.
Troy Radio & Telev. Co., 1144 S. Olive St., Los Angeles, Calif.
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.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECTIFIERS, Current

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

RECTIFIERS, Instrument & Relay

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

RELAYS, Small Switching

Allied Control Co., Inc., 223 Fulton St., N. Y. C.
Amperite Co., 561 Broadway, N. Y. C.
Bircher Corp., 5087 Huntington Dr., Los Angeles 32
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

Allied Control Co., 2 E. End Ave., N. Y. C.
Amer. Automatic Elect. Sales Co., 1033 W. Van Buren St., Chicago
Clare & Co., C. P., 4719 W. Sunnyside Ave., Chicago
★ Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Wick Organ Co., Highland, Ill.

RELAYS, Stepping

Advance Elect. Co., 1260-A W. 2nd St., Los Angeles
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

Amperite Co., 561 Broadway, N. Y. C.
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.

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., Brooklyn, N. Y.
Cont'l Carbon, Inc., Cleveland, O.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Jersey City, N. J.
Erie Resistor Corp., Erie, Pa.
Globar Div., Carborundum Co., Niagara Falls, N. Y.
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
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

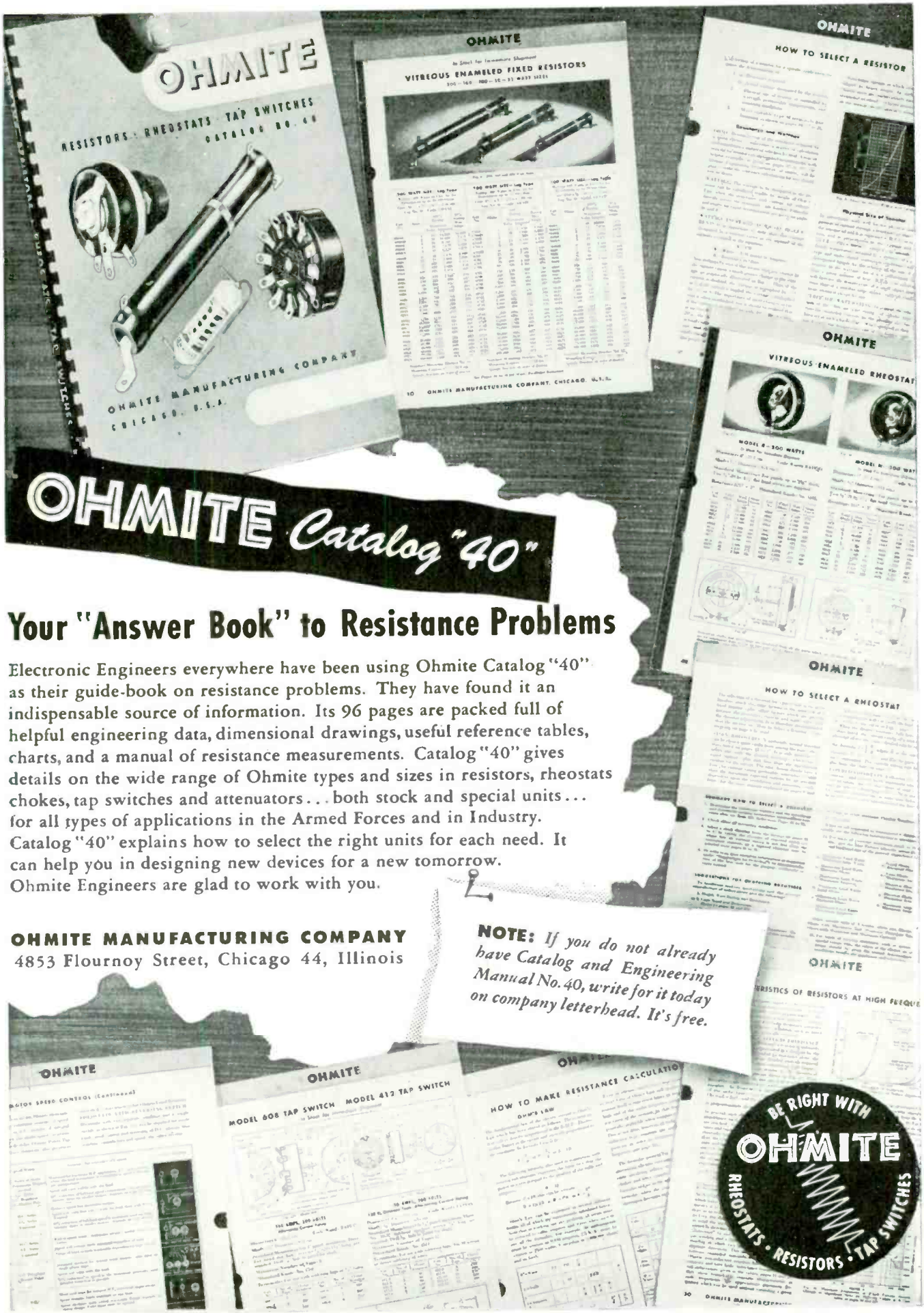
Instrument Resistors, Inc., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
★ Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Shallcross Mfg. Co., Collingdale, Pa.

