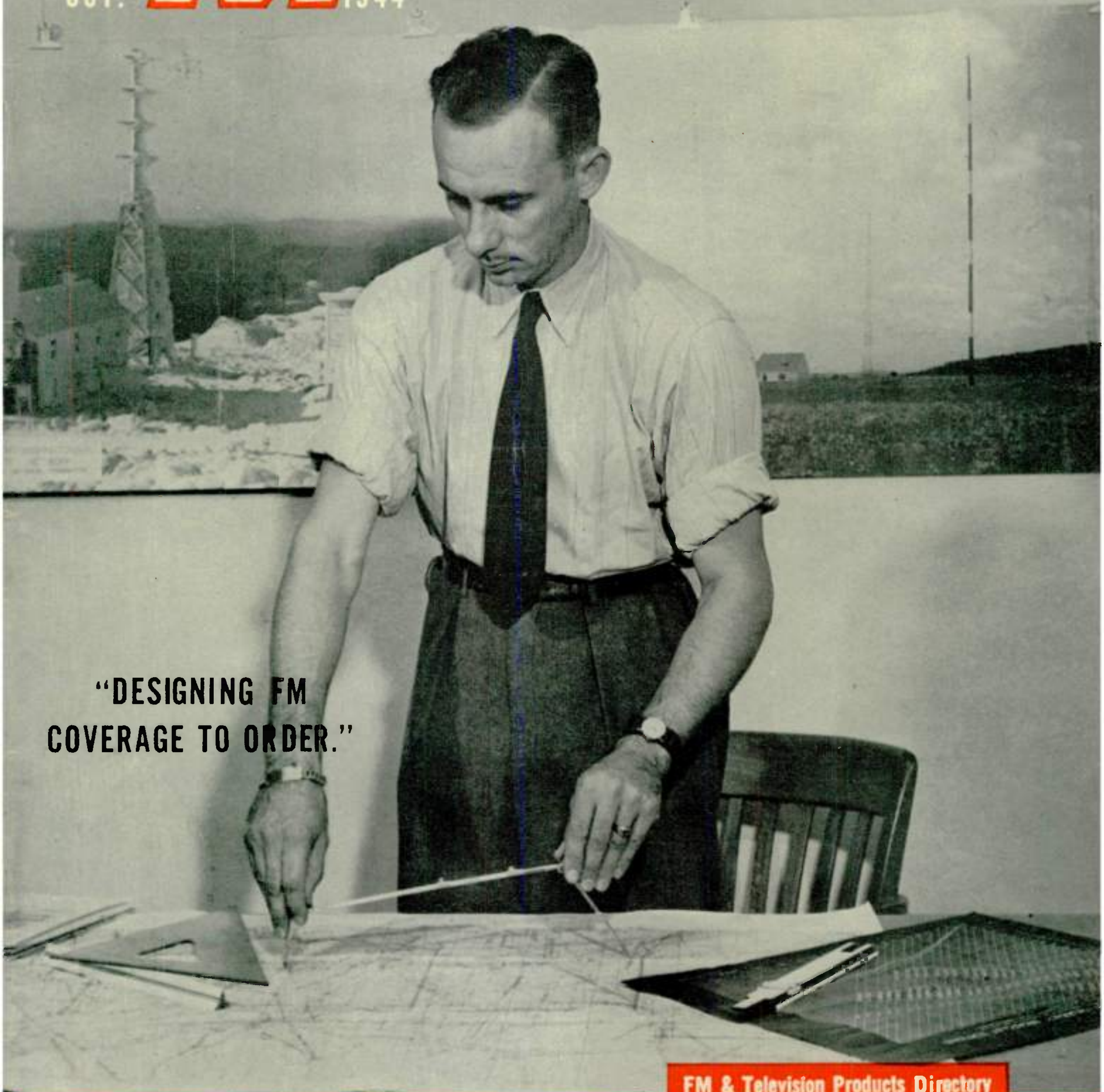
PRICE—TWENTY-FIVE CENTS

FM AND TELEVISION

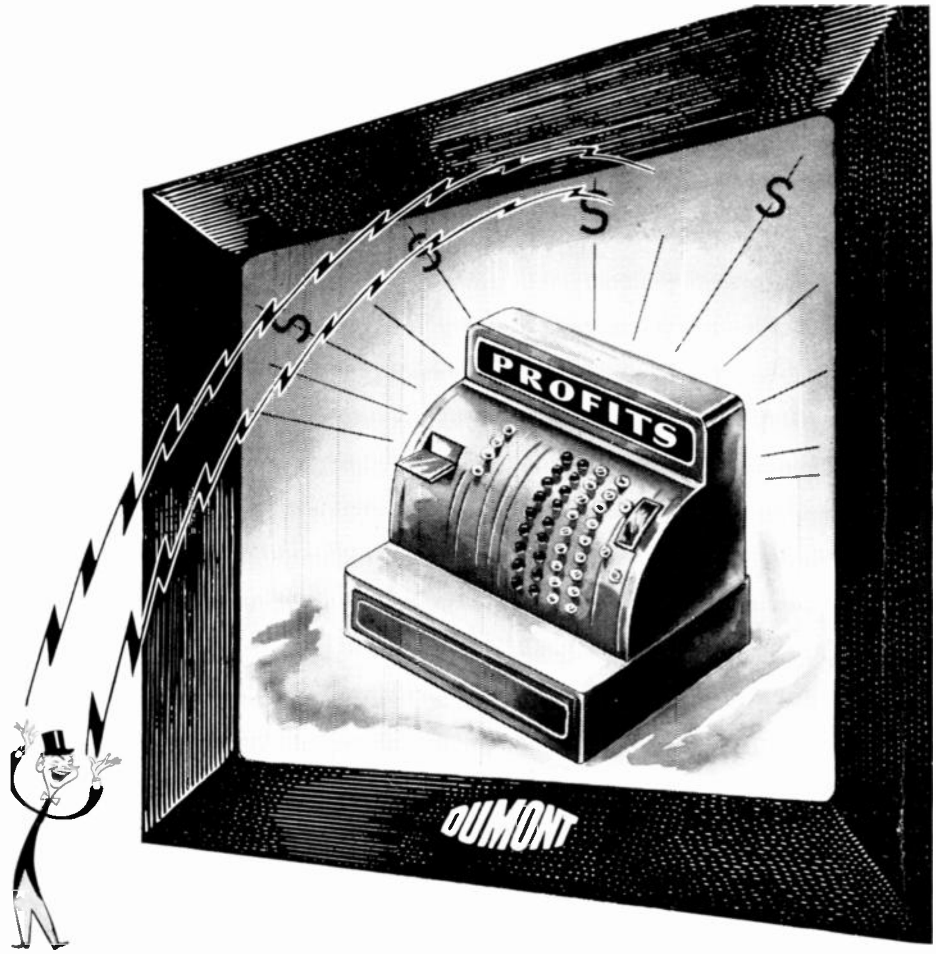
OCT. 1944



"DESIGNING FM COVERAGE TO ORDER."

FM & Television Products Directory

★ ★ Edited by Milton B. Sleeper ★ ★



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TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, NEW YORK

"HI, FELLOWS, SEE WHAT I FOUND"

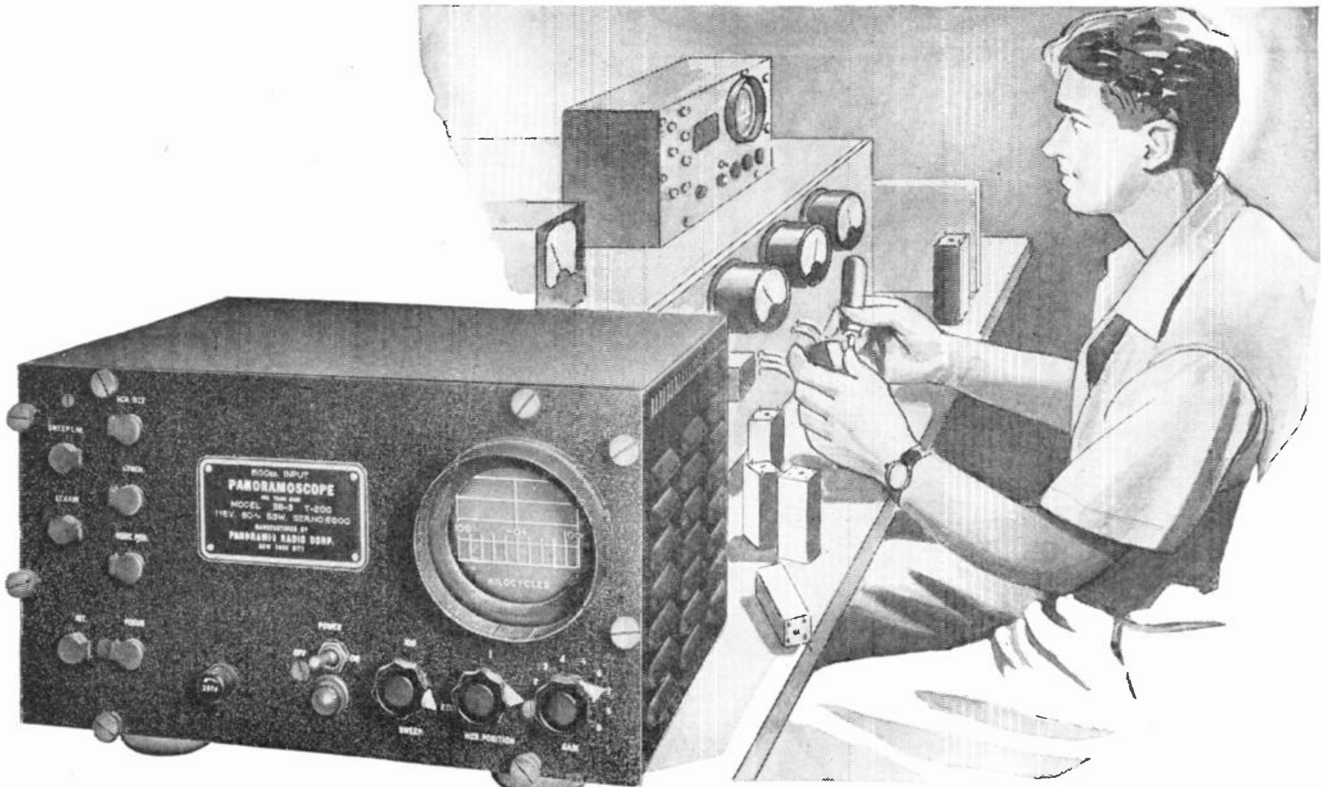
...One of the boys in this Company came back from the shore with something under his arm and said, "Hi, fellows, see what I found on the shore." Well you can't imagine how we all felt when he set it on a box near by, opened it up and it was a set from the National Company of Malden, Mass. So we had a Radio technician in our outfit, so he tested it, looked it all over and found it all intact, closed it up again, grounded it, then tried it. The salt water had not hurt it one bit—it gave us grand reception and each night, we, or about 12 of us, listened in and it seemed like a message from home.

(Excerpt from a letter we received from a soldier in the Pacific.)

NATIONAL COMPANY, INC.

MALDEN MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD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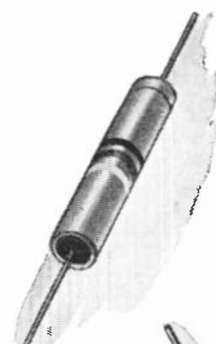

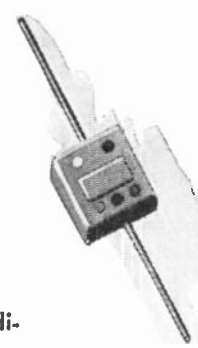

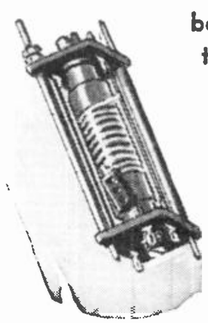

FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

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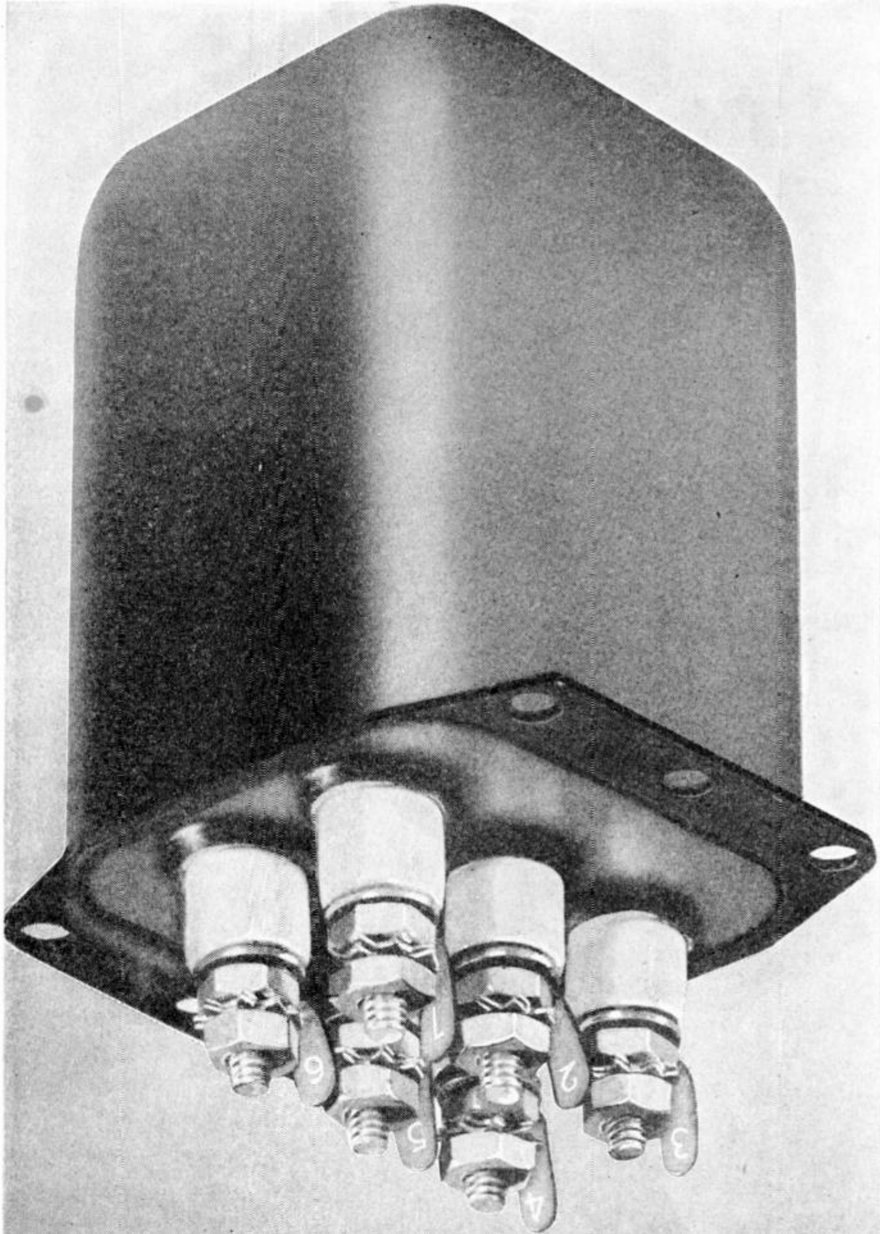
The publishers will be pleased to receive articles, particularly those well illustrated with photos and drawings, concerning radio-electronic developments. Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will FM Magazine be responsible for their safe handling in its office or in transit. Payments are made upon acceptance of final manuscripts.

THIS MONTH'S COVER

ONE of the great advantages of FM broadcasting is that this system enables a station to sell, and advertisers to buy, blanket coverage in a specific and solid area of primary service. There are no holes and dead spots in FM coverage. In case shadows are cast by some topographical condition, it has now been demonstrated by WMFM, Milwaukee, that a simple satellite can fill the gap. This month's cover shows Frank A. Gunther, vice president in charge of engineering at REL using the simple tools with which, in advance of construction, exact FM coverage can be marked out on a topographical map.



WHAT'S NEW THIS MONTH

1. Growth & Surprises
2. Is There a Better Way?

1. It's well worth while, at this particular time, to spend a moment on a quick review of what was happening in the radio industry just before the war, and what has taken place since then, because it is the background for what will be one of the greatest of all expansions in postwar industry. Since its commercial inception, the business of radio has been continually enlivened and nurtured by the unexpected. Thus it has expanded to broader horizons of service, and has grown in dollar volume of equipment sales.

In 1939, it appeared that radio, for purposes of communications and broadcast entertainment, had practically reached its peak, but that it would still move onward and upward by television's emergence from its laboratory swaddling clothes.

Then what happened? In 1940, while television was getting up its second wind, FM came over the radio horizon, and it suddenly dawned on home radio manufacturers that this improved method of broadcasting opened a way to make sales of $175 to $350 grow in a market that had been cultivated down to the $19.95 level.

Just as this prospect became a demonstrated certainty, bombs fell in the Pacific, and all radio manufacturers were told that no more AM, FM, or television equipment could be made for the duration because all production would be needed for our Armed Forces. Engineers saw their work come to a halt as the last of their brain-children were rolled into shipping departments, while front-office executives got red in the face from cooling their heels in offices of Army, Navy, and WPB officials who were too new to know what was expected of them, or what to ask of anyone else.

But in some way, still not altogether clear, a great number of men were re-educated in an amazingly short length of time, and very definite things began to happen. Among these, two were outstanding: a great cloak of secrecy, marked Radar, was thrown over television; and the new kind of broadcasting, called FM, became the greatest of all developments in military radio communications, both on land and sea.

Now, although the attack on Pearl Harbor is not quite three years ago, the

(CONTINUED ON PAGE 65)

Right—for Fighting Wings

In a modern bomber there are some six dozen places where radio and electron tubes find vital use.

Many of these uses were made possible by Sylvania's development of special radio tubes. For example — there are Sylvania tubes small enough yet powerful enough to operate effectively on standard storage batteries without need of extra, weight-adding generators.

With much of our production now going into such all-important service, you can be sure of one thing about its quality.

Every unit produced is designed and built to just one standard—the highest anywhere known.

For security reasons, radio equipment actually used in fighting planes is not shown here.

Right—for Future Fliers

No one is yet prepared to say how much the availability of rugged, lightweight radio and electron tubes will hasten the coming of the safe, light family plane.

But, obviously, wartime lessons in the possible uses of such tubes hold great promise for future developments.

Naturally, for such uses, only the highest and most dependable quality will do.

And they will represent a field in which you will have special reason to look for the Sylvania symbol as the mark of a single standard, and that the highest known. Sylvania Electric Products Inc., Executive Offices: 500 Fifth Avenue, New York 18, N. Y.

BUY WAR BONDS

FOR THE DURATION

America's war program gets first call on all our products, resources and skill

SYLVANIA

ONE STANDARD—THE HIGHEST ANYWHERE KNOWN

RADIO TUBES

Sylvania was first to propose a standardized 6.3-volt radio tube for both home and automobile radio sets. Such standardization eliminated about half of the previous tube types and reduced cost.

ELECTRONIC DEVICES

Heart of your postwar television set will be an electron tube. Such tubes are one of many types Sylvania is even now producing. Work in the field of electronics is a definite part of Sylvania's activities.

LAMPS AND FIXTURES

Most of Sylvania's Incandescent Lamps and Fluorescent Lamps, Fixtures and Accessories are now going into Victory-effort use. But the day is coming when either type of lighting, made by Sylvania, will be readily available for your home.

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ENGINEERING SALES

THE Parts Conference in Chicago marks a new phase of sales planning by manufacturers of components. Conceived in faith and hope, but with no assurance that it would meet with great success, word from the Windy City reports that attendance and the final roll call of manufacturers exceeds the most optimistic predictions of the sponsors.

In fact, directors of the RMA have tentatively approved a parts show of their own to be held in April, feeling, no doubt, that they do not want to lose control of this annual event which they staged in years past.

That the present show should be so successful is not surprising. Manufacturers of components always have the first move, for production of sets for war or peace cannot start until components have been delivered. Similarly they will be the first to be affected by military cancellations, and thus they must lay new plans even though the set manufacturers are still rolling out equipment for the Armed Forces.

Producers of components have some tough sales problems ahead. There is not only the initial matter of Government surpluses, there is also the question of position price competition. Between the two, a considerable number of companies will not be able to continue. There may be some of the old-timers included in that list, too. If so, they will be the ones that have grown fat in their production departments, and flabby in their sales and sales planning. On the other hand, some of the newcomers are now strong enough that they will not give up without a struggle.

Obviously, set manufacturers who plan to reestablish the $14.95 AC-DC market will have to have prewar junk. On the other hand, requirements of frequency stability for FM and television call for the best available in design, materials, and workmanship.

This added to the volume of commercial FM equipment will make up a huge market for high-quality parts. But it is a field that calls for engineering service, and the closest cooperation between engineering and sales departments.

Shocking Treatment for an Instrument

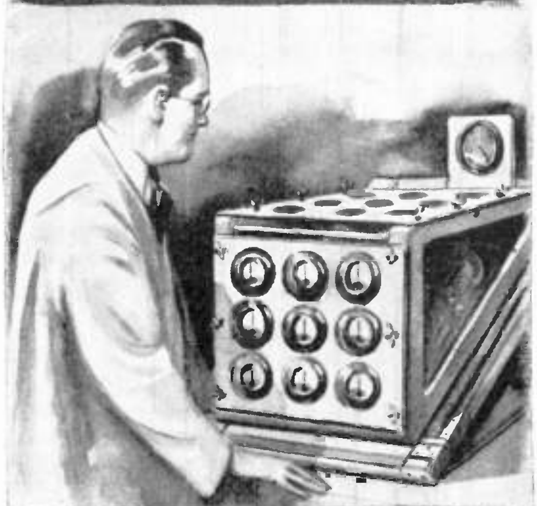
Simpson Shock Test — Instrument is mounted in sliding carriage, and dropped against bottom plate. Vertical scale permits shock of impact to be computed in multiples of g, the acceleration of gravity.

WHILE electrical instruments are delicate by their very nature, the conditions under which they must serve are seldom ideal—these days especially. Before entrusting them with vital responsibilities, it frequently becomes necessary to learn just how much abuse they can withstand.

With Simpson Instruments performance can be proved beforehand right in the Simpson laboratories. Complete facilities are provided to simulate practically any operating conditions, and to make an instrument live many, many years in a day.

Important innovations in design and construction have resulted. Exhaustive breakdown tests show that the Simpson Instruments of today are far more rugged than would have been thought possible just a few years ago.

To users of electrical instruments and testing equipment, this fact points out the value of Simpson's long experience. While constant research and testing can isolate specific problems of design or construction, it's the practical know-how Simpson has stored up through more than 35 years that supplies the answers.



Simpson Vibration Test — Specially designed equipment provides rapid movement of instruments in three different planes. Variable speed regulator permits vibration of any desired intensity.

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

Simpson

INSTRUMENTS THAT STAY ACCURATE

Model 260
High Sensitivity Tester

Ranges to 5000 volts, both AC and DC, at 20,000 ohms per volt DC, and 1000 ohms per volt AC. Current readings from 1 microampere to 500 milliamperes. Resistance readings from ½ ohm to 10 megohms. Five decibel ranges, —10 to +52 DB.

Buy War Bonds and Stamps for Victory

HARVEY 106 PA

200 to 300 VOLTS

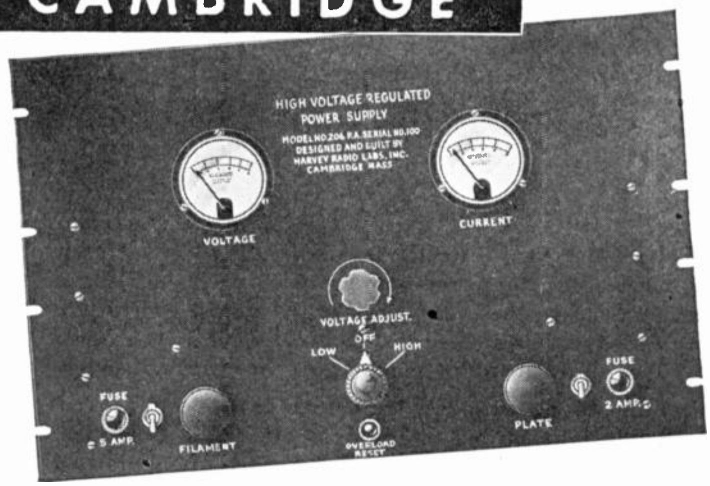
HARVEY

OF CAMBRIDGE

New

HARVEY 206 PA

500 to 1000 VOLTS



for REGULATED POWER SUPPLY

If you're looking for a dependable, controllable source of laboratory D.C. power for operation with pulse generators, measurement equipment, constant frequency oscillators, amplifiers and other equipment requiring a constant flow of D.C. voltage, it will pay you to get in touch with Harvey of Cambridge.

The Harvey Regulated Power Supply 106 PA will meet your every requirement in the lower voltages. It has a D. C. output variable from between 200 to 300 volts that is regulated to *within one per cent.*

The new Harvey Regulated Power Supply 206 PA is for higher voltages. This latest Harvey development operates in two ranges 500–700 at ¼ of an ampere and 700 to 1000 at .2 of an ampere. Both ranges have accurate regulation to *one per cent or better.*

Whatever your requirements, one of these Harvey Regulated Power Supply units will meet them with efficient, dependable performance.

• • •

We'd be happy to supply you with complete information on either or both of them.

HARVEY
OF CAMBRIDGE

HARVEY RADIO LABORATORIES, INC.