RESISTORS, Flexible

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

RESISTORS, Variable Laboratory Type

Biddle Co., J. G., 1211 Arch St., Phila.
Stiehl Co., Inc., H. H., 27 Park Pl., N. Y. C.



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RESISTORS, Variable

★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Instrument Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
Biddle Co., James G., Arch St., Phila., Pa.
Centralab, Milwaukee, Wis.
Chicago Tel. Supply Co., Elkhart, Ind.
Cinema Eng. Co., Burbank, Cal.
Clarostat Mfg. Co., Brooklyn, 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.
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors, Inc., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
Kellogg Switchboard & Sup. Co., 6650 S. Cicero Ave., Chicago
Lectrohm, Inc., 5125 W. 25 St., 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

Hardwick, Hindle, Inc., Newark, N. J.
Lectrohm, Inc., 5125 W. 25 St., Cicero, Ill.
★ Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SCREW MACHINE PARTS, Brass, Steel

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.
National 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.
Pheoli 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
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
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
Parker-Kalon, 198 Varick, N. Y. C.
Standard 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

★ Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.

SHOCK ABSORBERS

See MOUNTINGS, Shock Absorbing
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 Hardware Co., 476 B'way, N. Y. C.
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

Johnson Co., E. F., Waseca, Minn.
★ National Co., Inc., Malden, Mass.
Nat'l Fabricated Products, W. Belden Ave., Chicago
Ucinite Co., Newtonville, Mass.

SOLDER, Self-fluxing

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

SOLDER POTS

★ Elec. Soldering Iron Co., Inc., Deep River, Conn.
Lectrohm, Inc., Cicero, Ill.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

SPEAKERS, Cabinet Mounting

★ 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.
Magnavox Co., Fort Wayne, Ind.
Rola Co., Inc., Superior St., Cleveland, O.
Utah Radio Prod. Co., 842 Orleans St., Chicago

SPEAKERS, Outdoor Type

★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
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., Ind., 236–42 St., Brooklyn, N. Y.

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IN THE MARCH ISSUE

★ 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.
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.
★ Universal Microphone Co., Inglewood, Calif.

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

SWITCHES, Micro

Allied Control Co., Inc., E. End Ave., N. Y. C.
Aero Electric Co., 3167 Fulton Rd., Cleveland
Micro Switch Corp., Freeport, Ill.

SWITCHES, Rotary Gang, Bakelite Wafer

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

SWITCHES, Rotary Gang, Ceramic Wafer

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

TERMINAL STRIPS

Burke Electric Co., Erie, Pa.
Cinch Mfg. Corp., W. Van Buren St., Chicago
Curtis Devel. & Mfg. Co., N. Crawford Ave., Chicago
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
Jones, H. B., 2300 Wabansia, 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
Jackson Elec. Inst. Co., Dayton, O.
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.
★ Radio City Prod. Co., Inc., 127 W. 26 St., N. Y. C.
★ Radio Corporation of America, Camden, N. J.
Supreme Inst. Corp., Greenwood, Miss.
Tenney Engineering, Inc., Montclair, N. J.
Weston Electrical Inst. Co., Newark, N. J.

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 Power

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.
Automatic Windings Co., E. Passaic, 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 Specialty Co., Inc., 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., 400 S. Peoria St., 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., Los Angeles, Cal.
★ Nat'l Co., Malden, Mass.
Radex Corp., 1308 Elston Ave., Chicago
Sickles Co., F. W., Springfield, Mass.
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.
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
Dimlon 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.
Freed Trans. Co., 72 Spring St., N. Y. C.
Gen'l Radio Co., Cambridge, Mass.
General Trans. Corp., 1250 W. Van Buren, Chicago
Halldorson Co., 4500 Ravenswood, Chicago
Jefferson Elec. Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., N. Y. C.
Magnetic Windings Co., Easton, Pa.
★ Merit Coil & Trans. Corp., 311 N. Desplaines St., Chicago 6
Newark Transformer Co., Newark, N. J.
New York Transformer Co., 51 W. 3rd, N. Y. C.
Norwalk Transformer Corp., S. Norwalk, Conn.
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 Transformer 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.
Elsler Eng. Co., 7518 13th St., Newark, N. J.

TUBES, Cathode Ray

Dumont Labs., Allen B., Passaic, N. J.
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.

RAILWAY RADIO ENGINEERING

THE Browning Laboratories are in a particularly fortunate position to assist in the planning of postwar railway radio communications to supplement existing signal systems.

We have had pioneering experience in radio communications equipment using amplitude modulation and, subsequently, frequency modulation.

During the War, we have been given the responsibility for solving highly complex military problems of a related nature.

Our reputation for reaching sound, practical conclusions, suited to commercial applications, is long-established.

We are particularly conversant with the policies of public utilities, for whom we have executed commissions in many parts of the United States.