443 CONCORD AVENUE • CAMBRIDGE 38, MASSACHUSETTS

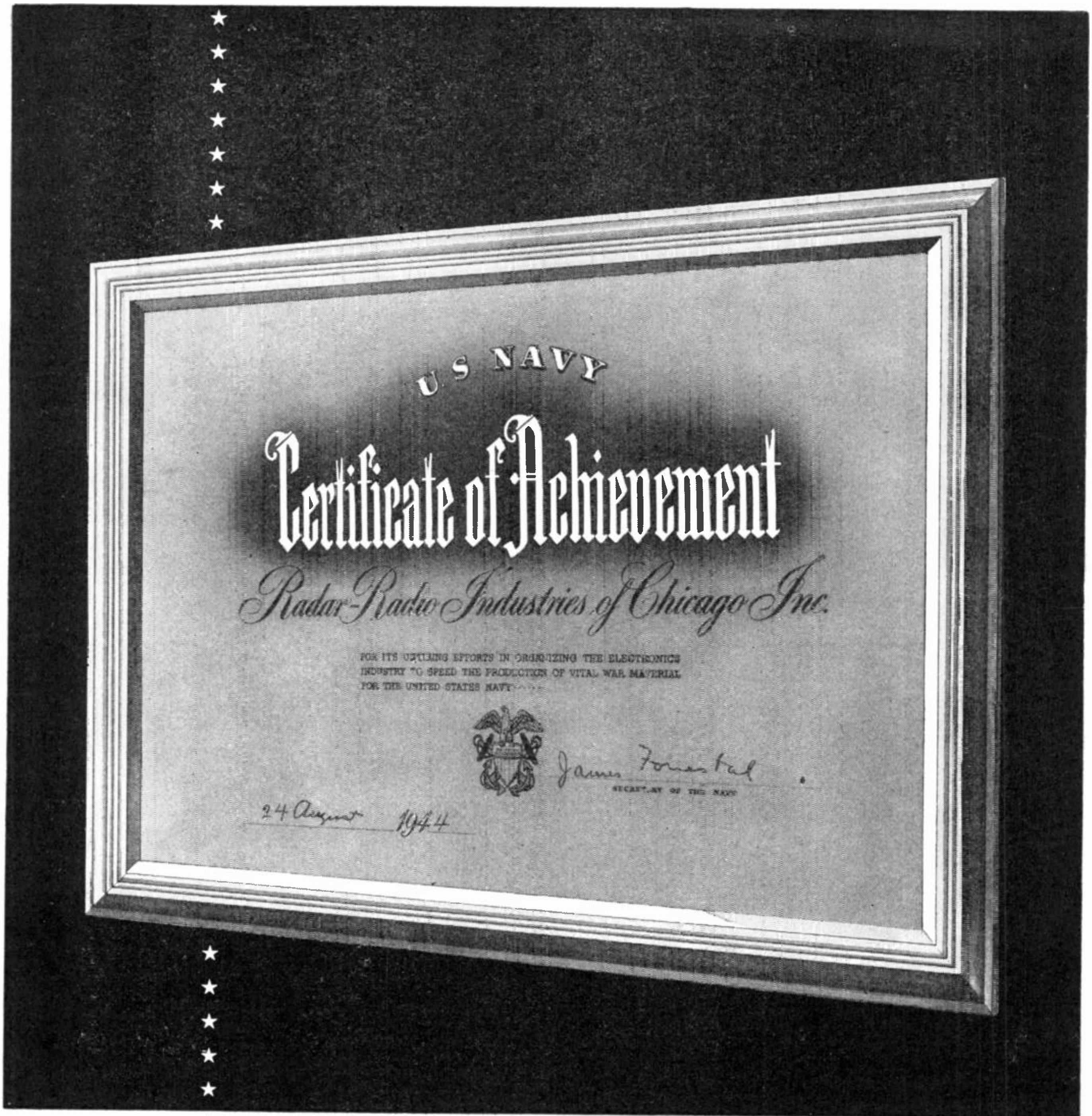
Keeping One Thing Straight!

SINCE PEARL HARBOR, all Finch resources have been devoted to the needs of Uncle Sam. It has been important for the general public as well as broadcasters to understand that Facsimile has been experiencing a consumer recess, *but no recession.* Advertisements in great general magazines are serving to keep this matter straight.

Finch Telecommunications, Inc., Passaic, N. J.

Automatically synchronizing

finch facsimile



The United States Navy has awarded the men and women of Hallicrafters a special "Certificate of Achievement"... first award of its kind... for outstanding service with the radar-radio industries of Chicago in speeding vital war material to the Navy. Added to the four Army-Navy "E" awards, this makes five times Hallicrafters workers have been cited for distinguished service. They promise that this kind of service will be continued until total victory is ours.

★ BUY A WAR BOND TODAY

hallicrafters RADIO

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

OUTLINE OF THE FCC HEARING ON FM

Observations on the Conduct of the Hearing and the Testimony Presented

BY MILTON B. SLEEPER

OF THE hundred-thousand-odd executives and engineers and the jobbers, dealers, and servicemen who turn the wheels of the radio industry, only a handful were represented in the audience at the FCC hearing on frequency allocations. Yet everyone should have at least an understanding of the conduct of this hearing, because all of us will be affected by the end results of the proceedings.

One of these days, we shall be told what frequencies are to be used by the different services. But on what information will the decisions be based, and how was the information obtained? In short, how was the allocations hearing conducted? The simplest way to answer these questions is to review the part of the hearing devoted to FM broadcasting. This was completed just before the closing time for this issue of *FM* AND TELEVISION.

First of all, the opportunity of testifying was offered to anyone concerned with FM broadcasting. Those who responded included representatives of the RTPB FM Panel, FM Broadcasters, Inc., equipment manufacturers, and broadcasters.

The hearing was held in the small auditorium of the Natural History Museum, at Washington. On the stage, Chairman Fly sat at the center of a long table, flanked by Commissioners Durr, Wakefield, Walker, Case, and Jett. At the left, a small table was provided for the witness and a stenographer. The FCC's general counsel Denny and chief engineer Adair sat at a table in the front of the auditorium.

Each witness called up by Mr. Denny, after being sworn by the Chairman, read a prepared statement of his views as to the frequency requirements of FM and their proper place in the spectrum, and the reasons for his recommendations.

Occasionally, one of the Commissioners or Mr. Denny interrupted to ask for clarification of some point. Most of the questions were held for the subsequent cross-examination conducted by Mr. Denny. When exhibits were introduced, such as charts or tables, they were numbered so as to make them, with the stenographer's transcript, a permanent record of the hearing.

The conduct of the hearing was simple, democratic, and dignified, yet sufficiently informal to put each witness at ease. But there was another side to the hearing, less obvious yet highly significant:

That was the purpose behind the preparation of testimony given by each witness. Some came for the unselfish purpose of making constructive contributions to the advancement of FM broadcasting. Others came to make out a case for special services, for revamping the present FM setup, or for what would secure special advantages over competitors. Some AM broadcasters, it might be suspected, presented plans which, if accepted by the Commissioners, would put FM at a competitive disadvantage, or limit the quality of FM to the point where it could provide no better service than AM. In several cases, one witness presented the general outline of his proposal, while a second witness followed with more technical supporting evidence.

From such an assortment of testimony the Commissioners must make their decisions. That is a difficult task, because simple statements of fact are not dramatic, while those who have selfish purposes do their utmost to dignify their plans with impressive presentations.

As Major Armstrong said, no one who had a part in building up the present FM standards wanted to change them. Moreover, the broadcasters and manufacturers were in complete agreement with recommendations presented by the the FM Panel of RTPB,[1] including the use of 41 to 56 mc. for educational and commercial broadcasting. This band was also acceptable to the Television Panel.

It was this observer's impression that the motives behind plans to change the RTPB recommendations were transparently selfish. Specifically, proposals to increase the number of channels by narrowing them to less than 200 kc., to shift the band to other parts of the spectrum, or to limit the coverage of FM stations to strictly local markets seemed unsupported by testimony which showed any advantage to radio listeners or FM broadcasters.

On the contrary, they indicated an indifference to improving the quality of service to the listeners, or a deliberate attempt by AM station operators to stop off FM as a competitor and probable successor to AM broadcasting.

An example of this was testimony, prepared in great detail, purporting to show that FM service will not be debased by lowering the present standards for fidelity and signal-to-noise ratio. The arguments presented were based largely on tests made to determine the hearing deficiencies of men and women of various ages, but not under conditions which apply to home radio listening.

Moreover, they were spot checks, and do not take into account the fact that the ear becomes both trained and conditioned by listening experiences. A person familiar with concert music would know instantly if instruments characterized by overtones above 8,000 cycles should stop playing even though, on test, he could not recognize pure tones above 8,000 cycles. But that same person would not find fault with the limited reproduction afforded by sound movies, because he has been conditioned to accept what sound movies provide.

The argument for lowering the present signal-to-noise ratio was based on Telephone Company tests which showed the average absolute level of residential room noise to be 43 db. That may be true in a city residence, but it is certainly not true in a suburban or country home, particularly if the walls are insulated as so many are now and as most new homes will be.

It is standard technique, with which the Commissioners must be familiar, to stall or side-track any proposal by first elaborating on its virtues, and then proposing improvements which take the form of sweeping revisions, supported by technical data so complex as to be utterly confusing. The intended result is to prevent a prompt decision by creating differences of opinion among those who must take the responsibility for drawing final conclusions. If the effort succeeds, the subject under discussion may die from being talked to death.

The radio industry cannot afford to have this happen to FM. Even under conditions now prevailing, manufacturers can complete their engineering plans for postwar transmitters and home receivers if they know the range of FM frequencies and the characteristics of the signals. This is necessary in order to change over to peacetime production fast enough to avoid serious unemployment.

It is expected that the FCC will give proper weight to this need, and will set aside fancy schemes intended to delay the postwar progress of Frequency Modulation.

[1] These recommendations were published in full in *FM* AND TELEVISION, August, 1944.

HOW FM SERVED IN SECOND HURRICANE

Police Radio Systems Largely Responsible for Low Loss of Life and Property Damage

BY JOSEPH A. HOFFMANN*

NOTHING could bring out the value of 2-way police radio communication more forcefully than a comparison of experiences during the Atlantic Coast hurricane of September 21, 1938 and that of September 14, 1944. The former occurred before FM equipment was available, while the latter found the state and municipal police departments in the entire coastal area affected, from North Carolina to Massachusetts, equipped for 2-way FM communications.

At the time of the first storm, there was little that the police could do before and during the hurricane. Their activities were limited largely to mopping-up operations after the loss of life and property damage had been visited upon their communities. But in the recent storm, police organizations were alerted as soon as warnings of approaching trouble were received from the Weather Bureau by teletype or from the broadcast stations.

Their services were threefold. First, the police took all possible precautionary measures to keep property loss at a minimum. Then they evacuated residents of threatened areas. And, finally, they were able to maintain effective patrols, so that cars could be dispatched after the storm struck to meet emergencies as they arose. Warnings were transmitted immediately when trees, fallen wires, and washed-out bridges created new hazards. Medical aid was rushed quickly where it was needed. The work of the Red Cross was expedited. And when the storm was over, protection was set up against looting.

In 1938, the loss of life exceeded 600. At this time of writing, less than 30 fatalities have been reported from the recent storm. This difference is largely due to the use of 2-way police radio. While the steps that could be taken to prevent property damage were necessarily limited, since there is no way the police can stop a tidal wave from sweeping up buildings, or trees from falling on houses, much was accomplished in this direction. For example, wherever police officers patrolling threatened areas found boats, automobiles, merchandise, or property that could be moved to secure locations, they reported the conditions immediately, and headquarters located and called the owners.

It has not been possible, at this time of writing, to put together a complete picture of the work done by state and municipal police departments during the hurricane. However, an account of events in some of the states gives a picture of the work made possible by FM, particularly during the height of the storm when power lines and telephone wires failed.

At approximately 7:00 A.M. EWT on September 14 the storm center was at sea opposite Wilmington, N. C. Major J. T. Armstrong, commanding the North Carolina State Highway Patrol, had alerted Troop A on the coast the previous evening. Lt. L. Jones, commanding Troop A, reported that all 2-way radio equipped cars in his troop were standing by, and went into action about 8 A.M.

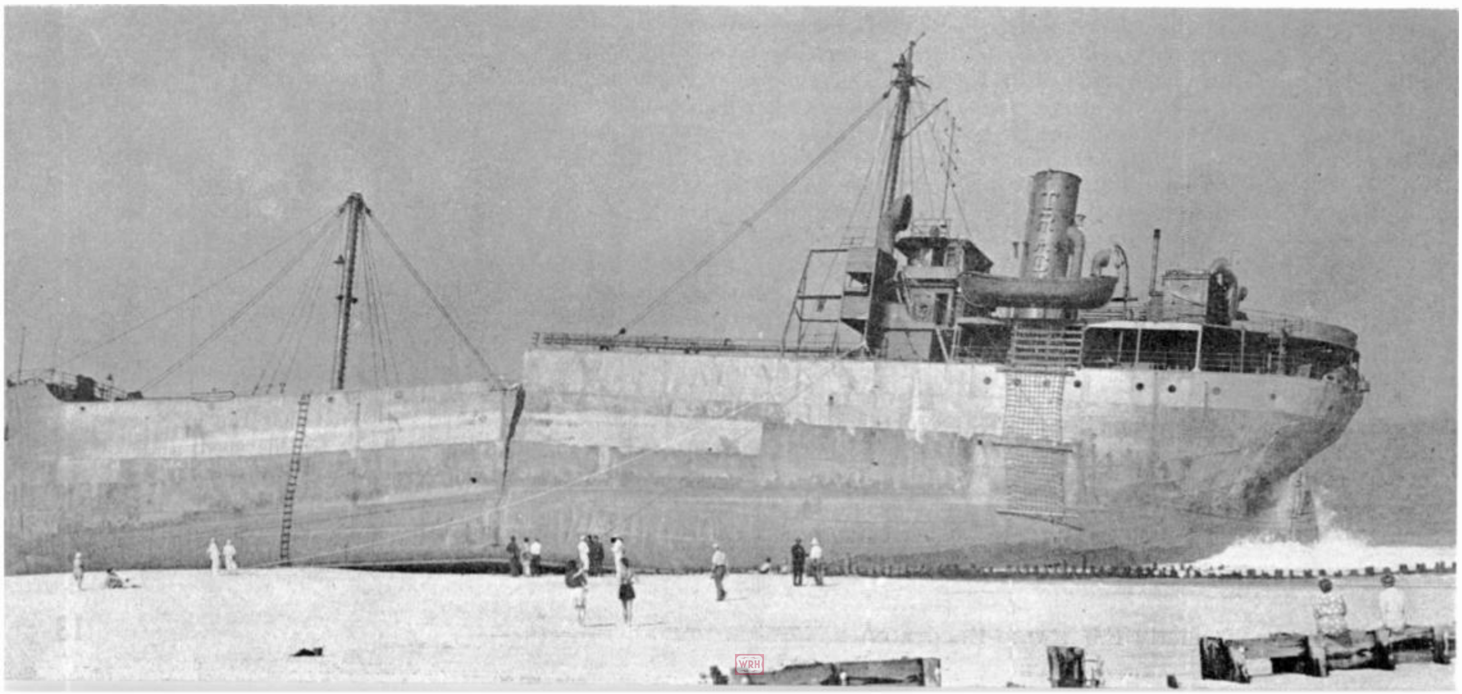
One of the most important services rendered through the radio net was to the Norfolk and Southern Railroad. The railroad bridge across Pamlico Sound was partially destroyed. Mr. Pettus, trainmaster at Edenton, called on Sergeant G. I. Dail of the Patrol for emergency communications. The sergeant immediately advised the Norfolk's division office in Raleigh of prevailing conditions. Traffic handled through the radio system for the railroad enabled them to direct and control trains both north and south, thereby keeping traffic open on this division which otherwise might have been brought to a standstill.

Near Mattamusket Lake in Hyde County, Patrolman C. E. Whitfield found all public services out, and flood waters rising rapidly. He hastily constructed a ramp, drove his 2-way radio-equipped car to a high platform, and operated his equipment as a fixed radio station. He maintained constant point-to-point communication with the main station at Williamston, where arrangements were made with the Red Cross and other relief agencies to dispatch aid into the flood-stricken areas.

Lt. Jones stated that FM played an important part in hundreds of incidents occurring as a result of the storm, and ren-

* Link Radio Corporation, 125 West 17th Street, New York, N. Y.

THIS VESSEL WAS TOSSED UP ON THE SHORE WITH SUCH VIOLENCE THAT IT BROKE IN TWO



dered public service that the taxpayers will long remember.

At 10:00 A.M., the storm center was passing between Cape Hatteras and the mainland. Virginia was fortunate in being on the outer fringe of the devastation. Patrol cars in the Hampton Roads area were quickly dispatched to points where fallen trees blocked the roads. Captain W. C. Thomas, Executive Officer of the Virginia State Police said, "We are very happy to state that the hurricane practically missed the Commonwealth of Virginia. However, about one week following the hurricane, there was excessive rainfall in the central portion of the State. Telephone lines on the Hames River between Columbia and Richmond were under water in places. A patrol car was dispatched to Columbia to transmit hourly gauge readings on the rise of the river, in order that Richmond officials and the Weather Bureau might be kept informed. The City was thus enabled to prepare sufficient barricades to prevent any serious damage to power and gas plants. In other sections of the State, patrol cars kept this Department and the Highway department apprised of sections of highways which were under water, and of a few secondary bridges which were washed out."

At 3:00 P.M. the eastern shore of Maryland came to full grips with the storm. Lt. W. H. Weber, Director of Field Operations and Communication Officer said, "Needless to mention, radio was the only means of communication during the major part of the catastrophe." First Sergeant P. J. Randall, Troop Commander at Salisbury gave a full report to Lt. Weber on September 15, from which the following observations were taken:

Ocean City: Detail continues to remain on duty under Sergeant Buckworth. Miss Anna Scarborough, age 74, suffered fractured leg. First aid was administered and she was transported to Salisbury Hospital in State Police ambulance, summoned by radio. Approximately 200 persons were evacuated by Red Star Busses. This transportation was summoned and dispatched by radio. One hundred were housed in cabins in Berlin, fifty at the hotel. Fifty more in Salisbury Armory. They were fed and sheltered by Red Cross. Red Star Bus will provide transportation to Ocean City for people called to salvage their belongings. Electric power is on, but there is no telephone communication.

A NEW JERSEY EMERGENCY CAR WITH RADIO AND SOUND EQUIPMENT

Snow Hill: Power lines are down, and we have put up detour signs. No lights or telephones. Trees, shrubbery, and several homes are extensively damaged. Highway to Girdletree under 2 ft. of water for 300 yards. Flares placed. Girdletree to Stockton, two power lines on poles down. Dead wires across road marked by flares. We have notified Stockton Electric Company.

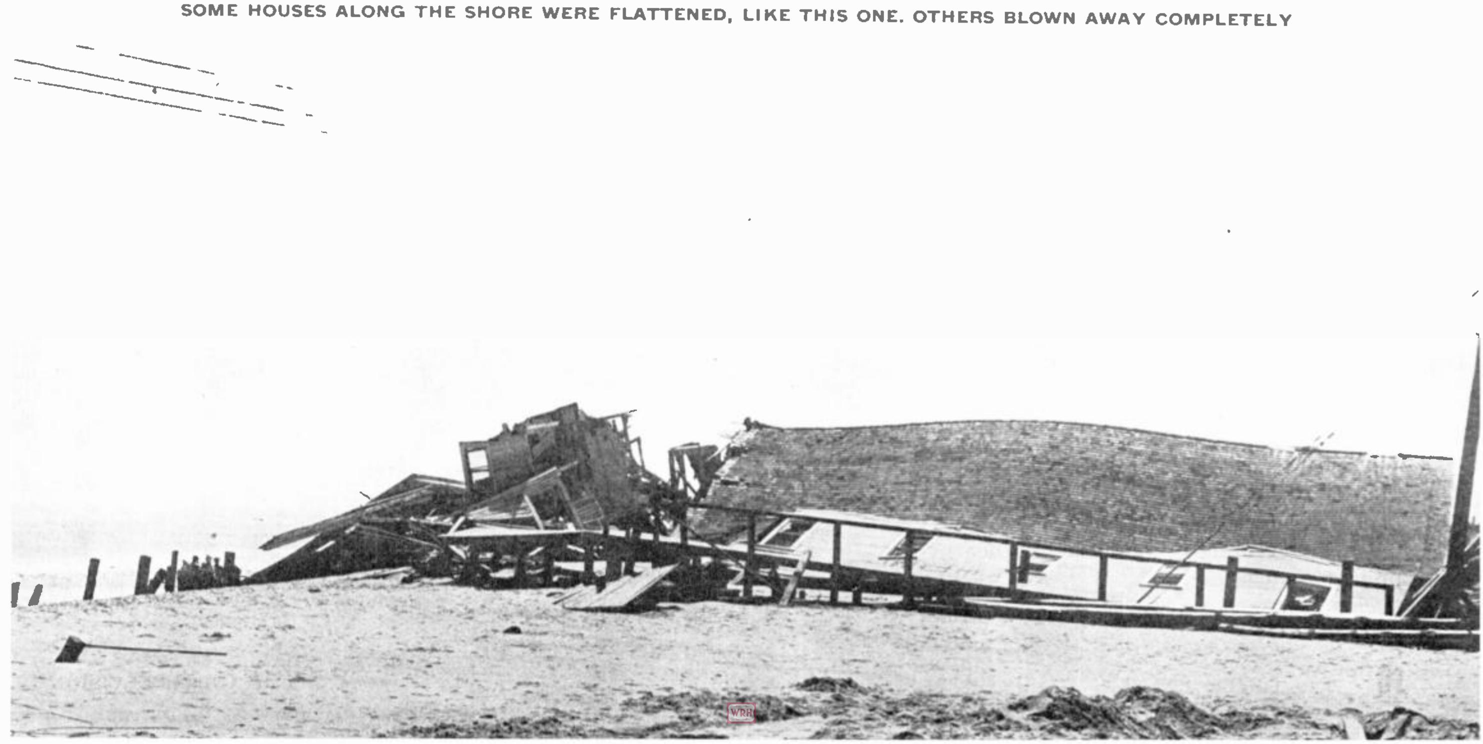
Pocomoke City: Route 1 south, 18 inches of water. No street lights. House current all right. 75 trees down. 10 homes damaged. Considerable damage to crops. Open south and north of this point.

Crisfield: Power out in residential and business section.

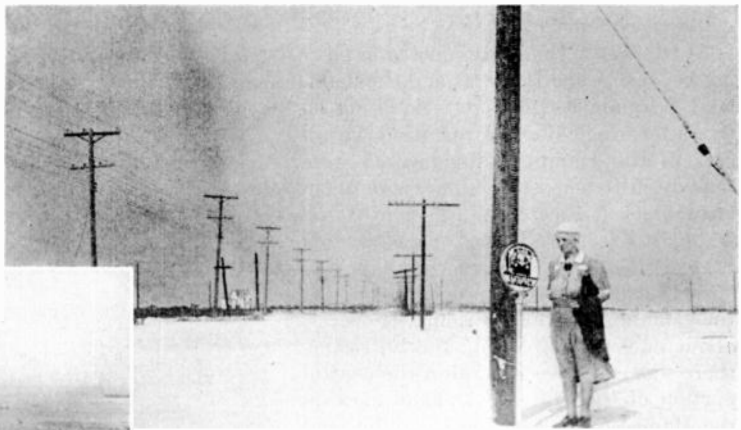
Wicomico County: Power off at 2:42 P.M. Auxiliary power unit brought from Easton, set up by radio division. Able to maintain FM radio communication between barracks and cars at Ocean City. Considerable wind damage throughout county. Trees down along highways have been cleared, roads now open. Detail remaining at Ocean City for night and can be called from the barracks.

From Maryland north, the storm center worked its way closer to land. P. W. Haviland, Superintendent of Delaware State Police reported: "Our Troopers carried on their work in a very efficient manner, and we realize that the work could not have been handled as efficiently without our radio communications." The Weather Bureau in Philadelphia advised Delaware that the hurricane would strike early in the afternoon. All Troopers were ordered to emergency duty. Hourly weather reports were transmitted from all Troops to Headquarters via FM radio, and they, in turn, furnished information to the local broadcasting stations so that the public could be advised. Thus Delaware operated its own weather bureau during the emergency.

SOME HOUSES ALONG THE SHORE WERE FLATTENED, LIKE THIS ONE. OTHERS BLOWN AWAY COMPLETELY



At approximately 4:00 P.M., all power lines in Sussex County, at the lower end of Delaware, were blown down. Simultaneously most all telephone lines were put out of commission in the storm area. Troop D's main station in Georgetown was put off the air by power failure. A portable generator, rushed from Dover to Georgetown, had them back on the air again in short order and 2-way communication with mobile units and Headquarters was resumed. Superintendent Haviland and Lt. Schnetter, Director of the Criminal Division, proceeded to the storm area and took charge of operations. Patrol cars were dispatched to ride all roads, keeping in constant contact with their main station. In this way all hazards to the public, such as fallen trees and live wires, were promptly called to the attention of the proper authorities for final disposition.



SOME 30 HOMES DISAPPEARED FROM THIS STREET AT BEACH HAVEN, N. J.

SMASHED REMAINS OF BOATS AND HOUSES LEFT AT HOALGATE, N. J.

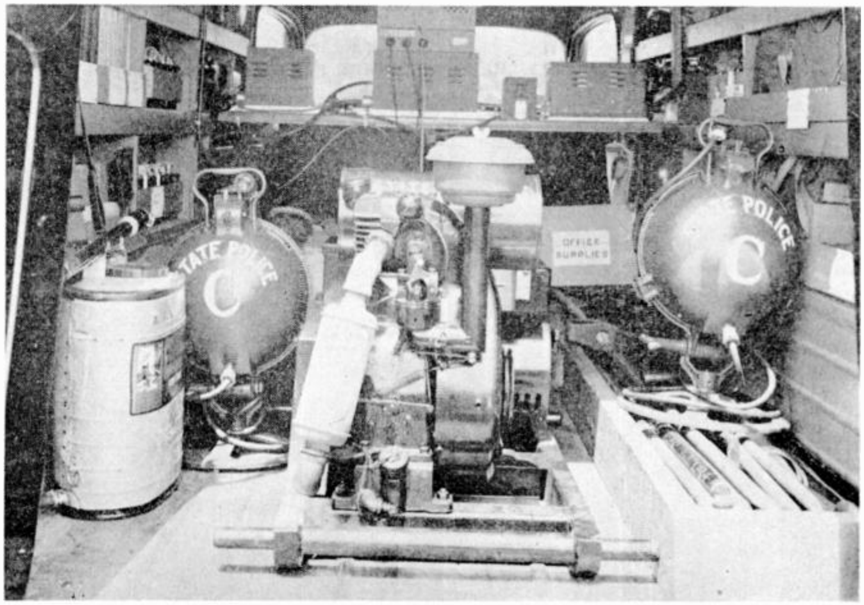
Special attention was directed against the looting of summer homes. In many instances owners were summoned through dispatches to appear and claim their property under guard by the Troopers. Constant requests poured into Delaware State Police Headquarters from residents in and out of the state, regarding the safety of relatives and friends in the storm area. Information in reference to these persons was promptly radioed back to headquarters and distributed to those who had inquired.