It is our belief that radio communications, properly coordinated with present railroad equipment, methods, and practices, can be highly effective in protecting life and property, and increasing the capacity of present yards and terminals.

Moreover, we are convinced that the use of radio will be a vital factor in meeting postwar competition.

Inquiries are invited from railroad executives who are preparing to make plans for the application of radio equipment to their lines.

BROWNING LABORATORIES, Inc.

751 MAIN STREET WINCHESTER, MASS.

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.
Heintz & Kaufman, S. San Francisco, Cal.
★ Hytron Corp., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
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.

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, Phonograph

General Industries Co., Elyria, O.
★ R C A Mfg. Co., Camden, N. J.
Western Electric Co., 125 B'way, N. Y. C.

VARNISHES, Insulating, Air-Drying & Baking

John C. Dolph Co., 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 Tool & Mfg. Co., 1014 Fullerton Ave., Chicago

VIBRATORS, Power Supply

Amer. Tel. & 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

VOLTMETERS, Vacuum Tube

Ballantine Labs., Inc., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett Packard Co., Palo Alto, Calif.
★ Measurements Corp., Boonton, N. J.
★ Radio City Prod. Co., Inc., 127 W. 26 St., N. Y. C.

WAXES & COMPOUNDS, Insulating

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

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.
Vellfl Mfg. Corp., Southport, Conn.

WIRE, Glass Insulated

Bentley, Harris Mfg. Co., Conshohocken, Pa.
Garitt 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.

WOOD, Laminated & Impregnated

Canfield Mfg. Co., Grand Haven, Mich.
Formica Insulation Co., Cincinnati, O.

WOOD PRODUCTS, Cases, Parts

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

FMBI CONFERENCE

(CONTINUED FROM PAGE 38)

Following is a list of the active members of FMBI, as of February 20th:

OPERATING COMMERCIAL FM STATIONS

Bamberger Broadcasting Service, New York, N. Y., WBAM
Baton Rouge Broadcasting Co., Inc., Baton Rouge, La., WBRL
Booth, John Lord, Detroit, Mich., WLOU
Capitol Broadcasting Co., Inc., Schenectady, N. Y., WBCA
Columbia Broadcasting System, Inc., Chicago, Ill., WBBM-FM
Columbia Broadcasting System, Inc., New York, N. Y., WABC-FM
Commercial Radio Equipment Co., Kansas City, Mo., KOZY
Evansville on the Air, Inc., Evansville, Ind., WMLL
Evening News Association, The Detroit, Mich., WENA
General Electric Company, Schenectady, N. Y., WGEM
Gordon Gray, Winston-Salem, N. C., WMIT
Interstate Broadcasting Co., Inc., New York, N. Y., WQXQ
Jones Advertising Agency, Wylie B., Binghamton, N. Y., WNBF-FM
Journal Company, The, Milwaukee, Wis., WMFM
Lee Broadcasting System, Don, Los Angeles, Calif., KHJ-FM
Marcus Loew Booking Agency, New York, N. Y., WHNF
Metropolitan Television, Inc., New York, N. Y., WABF
Moody Bible Institute of Chicago, Chicago, Ill., WDLM
Muzak Radio Broadcasting Station, Inc., New York, N. Y., WGYN
National Life & Accident Ins. Co., Nashville, Tenn., WSM-FM
Stromberg-Carlson Mfg. Co., Rochester, N. Y., WHFM
Travelers Broadcasting Service Corporation, Hartford, Conn., WTIC-FM
WBNS, Inc., Columbus, Ohio., WELD
WCAU Broadcasting Co., Philadelphia, Pa., WCAU-FM
WDRC, Inc., Hartford, Conn., WDRC-FM
Westinghouse Radio Stations, Inc., Fort Wayne, Ind., WOWO-FM
Westinghouse Radio Stations, Inc., Springfield, Mass., WBZA-FM
Westinghouse Radio Stations, Inc., Philadelphia, Pa., KYW-FM
Westinghouse Radio Stations, Inc., Boston, Mass., KBZ-FM
Westinghouse Radio Stations, Inc., Pittsburgh, Pa., KDKA-FM
WFIL Broadcasting Co., Philadelphia, Pa., WFIL-FM
WGN, Inc., Chicago, Ill., WGNB
WHEC, Inc., Rochester, N. Y., WHEF
WWSW, Inc., Pittsburgh, Pa., WTNT
Yankee Network, The, Mount Washington, N. H., WMTW
Yankee Network, The, Paxton, Mass., WGTR
Zenith Radio Corporation, Chicago, Ill., WWZR

HOLDERS OF CONSTRUCTION PERMITS FOR COMMERCIAL FM STATIONS

Radio Service Corporation of Utah, Salt Lake City, Utah, KSL-FM
Worcester Telegram Publishing Co., Inc., Worcester, Mass.