In the 24 hours following the storm, the 2-way radio-equipped cars of Delaware State Police provided the only means of communication with the outside from Lewes, Rehoboth, Bethany Beach and Fenwick Island. This emergency radio network unquestionably accomplished much in preventing loss of life and further property damage.

In his report of December, 1943, Colonel C. H. Schoeffel, Superintendent of the New Jersey State Police said: "Should New Jersey ever be confronted with a state-wide emergency brought about by air raid, mass sabotage, earthquakes, floods, explosions or other conditions affecting the welfare, security, and property of its citizens, the New Jersey State Police 2-way FM radio system will play a major rôle in directing the efforts of the police in bringing aid and restoring order." The performance of his FM system,[1] and his forethought and planning for emergencies have, no doubt, given him much satisfaction.

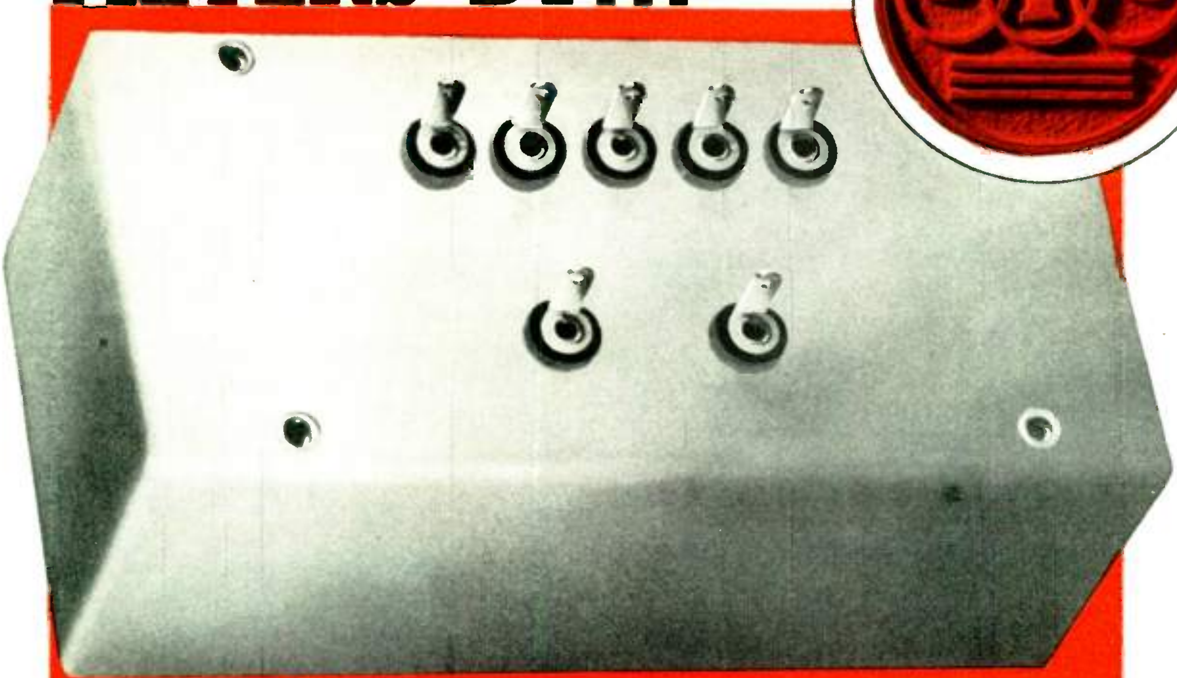
At approximately 7:00 P.M., the storm center was at its closest point to land since passing inside Cape Hatteras. The New Jersey coastline suffered more violence from the storm than any other state, the hurricane's severity receding from here northward. The greatest lesson learned in New Jersey was the importance of emer-

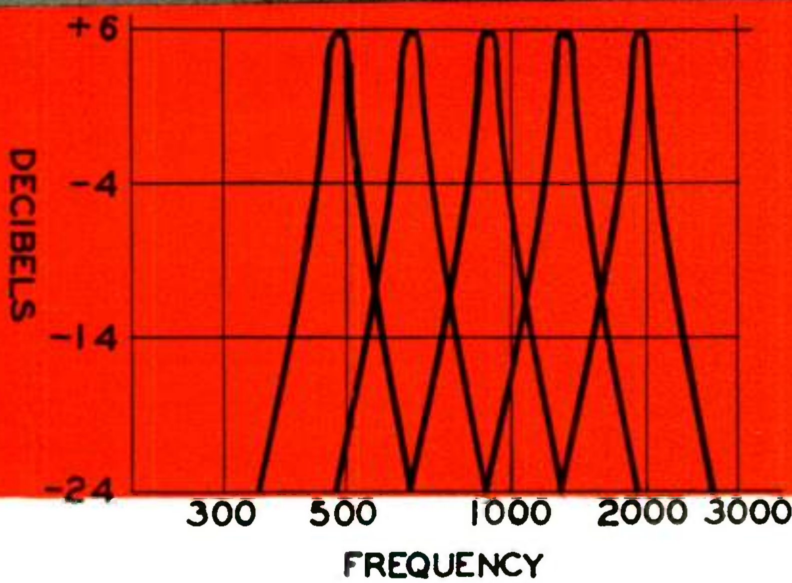
[1]For details, see *New 2-Way FM Plan for Jersey*, By Prof. Carl Neitzert and Lieut. John E. Murnane, *FM Magazine*, May, 1942.



INTERIOR VIEW OF A NEW JERSEY EMERGENCY RADIO CAR

MULTI-CHANNEL FILTERS BY...





Multi-Channel Filters lend themselves to remote control apparatus employing frequency selection. The unit illustrated is a five channel band pass filter of the interstage type with the inputs in parallel and 5 separate output channels designed to feed into open grids. This circuit arrangement provides a 2:1 stepup ratio, with a band pass attenuation of approximately 30 DB per half octave. The dimensions of this unit in its hermetically sealed case are 2½" x 3" x 6". Filters of this type can be supplied for any group of band pass frequencies from 200 to 7000 cycles.

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"Ham" Radio and HYTRON

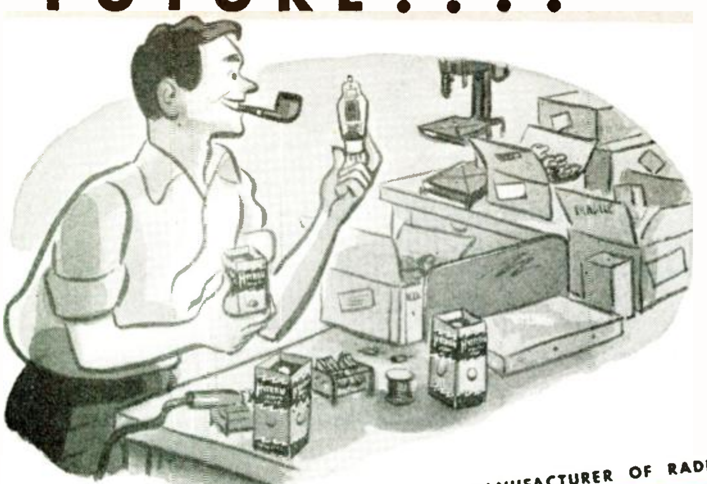
PAST . . . .

THE radio amateur trained himself during peace to be invaluable to the Nation during war. Specializing on tubes exclusively designed for ham radio, Hytron when war began was prepared for immediate and direct conversion to war production. Hytron transmitting and special purpose tubes proved by the ham were ideally suited—with little or no changes—to military applications. Years of practical experience made Army and Navy specialists of radio amateurs overnight. Peacetime tools of these same hams, Hytron tubes joined immediately this new fighting team.

. . . . PRESENT

HAMS with the Services in all parts of the world know the war job Hytron is doing. High-speed receiving tube techniques plus know-how derived from special purpose engineering of tubes for the amateur, make possible a flood of dependable Hytron radar and radio tubes to these fighting ex-hams and potential hams. Proud of winning the Army-Navy "E" for its performance on a huge production job, Hytron is also proud of its ham friends who are transforming innocent-appearing Hytron tubes into deadly weapons.

FUTURE . . . .



THERE should be no concern about adequate post-war amateur frequencies. Excellent wartime performance on far-flung battle fronts has made for ham radio many enthusiastic and influential friends. The ARRL reports that it looks forward with absolute confidence to the opening of new frontiers in expanded frequency ranges to be made available to the post-war amateur. Hosts of hams will return to their old friend, Hytron. For the more familiar lower frequency bands—the very high frequencies—or the new superhighs—their choice will be Hytron.

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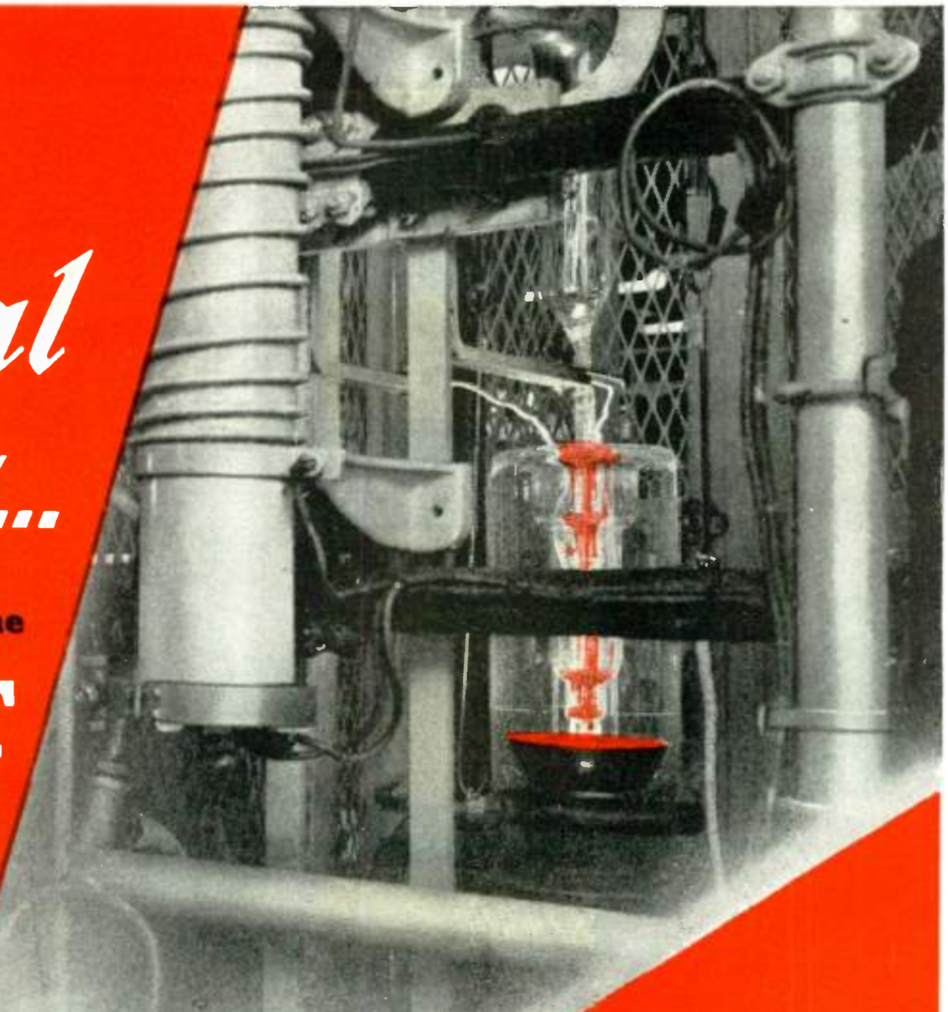

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Always in the forefront of tube research and development, Federal makes another advance and now has added exhaust units of entirely new and original design to its production equipment.

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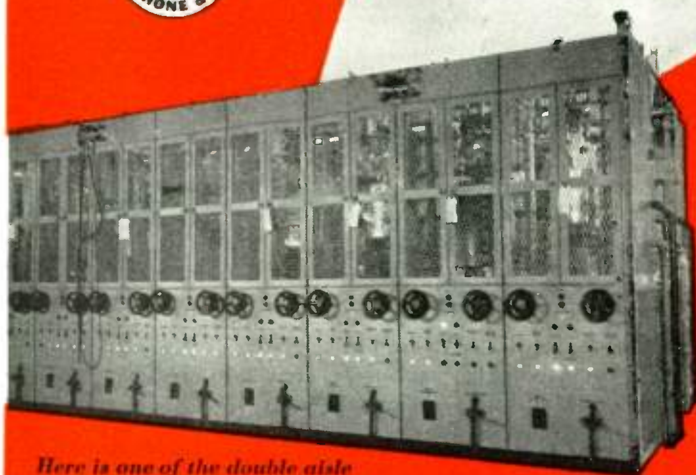
For any communication and industrial power tube need, turn to Federal now—test its reputation that "Federal always has made better tubes."



Here is one of the double aisle exhaust banks where 16 high power tubes can be exhausted at one time, each with individual control.

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.

A WALL OF WATER PICKED UP THIS SECTION OF A HOUSE AND DROPPED IT ON A CAR

COAST GUARD AND N. J. TROOPERS WORKED TO RESTORE POWER AND PHONE LINES

gency power. The storm did a thorough job on all wire lines. Power failures and demolished land lines silenced radio, teletype, and telephone. Troop C headquarters at West Trenton and the Barrack at Keyport went on the air using gas-driven generators for auxiliary power. The well equipped emergency trucks mounting 50-watt transmitters and two receivers gave a perfect account of themselves, as did all mobile installations.

Several radio units in patrol cars were immersed in negotiating flooded areas. Sergeant Kelly, Supervisor of Radio, reported that these units were removed, dried and replaced, and were operating in short order without replacements.

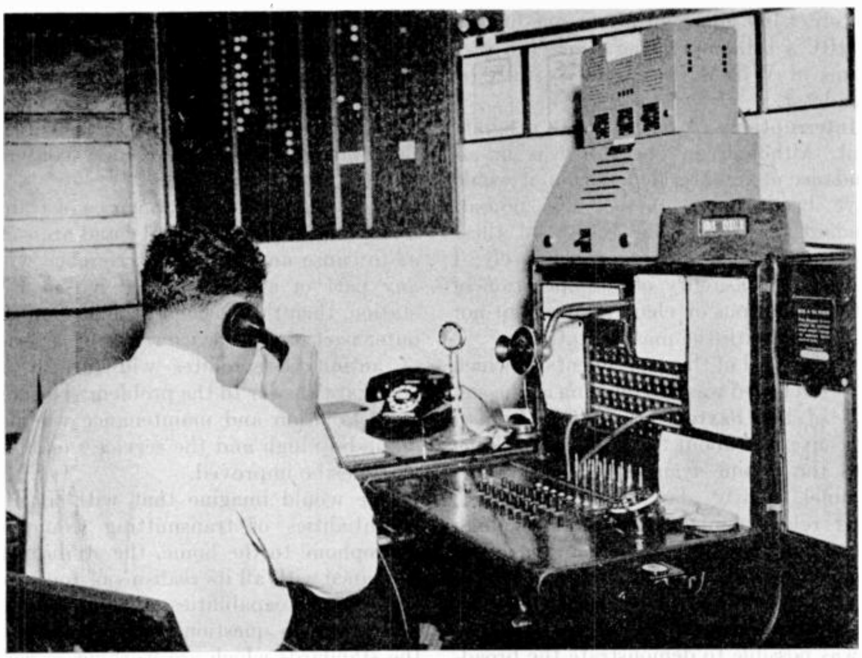
One of the hardest hit sectors was Long Beach Island with at least three lives lost and property damage estimated at $3,-800,000. Owing to wreckage and abnormally high water covering the 7-mile stretch from Manahawkin to Ship Bottom, a radio dispatch to Fort Dix summoned 40 high-wheeled Army vehicles and 80 men to this area. Colonel L. Sussman's coöperation in this matter was both timely and commendable. Before the Army troops arrived, State Troopers commandeered a bus, reached the island, established radio communications with Trenton Headquarters, and immediately went to the assistance of the storm victims. Under the personal supervision of Captain W. Coughlin, suffering was alleviated and order restored. Valuable assistance rendered by the U. S. Coast Guard, also summoned by radio, was responsible for saving many lives.

About 75 New Jersey State Police officers and troopers in this area worked in coöperation with the Red Cross in bringing up and distributing food, safe drinking water, shelter, and medical aid for the inhabitants. Measures were taken to prevent looting. Constant checks were made on persons reported missing, and a heavy volume of radio traffic was handled for municipal police authorities. As a result of the efficiency displayed by the State Police, many letters of commendation have been received by Colonel Schoeffel, expressing gratitude to the Department for unusual services rendered.

As the storm passed the New Jersey Coast, Colonel Schoeffel continued to direct the activities of his department, from Cape May to Atlantic Highlands, through the medium of FM radio from his headquarters in Trenton. This was a remarkable example of centralized control, and although this was the first acid test of the state-wide system, it functioned perfectly.

Like Virginia, New York and Eastern Connecticut received only a few short whirls in comparison to other localities. The storm track took a decided turn off

(CONTINUED ON PAGE 68)



OPERATORS AT N. J. POLICE BARRACKS HANDLED RECORD TRAFFIC VOLUME

DISCUSSION OF POSTWAR BROADCASTING

Complete Transcript of Major Armstrong's Testimony at the FCC Allocations Hearing

THE following text presents Major Armstrong's testimony and cross-examination[1] before the FCC hearing on frequency allocations, held at the Museum of Natural History, Washington, D. C., on October 12, 1944:

MAJOR ARMSTRONG: Eight years ago, I had the privilege of bringing to the attention of this Commission a new system of broadcasting which, I ventured to predict, would not merely supplement but rather would supersede the existing standard broadcast system. At that time, one transmitter and perhaps a half dozen receivers were in existence.

But for the advent of the war, it is a reasonable statement to make that this prediction would have been well under way to fulfillment. Beyond question, some hundreds of transmitters and a good many millions of receivers would have been operating in this country alone at the present time. The example set here has had an effect world wide in scope. Other countries, both on the North American Continent and on other continents, are preparing to follow in the footsteps of the United States, and the rest of the world, and most particularly the tropics, will follow along upon the termination of hostilities. It is an interesting comment that this world-wide revolution has been brought about without public exploitation, and it is the first time that any invention of major importance in the radio art has ever been so introduced.

It is a fair statement to say that the reception which the public has accorded the introduction of this system, following the placing of FM on a commercial basis in 1940, has borne out the predictions made about it to the Commission by the men then engaged in the pioneering of the system. As has been developed in the present hearing, the system has found wide use in many other fields, and as a consequence thereof and of its success in the broadcasting field, an increased demand for space in the spectrum has been created. An outstanding opportunity for peace-time service is just beginning to emerge in the field of educational broadcasting, and the extent to which its effects may be felt cannot now be forecast.

The problems raised by the success of the system with its concomitant requirement of greater spectrum space, and a number of other questions which have arisen from the same cause, have been considered by the FM Panel of the Radio Technical Planning Board, and with its conclusions as presented here I want to express agreement. I would like also to concur in the finding of the Sub-Committee of Panel 5, headed by Commander DeMars, to the effect that war-time developments have not changed the status of FM broadcasting as now practiced.

I would like to bring to the attention of the Commission at this time the results of two rebroadcasting and relay experiments which were carried out prior to the entry of this Country into the war. The first of these was carried on over a period of nearly two years in cooperation with Station WDRC on Meriden Mountain near Meriden, Connecticut, a distance of approximately 65 miles from Alpine. There was installed at this station an automatic repeating system whereby the 42.8-megacycle signals from Alpine were translated into 43.4-megacycle currents, amplified, and fed into the Meriden transmitter directly without the necessity of demodulation and remodulation of the wave. The receiving antenna on Meriden Mountain was located approximately 100 feet from its transmitting antenna. For approximately 2,100 hours, or about one-fifth of WDRC's total operating time, the programs of W2XMN were successfully rebroadcast.

Interruptions to service were insignificant. Although an operator was in attendance at the Meriden station, it would have been quite practical for non-attendant operation. The results of these experiments demonstrate conclusively, I think, the feasibility of the operation of satellite stations on channels near but not coincident with the master station.

The second of the experiments to which I have referred was the relaying of the signals of the Paxton transmitter from a pick-up point about 35 miles from Alpine into the Alpine transmitter on a relay channel slightly above 200 megacycles. This relay point was located on high ground so that both the reception of the Paxton signals and the transmission to Alpine were noise-free. During the short interval that this circuit was in operation, it was possible to demonstrate the broadcasting in the New York area of programs originating in Boston with a quality never before equaled for a Boston program. While this relay station likewise ran with an operator in attendance, it also could easily have been made automatic. In the case of both the relaying from Paxton and the relaying to Meriden, the fidelity of the reproduction was such that at receiving points capable of picking up a good signal from both the originating and the rebroadcasting stations, no difference in quality could be detected. This result, of course, was in accordance with expectations.

The Commission has also heard here of the successful operation of a satellite in conjunction with WTMJ on the same channel. This type of operation holds the greatest promise, and I feel that a year's work on co-channel development under peace-time conditions would produce some surprising results.

The Commission will also hear much testimony of the actuality of main-line relays operating from point-to-point in extremely high frequencies which will furnish transmission of a quality and noise level hitherto unavailable to the broadcast industry.

THE CHAIRMAN: What are you referring to there, the high radio frequencies?

MAJOR ARMSTRONG: Yes, Mr. Chairman. The possibilities afforded by all these methods of distributing programs are mentioned because they afford much opportunity for the exercise of ingenuity for the distribution of programs within regions that may be remote for many years to come from the introduction of the main-line relays which are now contemplated.

In my opinion, if the vagaries of transmission on the present FM band are such as to cause any serious interference with any part of an area served by an FM station, then the raising of the level in the outer part of the service range by a series of automatic satellites will furnish an adequate answer to the problem. The cost of installation and maintenance will not be unduly high and the service should at all times be improved.

One would imagine that with all the potentialities of transmitting from the microphone to the home, the studio performance with all its realisms of tone and the system's capabilities of suppression of noise that no question could arise about the standards which are working so well. No one who has had a hand in building

[1] This text is from the transcript furnished by Ward & Paul, official reporters, 1760 Pennsylvania Avenue, N. W., Washington 6, D. C. Certain obvious typographical errors in the transcript have been corrected (EDITOR).

them up wants to change them. The demand for channels, however, seems to have engendered the belief that the simplest way of providing them would be to reduce the present 200-kc. channel widths to one-half. The proposal is probably made in most instances with a lack of knowledge of the factors involved or recognition of the results which would follow to the grade of service which could be rendered. On account of the complexity of the problem, some of the phases of the situation may not be generally understood and I would, therefore, like to point out some of the considerations which must be taken into account.

Disregarding for the moment the practical consideration of the frequency drift in the oscillator, and problems of maintaining alignment of the intermediate frequency transformers and discriminators, and assuming that all factors are reduced in proportion, we have the following situation:

At the present time the standard set is 60 decibels or a ratio of power signal to noise voltage of 1,000 to 1. The proposal is made that that is too high, that 50 decibels would do.

Now, there is quite a difference between theory and practice, and I would like to cover some of the experiences of the people who introduced this system with the original phase shift modulator, which was then the only type of transmitter in existence. That modulator had inherent in it, when it was properly adjusted, a noise level of about 65 db down. Over reasonably short distances, the noise which would be heard in a receiver would be the noise of the transmitter itself. As the receiver was taken farther away from the transmitter, eventually the surrounding noise would become the limiting factor. But under the conditions under which most of the demonstrations were given in the early days, the noise in the transmitter was not a limiting factor.

During a number of the demonstrations, attention was called to the fact that there was a hiss in the reproduction, and questions were asked as to why the hiss was there. FM was supposed to be noise free. It was pointed out in quite a number of the demonstrations I gave, and when an FM transmitter was installed in the Zenith station in Chicago, the original modulator with 65 db noise level was replaced by another type of transmitter capable of giving frequency modulation known as the reactance-tube type, because it was quieter and did give something upward of 70 db freedom from noise. Mr. Brown of the Zenith Radio Corporation is here, and will be glad to confirm that statement.

On a number of occasions, it was necessary to carefully readjust the phase shift modulator in order to prevent complaints about the 65 db or less noise level. When competition entered the field, three other transmitter manufacturers produced the reactance type modulator. It was pointed out, and it is a matter of record in several places, that the reactance type of modulator did not give the disturbing noise levels that the phase shift type of modulator did. That led to a situation which to me, as the inventor of the phase shift type of modulator, was intolerable. I thereupon devised a new type of phase shift modulator which will give a noise level of some 73 to 75 db down, and that, I believe, speaking as the inventor, is destined to be the system of the future. But I mention that to show that attention is called even to a noise level of minus 65 db.

MAJOR ARMSTRONG'S testimony at the FCC allocations hearing deserves the most careful consideration because, since he is neither a commercial broadcaster nor a manufacturer, he is not called upon to support the policies of any company organization. However, as the inventor of FM, his best interests are served by that which best serves the interests of radio listeners.

Two remarks in his testimony stand out because of his long experience in operating station W2XMN, and in giving demonstrations of FM performance. Concerning present FM broadcast standards, he said: "No one who has had a hand in building them up want to change them." And of audio fidelity: "— the difference between 10,000 cycles and 15,000 cycles is the difference between something that is good and something that is real."

One of the concomitant proposals which have gone along with the suggestion that 50 db was a good enough noise level is the proposal to narrow the band from 200 kilocycles to 100 kilocycles. Now, that word, "narrow" the band, ought to be subject to definition. Superficially, one might take it to mean that everything ought to be reduced in proportion. Let me give an example:

It is standard practice in the 200-kc. channel, using a deviation of plus-and-minus 75 kc., to adjust the shape of the over-all resonance curve to be down to one-half its value in the extremities of the swing. Taking the same case for the 100-kc. channel, and using a deviation of plus-and-minus 37.5 kc., the resonance curve of the receiver would be down to one-half its value at the extremities of the swing. Under these conditions the third harmonic phase shift distortion in the receiver is doubled.

But disregarding that for the moment and looking at the effect on the swing, we still have the same factor of oscillator drift, which will be the same regardless of the bandwidth.