APPLICANTS FOR COMMERCIAL FM STATIONS

American Broadcasting Corporation of Kentucky, Lexington, Ky.
E. Anthony & Sons, Inc., New Bedford, Mass.
Anthony, Earle C., Inc., Los Angeles, Calif.
Ashland Broadcasting Co., Ashland, Ky.
Breiner Broadcasting Corp, Newark, N. J.
Courier Journal & Louisville Times, Louisville, Ky.
Evening Star Broadcasting Co., Washington, D. C.
Federated Publications, Battle Creek, Mich.
Globe Democrat Publishing Co., St. Louis, Mo.
Greater New York Broadcasting Corporation, N. Y. C.
Head of the Lakes Broadcasting Co., Superior, Wis.
Houston Printing Co., Houston, Texas
Mercer Broadcasting Co., Trenton, N. J.
National Broadcasting Co., Inc., New York, N. Y.
Outlet Co., The, Providence, R. I.
Piedmont Publishing Co., Winston-Salem, N. C.
Portland Broadcasting System, Inc., Portland, Maine
Pulitzer Publishing Co., St. Louis, Mo.
United Broadcasting Co., Cleveland, Ohio
WJJD, Inc., Chicago, Ill.
WJR, The Goodwill Station, Detroit, Mich.

OPERATING EXPERIMENTAL OR DEVELOPMENTAL FM STATIONS

Crosley Corporation, The, Cincinnati, Ohio, W8XFM
Jansky & Bailey, Washington, D. C., W3XO
Midland Broadcasting Co., Kansas City, Mo. W9XER

AFFILIATE MEMBERS

Agricultural Broadcasting Co. (WLS), Chicago, Ill.
The American Network, Inc., New York, N. Y.
Belmont Radio Corporation, Chicago, Ill.
Bendix Radio Division of Bendix Aviation Corporation, Baltimore, Md.
Blaw-Knox Division of Blaw-Knox Co., Pittsburgh

(CONTINUED ON PAGE 56)

FMBI CONFERENCE

(CONTINUED FROM PAGE 55)

Capital Broadcasting Co., Inc., Montgomery, Ala.
Carter Publications, Inc., Fort Worth, Texas
Central Broadcasting Co., Des Moines, Iowa
Cherry & Webb Broadcasting Co., Providence, R. I.
The Chicago Sun, Chicago, Ill.
Doolittle Radio, Inc., Chicago, Ill.
DuMont Labs., Inc., Allen B., Passaic, N. J.
Federal Telephone & Radio Corp., Newark, N. J.
Fetzer Broadcasting Co., Kalamazoo, Mich.
FM Magazine, New York, N. Y.
Freed Radio Corp., New York, N. Y.
Gazette Printing Co., Janesville, Wis.
Graybar Electric Co., New York, N. Y.
Iowa Broadcasting Co., Des Moines, Iowa
Johnson Co., E. F., Waseca, Minn.
Josh Higgins Broadcasting Co., Waterloo, Iowa
Macon Telegraph Publishing Co., Macon, Ga.
Maryland Broadcasting Co., Baltimore, Md.
May Broadcasting Co., Shenandoah, Iowa
McClatchy Broadcasting Co., Sacramento, Calif.
Minneapolis Star Journal & Tribune Co., Minneapolis.
Minnesota Broadcasting Corp., Minneapolis, Minn.
Nashville Radio Corp., Nashville, Tenn.
Ohio Broadcasting Co., Canton, Ohio
Onondaga Broadcasting Corporation, Syracuse, N. Y.
Oshkosh Broadcasting Co., Oshkosh, Wis.
Press Publishing Co., Sheboygan, Wis.
Racine Broadcasting Corp., Racine, Wis.
Radio Engineering Labs., Inc., L. I. City, N. Y.
Radio Station WBNY, Buffalo, N. Y.
RCA Victor Division of RCA, Camden, N. J.
Speidel Newspapers, Inc., Colorado Springs, Colo.
Tulsa World Tribune, Tulsa, Okla.
WAKR, Akron, Ohio
Western Electric Co., New York, N. Y.
WFMJ Broadcasting Co., Youngstown, Ohio
WHB Broadcasting Co., Kansas City, Mo.
WKBH, Inc., La Crosse, Wis.
The Wisconsin Network, Inc., Wisconsin Rapids, Wis.
World Broadcasting System, New York, N. Y.

TELEVISION AWAITS ONE ANSWER

(CONTINUED FROM PAGE 13)

No, reflections, or multipath distortion, can't be eliminated by going to a lower frequency. Even if there were no reflections on 44 to 50 mc., there would be room for only one television station in cities like Chicago or Los Angeles. And New York and Philadelphia would have to share time, because stations in these two cities couldn't operate simultaneously on the same frequency!

Of course, New York City will want six or eight stations of its own, and Philadelphia will probably want half a dozen. That means the use of at least 12 television bands 6 mc. wide, and they will require a 72-mc. space in the radio spectrum. The space is available. In addition to the 50- to 56-mc. band which will probably be assigned to FM broadcasting, the following have been set aside for television by the FCC:

60 to 66 mc.
66 to 72 mc.
78 to 84 mc.
84 to 90 mc.
96 to 102 mc.
102 to 108 mc.