Now, in so far as the fluctuation noise or noise which lies below half the level of the carrier, we can say that roughly the signal-to-noise ratio on the narrower channel would be doubled. But that is not the important thing. The important thing is the effect on impulse noise which is greater in amplitude than the carrier, the ability of the system to reject noise when it is greater in extent than the carrier, and that is something which occurs in practice regularly. Ignition noise may rise to 10 or 20 fold the level of the carrier in some locations. Now, under those conditions, if the carrier drifts and if the receiver oscillator drifts 10 or 15 kilocycles, as it will, then we have a situation which is quite different from what has been discussed in the various curves which have been presented from time to time before this Commission. What happens there is that the ignition noise rises in amplitude in proportion to the contraction of the swing and in fact to more than that proportion.

Comparisons have been made of the ratios of ignition noise obtained under conditions where the frequency has drifted 12.5 kc. from the center point, using receivers having bandwidths of 150 and 75 kc., respectively, each down 6 db at the edge of the band. For equal signal outputs at the full swing of 150 kc. in the wide band and 60 kc. in the narrow band, the noise-voltage level in the narrow band was approximately 3½ times that of the wide band. This gives a noise power ratio of approximately 12 times in favor of the wide band system. The noise power, which is available for creating noise in the ear, being proportional to the square of the voltage ratios.

THE CHAIRMAN: I did not quite understand that, sir. I did not get the implication of the square of the voltage.

MAJOR ARMSTRONG: Perhaps I can explain that best this way, Mr. Chairman. When the voltage is 3½ times as great, that causes 3½ times as much current to flow in the circuit, the current being proportional to the voltage, and the power is the product of the current times the voltage, which, of course, is 3½ times 3½, or roughly 12.

It should be noted that where the level of the ignition peaks is high, the matter cannot be cured or the disturbance in the narrow band equalized with the wide band by any increase in the power of the transmitter within reason. For example, if the ratio of the ignition peaks were 10 times the carrier level, a case of common occurrence, then an increase in the power of the transmitter of fifty-fold would not suffice to reduce the interference to the level of the wide band system.

The explanation of that is a long and complicated one, and I will pass it by for the time being, but state it to be a fact.

In this consideration of the effect of oscillator drift, all the other elements of the receiver, that is, the intermediate-frequency transformers and the discriminator, were carefully centered with respect to each other. Any time change in their constants will further change the ratio to the detriment of the narrow band.

There has been some discussion of how many cycles were good enough for the average listener. I think the best way to state the difference between 10,000 cycles and 15,000 cycles is the difference between something which is good and something which is real. When I demonstrated for the first time to the different groups who manifested an interest in the FM system, one thing was mentioned in all cases. That is, they spoke of the effect of the presence of the speaker when an announcer made an announcement, or when a bell or a musical instrument was transmitted. There was the effect of presence and it struck everyone who heard it for the first time. Now, I am sorry that we have not yet attained in everyday practice what I was able to demonstrate on those early experiments, but that is what we are aiming for, and that is what we can do. But that is the difference between 10,000 cycles and 15,000 cycles.

I would also like to point out that the adoption of a 100-kc. channel will make the use of any multiplexing service a practical impossibility.

In conclusion, I would like to leave this thought: In the development of any new project of this magnitude, all sorts of problems, real and fancied, are encountered. Ordinarily, the cures are worked out by the men who are building the industry, frequently in advance of the problem ever being realized by many engaged in it. At the present time, we are in an unprecedented situation, something that has never happened before. We are three years behind in invention. For three years no attention has been given to these problems by the men who build the system. They had more important work to do. The problems, however, have accumulated so that, en masse, many people see them and worry about them. I do not. A year or so of attention to them under peacetime conditions will make them fade, as have all the others. I feel the hardest ones were overcome years ago before anyone knew of their existence.

THE CHAIRMAN: You mean anyone else. (But yourself.)

MAJOR ARMSTRONG: There have been a number of subjects considered, Mr. Chairman, during the past few days which I have not touched on here in this discussion as I felt it would perhaps economize time to discuss them in response to any questions on the subject that the Commission might care to inquire about.

THE CHAIRMAN: I should like to have your comment, sir, on two questions. One is as to the number of 200-kilocycle channels you think should be provided to give adequate service; and the other I would like to have your judgment on is the comparison of the frequencies, say around 50 to those around 100 megacycles.

MAJOR ARMSTRONG: In regard to the first question, Mr. Chairman, I, in common with everyone else, made a mistake on that a good many years ago. I thought that perhaps 5 megacycles might see us through in 1936, and in 1940 I think we felt that 8 megacycles in one place would do us for quite a while. I rather think that outside of the principal centers, such as New York, Chicago, and Hollywood, what has been suggested in the Planning Board would do pretty well unless I am underestimating again how this system is going to spread.

COMMISSIONER JETT: That is 75 channels.

MAJOR ARMSTRONG: Something of that order.

COMMISSIONER JETT: 41 to 56 megacycles, I believe, is what the RTPB proposal is.

MAJOR ARMSTRONG: Something of that order, yes.

THE CHAIRMAN: Would you care to give us your judgment, sir, on the feasibility of the different frequency ranges, say roughly comparing the 50 to 100?

MAJOR ARMSTRONG: In regard to the second question, I have, as the Commission knows, conducted a good many experiments and operated over a period of years on 117 megacycles. As a matter of fact, most of the demonstrations to the art were conducted during 1935, until Alpine was ready in 1938 or 1939, on 117 megacycles.

With respect to coverage, the 40-megacycle band was the band that I chose to operate in, principally on account of the effect of shadows and also for the reason that we could get higher power at those frequencies.

THE CHAIRMAN: But not greater coverage in relation to power?

MAJOR ARMSTRONG: Yes, Mr. Chairman, we could get greater coverage in relation to power because the comparisons between 40 mc. and 117 mc. were made with the same power.

THE CHAIRMAN: I thought you had 100 watts at 117 mc.

MAJOR ARMSTRONG: The original demonstration to the Institute of Radio Engineers was made in November of 1935 with about 100 watts. That power was raised and a 2-kilowatt transmitter was installed at Alpine and started operating in April of 1939. When that power was raised to 5 kilowatts in September of 1941, it was put into an antenna with a power gain of about 3, so that in effect 15 kilowatts were available.

COMMISSIONER JETT: On 117 mc.?

MAJOR ARMSTRONG: On 117 mc., up to 8 kilowatts were developed for short periods of time, but the safe operating figure was around 5 kilowatts.

Now, on the basis of skywave interference as it is at the present time, I think there will be interference on occasion, but the worst interference that I have seen, the worse case of interference which is in the Commission's report as I understand it, would reduce the range of a station like Alpine, for example, to about two-thirds of what it would normally serve. That would be, as I analyze the results, for eleven hundredths of a percent of the yearly time, about one-ninth of a percent of the time. That is as far as the present is concerned.

Now, as to the future, I cannot answer; I could only be guided by the men who have made a study of the subject. Dr. Dellinger has thought that perhaps it would not be serious. I think he was quite positive in his statement. But, if it is serious, then we have this condition: If FM cannot work in those channels, what can we put in there? No amplitude modulation system can live in that band, so we really have to take another look at the whole situation. I wish I could be more helpful about it.

THE CHAIRMAN: I did not quite understand your reference to a limitation of the area, the reduction of the area by one third. Was that simply on the assumption of a change in frequency?

MAJOR ARMSTRONG: Maybe I did not make that clear, Mr. Chairman. As I understand Dr. Wheeler's report, he broke down the interference on the skywave received at Atlanta from Princeton into various levels and, taking interference that was 250 microvolts or greater, the figure arrived at was eleven hundredths percent of the time. Now, if you take a distance, let us say, from a station like Alpine, at the 50 microvolt level into the 500 microvolt level, you will find that you are about two-thirds of the way out from Alpine, according to Norton's Curves. That would be the interference point. Now, there will be times, perhaps, when the level will go higher than that.

THE CHAIRMAN: In other words, you are talking about the extent of the rare, occasional interference upon that station at its present frequency and power?

MAJOR ARMSTRONG: Yes.

COMMISSIONER JETT: In the area from the 500-microvolt contour out to the 50; is that what you mean?

Major Armstrong: There would be interference in the area from 500 out to 50.

Commissioner Jett: The standard ends for primary service?

Major Armstrong: Yes.

The Chairman: Do you have any judgment as to what that interference would be if it were operating say at 100 megacycles?

Major Armstrong: No, Mr. Chairman, I think that this particular type probably would be less, although I am in a field where I have to hazard an opinion.

The Chairman: Are you talking about the sporadic E bursts or F, too?

Major Armstrong: Principally the sporadic E and F. The bursts I do not think are a problem to any FM system.

The Chairman: I assume you do not have any question about the ability to generate sufficient power at the higher frequencies?

Major Armstrong: No, I think within time that the same amount of power that we are now generating at 40 mc. can be obtained at 100.

The Chairman: Well, assuming that power is available now, what, then, is the major difficulty or impediment, as you see it, in a possible move to 100 megacycles?

Major Armstrong: I suppose the principal worry about a change of that sort is whether you might not get into some other difficulty that we do not know about yet, because no high power stations exist, and the worry over what might happen to FM in the interval if anything runs wrong. There have been three occasions when FM escaped oblivion by a very narrow margin, and I wonder if it would not be tempting the gods to take it again.

The Chairman: In other words, you do not think we have enough practical experience in that region to give us the assurance of performance.

Major Armstrong: Unless something very much out of the ordinary happens in these channels, I would prefer to meet the problem of sporadic E head on, with boosters wherever it is necessary. I do not say, Mr. Chairman, that we could not do it. It is the risk that we run in case any unforeseen event came up.

The Chairman: I take it, sir, it is largely not the problems we see, but the fear of the problems which we cannot see now.

Major Armstrong: I think that is true both ways, Mr. Chairman, both as to the sporadic E which we may have or the sporadic F which we may have on the present channels, or something that we may encounter on the higher channels that we do not know of. In that connection, during the interval that I was operating Alpine on 5 kilowatts power, there were a number of reports from amateurs using 117-megacycle super-generative receivers in Rhode Island and in the Boston area who were surprised to find a signal in that region.

The Chairman: Where was the transmitter located?

Major Armstrong: Alpine, New Jersey.

The Chairman: Then, in your operation of that transmitter, you did not find any major problems or difficulties?

Major Armstrong: No, I do not think so at all. It worked quite according to Hoyle, and we could have raised the power had there been more.

Mr. Loudermilk: What did you experience with respect to shadows on 117?

Major Armstrong: The shadows were more pronounced; there was no question about it.

The Chairman: Do the shadows tend to diminish in ratio to the signal strength at a given point?

Major Armstrong: Yes, I think that is always so. This was purely a relative comparison between the two frequencies, and it was a qualitative judgment of where FM could best give service in the rural areas, because one of the questions or objections always raised against FM was: What are you going to do for the farmers? In the early days, the use of these ultra high frequencies was supposed to be strictly limited. Now, there has been expressed the opinion here that maybe they go too far in so far as service area is concerned. I am not referring to the sporadic E.

The Chairman: Just one more question: Do you have any experience with the skywave problems? I assume you did not in that region.

Major Armstrong: No, there were no reports beyond the Boston area.

Mr. Denny: Major, you have pretty well covered, I think, all of the questions in this list. I am certain the Commission would like to have your views on any of the questions in the list I gave you which you do not think you have covered or which you would like to add something to.

Major Armstrong: I think perhaps I have covered most of them.

Mr. Denny: I think multipath is probably the only one you have not touched on. You have had experience with multipath, haven't you, that is, you have looked for it and have not found it?

Major Armstrong: That is dating back to 1931. At that time it was long distance and bona fide multipath. But I have never observed multipath transmission. I do not doubt that you can go into the mountains and select a place where the direct ray and the reflected ray from a distant ridge will give you the effect. I think that is a very real thing, but I do not think the places are very many compared to the rest of the United States. I have never found it within a city.

Mr. Denny: You did mention ignition noises, and I would like to get your opinion as to whether or not the problem of ignition noises is sufficiently serious so that it would be desirable, when manufacturers again resume the building of automobiles, that consideration be given to designing the ignition system to prevent those noises?

Major Armstrong: Yes, I think it would be highly desirable, and I do not think it would cost a great deal.

Mr. Adair: With respect to operation in the present band, as I understand it, you feel that band would be satisfactory for all time to come, that is, you see nothing that would make it desirable to move out of there at this time or in any reasonable predictable future?

Major Armstrong: Not at the present time, but by "all time to come," perhaps that would be a little too far for an inventor to go, and I really would like to suggest that some band in the higher frequencies be set aside for experimental work just to see what can be done.

Mr. Adair: Well, if we got settled in the present band, that band would not do us a whole lot of good if we had to move later, would it? We would be up against a worse problem than we are now.

Major Armstrong: Once upon a time, it was considered that the standard band was there for all time. So it was for 15, 20, maybe for 25 years, but I never liked to guess more than 5 years ahead. I do not see any reason for thinking that we would move to 500 megacycles in any time that I can forecast, but I just do not like to foreclose myself from the opportunity of experimenting.

Mr. Adair: As I understand it, some of the receiver designers have indicated it would be rather difficult to design a receiver beginning at 42 megacycles to extend much above 60 without materially changing their present designs, and that would rather limit your expansion in that portion of the band, would it not?

Major Armstrong: Yes. I think that is so, and I was not considering or contemplating the changing of the existing system, although it is not beyond the bounds of possibility to put a converter, crystal control, or some very high Q circuit ahead, and receive in the hundreds of megacycles, but I am not too sure.