Still more bands are available at higher frequencies.

In order to accommodate the number of stations required for adequate public service, television engineers must face and solve the problem of eliminating ghosts on all these frequencies. That's why it doesn't make sense to spend time now discussing non-existent troubles with the sound channel.

But if the members of Panel 6 will dispose of the ghost problem for video reception, plans can be made now to launch television on a national scale during the period of postwar reconversion.

SPOT NEWS NOTES

(CONTINUED FROM PAGE 24)

Phonograph Records: National distribution is being set up for records to be sold under Sonora name by Sonora Radio & Television Corporation, 205 W. Wacker Drive, Chicago. According to Joseph Gerl, president, arrangements have been made to use the facilities of the Mutual Broadcasting System, New York City, for making Sonora recordings. Distribution to dealers will be made through jobbers.

Ludwig Arnson: Awarded the Marconi Memorial Medal of Achievement by the Veteran Wireless Operators Association. Now head of Radio Recaptor Company, Inc., New York City, manufacturing radio range and airport traffic control equipment, he was operator on the sixth American ship to be equipped with wireless apparatus. He was the first American engineer hired by Marconi, and he took part in the installation of the famous old station at South Wellfleet, on Cape Cod.

Condenser Deliveries: A circular issued by Sprague Products Company, North Adams, Mass., lists a wide variety of condensers available for immediate delivery. These included A-N types of oil-filled bathtubs with single and dual condensers for 50 to 1,750 volts DC, tolerance minus 20%, plus 30%, and oil-filled can types of 1.0 to 17.0 mfd. of various AC and DC ratings. Listed also are molded mica condensers of many values for 1,000, 2,500, and 5,000 volts.

Williamsport, Pa.: Production of industrial apparatus at the Sylvania Electric Products plant at Emporium, Pa., is being transferred to the Company's plant No. 2 at Williamsport. Some departments are making the change on a progressive basis, while the administrative and engineering departments are being moved intact, according to Roger M. Wise, director of engineering. Virgil M. Graham will continue as manager. Space made available at Emporium by this shift will be taken over by units of the production development section of the main receiving tube plant.

Screws, Nuts, Fasteners: A stock record in folder form is available from Manufacturers Screw Products, 216 W. Hubbard Street, Chicago, for the use of purchasing agents. It is a periodic record of in-stock items of screws, nuts, washers, bolts, fasteners, drilled screws, and similar items in brass, steel, stainless steel, and aluminum.

(CONTINUED ON PAGE 58)

SPOT NEWS NOTES

(CONTINUED FROM PAGE 57)

Television Relay Station: An application for a television relay station to be located in the New York area has been filed by Philco Radio & Television Corp. This relay, to operate with 15 watts at 204 to 216 mc., will be used in conjunction with W3XE and WPTZ.

S. N. Shure: General manager of Shure Brothers, Chicago microphone manufacturers, led the workers in singing "We Did It Before and We'll Do It Again" when the Company was presented with a white star to be added to the "E" flag awarded last year.

Cleveland: Franklin G. Gepfert, chairman of the board, has announced the formation of the Mec-Rad Division of Black Industries to manufacture mechanical components of radio and electronic devices.

Chief engineer of Mec-Rad is John Altmayer. Theo. R. Finke is engineer in charge of development and production. Major products will be precision-type transmission lines and radiation components.

Brooklyn N. Y.: Additional production facilities have been put into operation by Amperex Electronic Products of 79 Washington Street, Brooklyn, N. Y. Plant No. 2 is located conveniently at 25 Washington Street, according to an announcement from sales manager S. E. Norris.

DR. VICTOR J. ANDREW AND J. J. BACKER

West Coast: Products of the Andrew Company, Chicago manufacturers of coaxial cables and accessories, will be warehoused in Seattle and San Francisco, in order to speed deliveries in that area, according to Dr. Victor J. Andrew. The items include 3/8-in. and 7/8-in. coaxial cable, glass seals of these sizes, connectors, and pumps for dehydrating the cables. James J. Backer, of Seattle, has recently been appointed sales engineer for the West Coast territory.

for

the men who set the PACE the industry follows

We're Preparing for Your Postwar Plans

NEARLY four years ago, while I was working out the editorial plan and character of FM Magazine, some of my friends warned me: "You won't be able to get editorial material. There's nothing to this Frequency Modulation!"

I told them: "Frequency Modulation is an improved method of broadcasting and communication. Major Armstrong's system will succeed because, in our Country, progress can't be held back. I suppose that people who fear the changes brought about by progress won't read a magazine called FM. But I'm going to publish a magazine *for the men who set the pace the industry follows.*"

FM Magazine was hardly in its second year when the United States entered the War. Some of my friends said: "Too bad. Frequency Modulation is frozen for the duration."

Well, the other day, Mr. F. R. Lack, vice president of Western Electric, said that "During 1942 and 1943, with the assistance of our subcontractors, we delivered 129 million dollars' worth of FM equipment." You'd probably rank Mr. Lack among *the men who set the pace the industry follows.* I remember that he was one of the early subscribers to FM Magazine. And Western Electric is only one of the companies producing FM equipment in huge quantities for our Armed Forces.

I'm glad I wasn't persuaded to abandon the original plan and character of FM Magazine, for its usefulness and influence have grown until, today, it's position of leadership among radio publications has been made secure by its long service to *the men who set the pace the industry follows.*

Now, to make this position of leadership doubly secure, the editorial scope is to be extended to include the other great field of future radio progress — Television.

Effective with the April issue, the name of this Magazine will become FM AND TELEVISION. This will not be merely a matter of adding the word to the title. It means active, constructive editorial recognition of Television as the second avenue of future radio expansion.

It means that this Magazine, as FM AND TELEVISION, is preparing now to serve completely the postwar interests of *the men who set the pace the industry follows.*

MILTON B. SLEEPER, *Publisher*

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

to reward their efforts with favorable results.

One would expect the Japanese to be useless as employees in our laboratories, for they appear to be so limited intellectually that they would not be able to take the next step because they would not have mastered the one previous!

If the picture of these people is portrayed accurately in their radio equipment, then they pose a 20th Century parallel to the Indian problem that faced our forefathers in this Country, and exists today, though to a less troublesome extent, in some of the South American countries. To the Japanese, as to the Indians, a man of another race is a natural enemy. It is as natural, to their primitive intellect, to kill and torture the men and women on Bataan as it was for the Indians to treat the white settlers in the same fashion.

As long as the Indians lived together in numbers, there was no way to reach and reorient the group thinking. In the defense of civilization, it was necessary to exterminate them.

Our experience with the Japanese has been the same. They have tolerated our people, whether they were missionaries, engineers, or industrialists, only to use against us what we have taught them and sold them. Their group thinking has accepted the results of our arts and sciences, but has consistently rejected philosophical fellowship among men of good will. Now, armed with what they have acquired from us, they have visited themselves upon us as a plague, and we must defend ourselves against them by wiping out their breeding places.

This would surely be the conclusion of any engineer who took the time to see the Japanese mind as it is expressed in the exhibit of their radio equipment.

2. One of the contemporary radio papers directed to dealers recently let off a large cloud of steam over the civilian replacement tube situation, winding up with a haymaker about the incapacity, inefficiency, and incompetency of WPB's handling of this matter.

The editorial effort was unquestionably sincere, but it was conclusive only in that it showed how difficult it is for an outsider to understand the inner operations involved in fighting a total war.

Similarly, if figures on cut-backs and cancellations which are being handed out these days were made public, they would probably be used to prove that the War is practically over.

Perhaps some factual information may help to give a clearer picture to those who are not in a position to see for themselves.

In the first place, the Radio and Radar Division of WPB is now doing an exceptionally fine job. The period of initial

(CONTINUED ON PAGE 61)

(CONTINUED FROM PAGE 60)

struggle, before its responsibilities had been defined clearly, is now long past. There may have been times when Ray Ellis might have walked out in despair or disgust. Fortunately for WPB and the radio industry, he has stuck to his post, and everyone has benefited by the continuous administration of one man who has maintained a consistently high average of right answers.

It is apparent to anyone who has been active in the business of manufacturing military equipment that this group has developed the capacity for handling its duties in a highly efficient and competent manner.

What many outsiders, particularly those concerned only with civilian business, do not seem to understand is that the Radio and Radar Division of WPB only performs administrative functions. It does not produce equipment. Neither does it consume equipment.

The prime responsibility of WPB is to protect our Armed Forces against shortages, and to so control the flow of materials and finished goods as to maintain the pressure of production where supply is most needed at any given time.

A short time ago, military requirements were such that it seemed likely that materials and production facilities would be available for the manufacture of civilian types of tubes. Unfortunately, military needs changed, or estimated requirements were revised, and the civilian tubes have not been forthcoming, although some 4,500,000 had been promised in the first quarter of 1944.

Promised? There is no such a thing as a promise of civilian radio production. The only promise the Radio and Radar Division ever makes is that the needs of our Armed Forces will be served first, and that any civilian production authorized will not jeopardize the fulfillment of military requirements.

If the failure of civilian tubes indicated that the men in this group are inefficient and incompetent, it is true only to the extent that they can neither control the progress of the War nor are they able to manufacture vacuum tubes.

Two months ago, it was stated in this column that "the shortage of tubes for civilian use will be much worse before there are any signs of relief." Subsequent developments show that the situation still isn't bad enough to reach the point of improvement.

3. Much of the news that circulates via the radio grapevine is misleading because, while it may be true, it contains only a part of the whole truth. Word is getting around that a number of contracts for military radio equipment are being cancelled, or cut back.

(CONTINUED ON PAGE 62)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 61)

And this means that the War will not last much longer? No, it doesn't. It has nothing to do with the duration of hostilities.

This is made clear by a review of the three stages of progress since Pearl Harbor: First, our Armed Forces placed orders for as much radio equipment of all kinds and types as they thought might be needed. Then, as quantity deliveries got under way, and the equipment was put into use, some of it was found to be excellent, some was only good enough to use until it could be replaced with improved designs, and not a little was found to be worthless.

In the second stage, new instruments of functional military design were started in production, while others were redesigned in the light of battle experience. Quantities were increased in step with the anticipated needs of an Army, Navy, and Merchant Marine growing at a fantastic rate. The mortality of radio apparatus was extremely high, partly because it was handled by men not yet expert, but more because the instruments themselves weren't tough enough for combat duty. During this period, there was time to analyze, from first hand experience, the virtues, weaknesses, and adaptability of various designs.

Now, we have reached the third stage. Requirements are becoming stabilized, and today our Armed Forces can forecast their needs so that, by periodic readjustments in schedules, production can be geared to consumption. Readjustments are, of course, expressed in terms of cancellations and cutbacks on some contracts, and additional quantities on others.

The only conclusion that can be drawn from a cancelled contract is that the item in question has not proved successful, that it is no longer needed, that the quantity ordered has not been distributed or consumed as rapidly as originally anticipated, or that, in the course of standardization, the function of the item has been found to duplicate that of another type which has superior characteristics.

4. What is significant about the progressive readjustments of military contracts is that some plants are running out of work, or will within the next few months, while new contracts are going to a relatively small number of manufacturers.

The former are, in the main, companies which have not built up and strengthened their organizations by developing special skills or engineering talent. They have made no contribution to the war effort beyond offering the services of semi-skilled labor. On the other hand, more contracts are being awarded to radio manufacturers who put forth the effort to

(CONTINUED ON PAGE 63)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 62)

build strong engineering staffs, to introduce improved, precision methods of production and control, and to develop new equipment which enhances the effectiveness of our fighting forces. In many instances, the development of instruments covered by these new contracts was initiated by the companies themselves, or carried on in collaboration with one of the Government laboratories. Others are for items so complicated mechanically or electrically as to require precision manufacture, with a high ratio of engineering to factory labor man-hours.

Now that all companies have been converted to military production long enough to reach again their proper levels in the scheme of the industry, we find the richest rewards going to those who have truly earned them, while those who have put in very little are wondering how they can continue to take out enough to keep going until the War is over.

These are the concerns which, as their military contracts run out, are going to demand that they be allotted materials for civilian sets. They will cry: "Give us Government contracts or else materials for civilian radios. We are being discriminated against!" Yet the true cause of their plight will lie in weak management or selfish policies, and there is no reason why they should be given special consideration to make up for what they could not or did not do for themselves.

Companies should earn the right to survive the War by their contributions to the War effort during this period of national emergency.

Companies that are not earning their right to survive the War by contributing to the War effort are going to be the next headache for the Radio and Radar Division of WPB. — MILTON B. SLEEPER.

HIGH-FREQUENCY SIGNAL GENERATOR

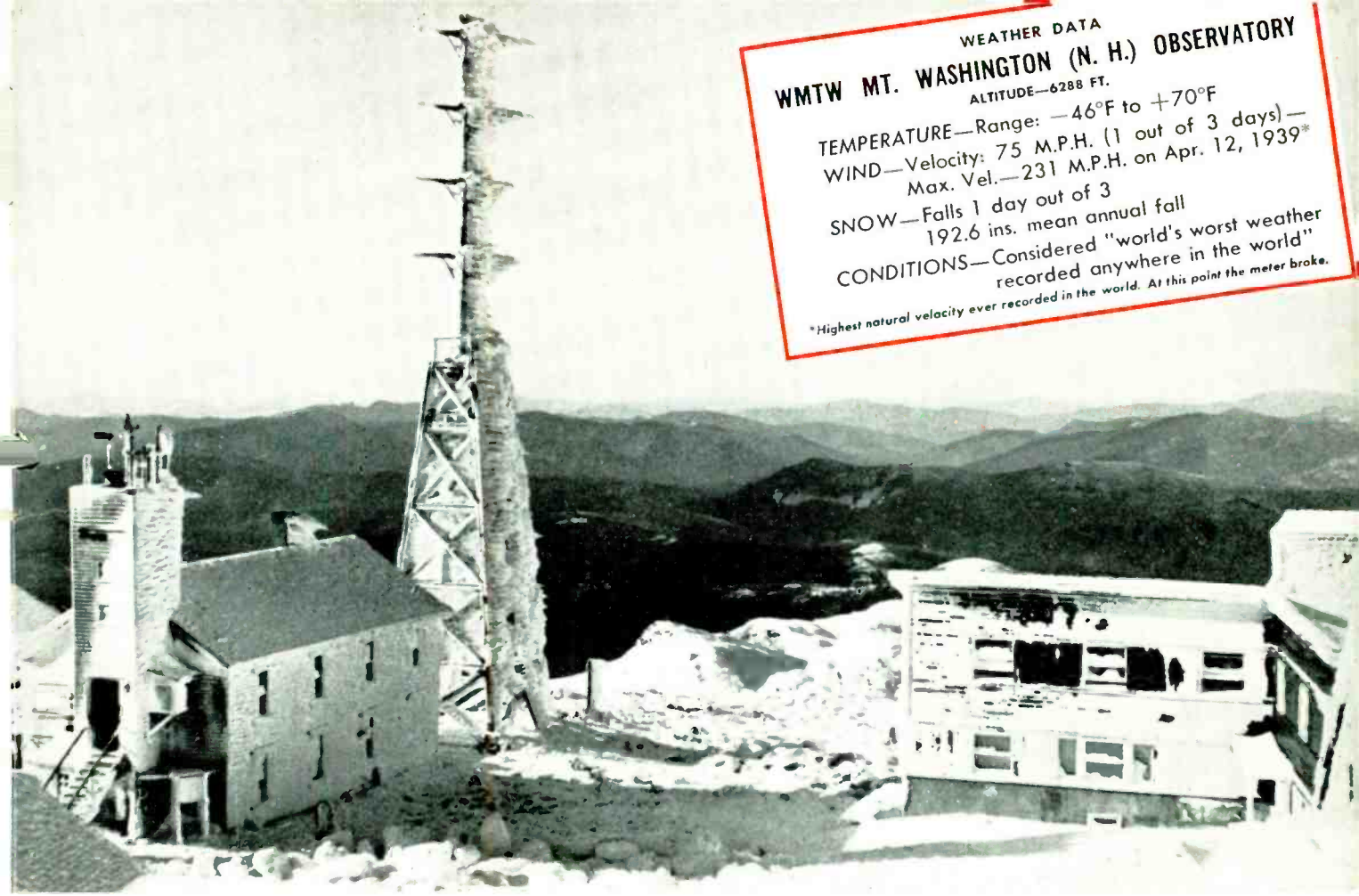
(CONTINUED FROM PAGE 34)

serious frequency errors occur, and that proper balance between the two sides of the output system is maintained. After the attenuator checks have been completed, the generator is checked to make sure that no excessive leakage is present. Finally, the generator is calibrated against harmonics of a crystal oscillator.

The design of this generator offers the following features:

Modulation to 50% from the internal 400- or 1000-cycle oscillator, or from an external source covering the audio range. The frequency range is 50 to 400 mc.

Calibration accuracy, due to the high stability of the oscillator, can be maintained to better than ½% over long periods. The output voltage is continuously variable from 0.2 volt to 0.2 microvolt. Leakage below 300 mc. is not measurable on a sensitive receiver. Recent experimentation has enabled us to hold leakage at 400 mc. at less than 1 microvolt.



THE FORERUNNER OF POSTWAR

MOUNTAIN-TOP FM TRANSMITTERS

Experience REL is the only manufacturer of FM transmitters able to furnish, from experience over a period of years, exact engineering information and cost data on mountain-top installations.

Pioneering The first installation of this sort ever made was the 1-kw. REL transmitter at Yankee Network's WMTW on Mt. Washington, where scheduled broadcasting started December 18, 1940. In November, 1941 this was replaced by a 10-kw. REL model 520 DL transmitter.

Reliability The record of performance is truly amazing. Operating under conditions described by meteorologists as "the worst weather in the world," this transmitter has been on the air for over 18,000 hours, with a present schedule of 24 hours per day.

FM Program Link All programs are picked up on 44.3 mc. from the 50-kw. REL transmitter at Yankee Network's WGTR, Paxton, 142 miles away, and are rebroadcast from WMTW on 43.9 mc.

ST Link All programs originate, however, at Boston, and are beamed to Paxton by a 156-mc. REL studio-to-transmitter link which has been on daily schedule since July 24, 1939.

Reliability The outstanding reliability record of this FM equipment has been made possible by the use of the Armstrong Crystal-Controlled Phase Shift method of modulation.

Postwar REL is ready, as soon as conditions permit, to handle all details of planning and constructing mountain-top FM stations and unattended satellite transmitters.

PIONEER MANUFACTURERS OF FM TRANSMITTERS EMPLOYING ARMSTRONG PHASE-SHIFT MODULATION

RADIO ENGINEERING LABS., INC.

Long Island City, N.Y.

RUMFORD PRESS
CONCORD, N. H.

Reach for the Moon

...but keep your feet on the ground

Hints of the wonders to be unveiled after Victory promise many innovations, including electronic devices and radio communication equipment.

Our engineers and designers have always had the vision to forge ahead while retaining an unwillingness to discard a proven development until sure of something better to take its place. . . They "reach for the moon" while prudently keeping their feet on the ground.

We foresee no "startling" development but with our skill sharpened by war work, Link FM radio communication equipment will continue in the forefront . . . preferred by engineers and technicians who well know the meaning of sound progress and true quality.

Preferred

FM

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