The Chairman: That is not a very feasible operation, is it?

Major Armstrong: I think it could be done, sir, but I am not expecting that it is going to be done. I have just pointed to it as a possibility. If this part should ever, in the dim and distant future, go to 500 megacycles, I think the receivers will have

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SPOT NEWS NOTES

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

FM Network Lines: Ernest W. Baker of AT & T, addressing a joint meeting of AIEE and IRE: "The present extensive (radio) program networks are made up largely of facilities equalized to 5,000 cycles. However, if the broadcasters decide that they want circuits wider than 5,000 cycles, the Telephone Companies will be able to supply them, whether the demand be for 8,000 cycles, 10,000 cycles, 15,000 cycles, or even higher." No data was presented on increased charges.

Suspended: Eagle Radio Company, 84 Cortlandt Street, N. Y. C., has been suspended by WPB for 3 months for buying and selling radio equipment to the value of $42,208 in wilful violation of limitation Order L-265. According to R. A. McGovern, WPB regional manager, the proprietors, Victor and William Krans, diverted highly critical tubes and components to non-essential, civilian use. They accepted equipment valued at $12,210 in violation of L-265, and unlawfully sold other equipment amounting to $29,997.

Norman J. Foote: Former assistant engineer at KWNO and amateur pioneer on 110–112 mc. operating 9GQP, has been appointed Hallicrafter development engineer. He will design new UHF and VHF equipment for postwar services.

RMA Parts Show: Has been authorized by the board of directors. Contingent upon the early defeat of Germany, it is tentatively scheduled for April, 1945. No receiving sets will be shown. Last RMA Trade Show was held in 1932, when radio sales volume had hit the toboggan.

Radio Frequencies: Just in case you've forgotten the nomenclature adopted some time ago, radio frequencies are now grouped as follows:

LF — Low Frequency .03 to .3 mc.
MF — Medium Frequency .3 to 3 mc.
HF — High Frequency 3 to 30 mc.
VHF — Very High Frequency 30 to 300 mc.
UHF — Ultra High Frequency 300 to 3000 mc.
SHF — Super High Frequency 3000 to 30000 mc.

Dr. C. B. Jolliffe: Chairman of RTPB Panel 2, on frequency allocations: "We have more frequency demands than there is frequency space. It is true not only below 300 mc. but above 300 mc."

Baby R.R. FM Network: Is being installed by Westinghouse for communication between a control dispatcher's office in Pittsburgh and 5 diesel-electric locomotives operating between the Company's plants in East Pittsburgh, Trafford, and Linhart. At present, a locomotive that has completed a switching operation as much as 5 miles away must return to the dispatcher's office for new instructions. With the new FM system, orders can be requested and given immediately to any locomotive at any point on the 25 miles of Company-owned track. FCC and WPB authorization have been issued for this project. Locomotive engineers are now taking radio instruction preparatory for Class 3 operator's tests.

MEDAL FOR DONALD H. MITCHELL

Donald H. Mitchell: Chief engineer of Galvin Manufacturing Company, has been awarded the Chicago Tribune War Workers Medal, in recognition of his contribution to the war effort by developing, in conjunction with Signal Corps engineers, the famous handie-talkie. In the photograph above, left to right, are: Donald Mitchell, Walter Stellner, Col. Leland Stanford, Col. Schaal, and Jack Davis, assistant chief engineer.

High Postwar Prices: Announcements of television receivers at $125 to $200, presumably equivalent to models which cost $500 in 1939, are leading the public to expect commensurate reductions on FM-AM broadcast receivers. This, coupled with published prophesies that the first broadcast sets will be revived 1941 models, may well result in the "I guess I'll wait awhile" attitude when the first new receivers are offered at prices as high or higher than prewar levels.

Dr. A. M. Skellatt: Formerly of Bell Telephone Laboratories has joined National Union Radio Corporation as chief engineer in charge of research. He will be at the Newark plant. Before going to Bell Labs, he was assistant professor of physics at the University of Florida, and chief engineer of WRUF.

Ray Ellis: Who has served as Director of WPB Radio and Radar Division since it was formed on July 1, 1941, has resigned and returned to General Motors. At the New York office, Broadway and 57th Street, he will take up new duties connected with GM problems of reconversion and public relations. He will be succeeded at WPB by Louis J. Chatten, former eastern sales and service manager for Bendix Home Appliances, Inc.

William B. Lewis: Executive vice president and general Manager of the recently dissolved American Network, Inc. has become vice president of Kenyon & Eckart and radio director of activities in the company's New York, Chicago, and Hollywood offices. He succeeds Dwight Mills.

147 FMBI Members: Six more FM station applicants have been admitted to FM Broadcasters, Inc. They are:

- Green Bay Newspaper Co., Green Bay, Wis.
- James Broadcasting Co., Inc., Jamestown, N. Y.
- Record Herald Co., Wausau, Wis.
- Star-Times Publishing Co., St. Louis, Mo.
- Toledo Blade Co., Toledo, Ohio
- WIBM, Inc., Jackson, Mich.

WEAF-FM: Now on the air as a commercial station with a 7-day schedule, 3:00 P.M. to 11 P.M. New call supercedes original W2XWG. Time on WEAF-FM is given as a bonus to sponsors whose programs are carried on WEAF during FM operating hours.

FM in Canada: Over 60 applications for FM broadcast stations have been filed in Canada according to Dr. Augustin Frigon, general manager of the Canadian Broadcasting Corporation. First FM stations will go on the air at Toronto and Montreal, and a number of receivers will be distributed among those chosen as qualified to pass judgment on the new transmission. Demonstrations of reception will be given by radio and department stores, although sets will not be sold until sometime after 1945. Standards of transmission will be the same as in the U.S.A.

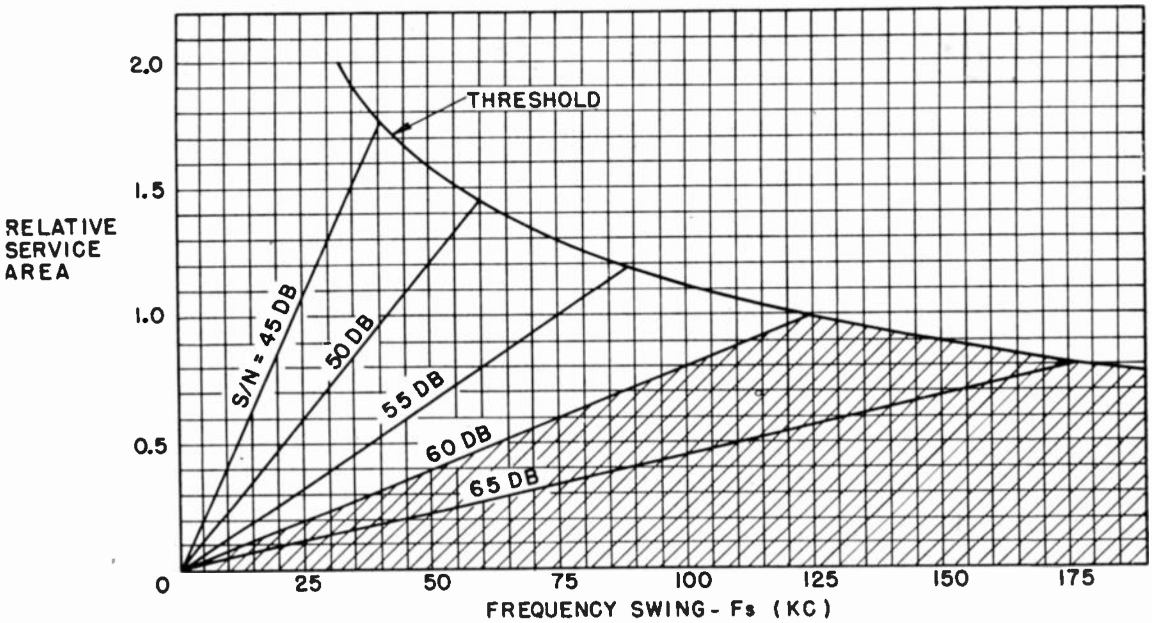

FIG. 2 THE SHADED AREA SHOWS REGION OF NOISE-FREE RECEPTION, WHERE SIGNAL-TO-NOISE RATIO IS 60 DB OR BETTER. INVERSE-SQUARE-LAW PROPAGATION IS ASSUMED.

dom nature, which is true of fluctuation noise and is approximately the condition in the case of impulse noises of the type usually encountered in practice, the peak noise voltage in the receiver will be proportional to the square root of the receiver band width.

An amplitude modulation receiver does not have a definite threshold point, but gives unity audio peak signal-to-noise-ratio when the radio frequency peak signal is equal to the peak noise. Since the peak RF signal for 100% amplitude modulation is twice the carrier signal level, and the receiver band width required is twice the highest modulating frequency, we can express the carrier signal level at which unity signal-to-noise ratio occurs as

$$E_1 = K/2\sqrt{F_a} \qquad (3)$$

where E_1 = AM carrier input voltage for $S/N = 1$, and K is a constant.

Similarly the threshold signal for an FM receiver is

$$E_t = 2K\sqrt{F_s} \qquad (4)$$

where E_t = FM threshold voltage and

$$E_t/E_1 = 4\sqrt{F_s/F_a} \qquad (5)$$

From equations 1, 2, and 5, together with the factor of 13 or 14 db for pre-emphasis, we can calculate the curves shown in Fig. 1, which are peak signal-to-noise ratios obtained at the receiver output as a function of the ratio of receiver signal input required to an amplitude modulation receiver to produce unity signal-to-noise ratio. This ratio is used merely to provide a measure of signal levels which is independent of actual radio frequency noise levels, antenna gain, etc.

To determine what frequency swing should be used, it is necessary first to decide what signal-to-noise is acceptable. The Federal Communications Commission at present requires FM broadcast stations to maintain an over-all transmitter system noise level 60 db below full modulation, on the basis that such a noise level is low enough to provide true high-fidelity reproduction of the majority of programs. This figure is not extreme as the dynamic range of a symphony orchestra may be as great as 70 db, the extreme range of speech 60 db, and the range from the average residence background noise level to the volume of painful hearing [3] is as much as 90 db. Then in order to prevent noise at the receiver from degrading the system signal-to-noise ratio, we should maintain a signal-to-noise ratio in excess of 60 db.

An examination of Fig. 1 shows that a signal-to-noise ratio of 60 db can be obtained by the use of any of the frequency swings, but will be obtained with the minimum signal strength when a swing of about 125 kc. is used. This means that if we want to cover the maximum service area with a quality of received signal essentially as good as that provided by the transmitter system, it will be necessary to use a frequency swing of 125 kc, and a channel width in the order of 300 kc.

If a smaller frequency swing is used, the same signal-to-noise ratio will be obtained only with greater signal strengths. For example, if the swing is reduced from 150 kc. to 75 kc., twice the signal strength is required to produce the same signal-to-noise ratio as is obtained at a given distance for the 150 kc. swing. If the signal strength is not changed, and the swing is reduced from 150 kc. to 75 kc., the area receiving the same signal-to-noise ratio as for 150 kc. will be reduced by one-half. This assumes inverse square law propagation which is applicable to the first horizon.

On the other hand, if we are willing to accept a somewhat degraded service, with a signal-to-noise ratio 10 db poorer than we had with 150 kc. swing, the service area is actually increased about 50 percent, but only one-third of this area will receive service of the same quality as was obtained with 150 kc. swing. Of course still smaller swings would provide even greater service area with further degradation of the signal-to-noise ratio, but carrying this process too far results in entirely unsatisfactory service. For instance, if only 40 kc. swing is used, the signal-to-noise ratio at the edge of the service area becomes about 45 db, which is no better than is obtained in the standard broadcast band and would therefore almost completely nullify the primary function of FM, which is the elimination of noise in radio reception.

These conclusions are shown in graphical form in Fig. 2, which is a plot of relative service area as a function of frequency swing, with signal-to-noise ratio as a parameter. It shows clearly that if we wish to maintain a signal-to-noise ratio of 60 db, we can serve the maximum area by employing a swing of 125 kc. If we are

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[3] Pender-McIlwain, *Electrical Engineers' Handbook*, Section 9.

SOUND CONDITIONING FOR POSTWAR HOMES

Review of Techniques Which Will Enhance High-Fidelity Effects of FM Reception

THIS article, prepared by the staff of Architectural Forum, September, 1944, reviews the application of sound conditioning to new and remodeled homes, with particular reference to enhancing the quality of FM reception. As the authors point out, "a $500 radio in a small, acoustically bad room is not heard to best advantage. But if the room is acoustically planned for its use, the room seems bigger, the tone much richer."

Another problem discussed is that which arises when "Mother plans to listen to a symphony concert on the radio, Father wants to go over some reports, and Junior has homework to do."

Consulting engineers who associate themselves with leading dealers and architects in their communities will find many problems of home sound conditioning presented for solution as radio listeners learn how their enjoyment of FM reception can be augmented by simple acoustic treatment of walls and ceilings.

WITH present advances in the science of acoustics, sound conditioning should at last get its share of attention in the planning of modern homes. Segregation of sound to provide quiet areas in different parts of the house, reduction of clatter within a room, and acoustical treatment for accurate sound reception would add much to family comfort and should be considered while design of a house is in progress.

Progress of Sound Conditioning ★ Sound conditioning has already been applied with brilliant success to nonresidential interiors such as theaters, broadcasting studios, restaurants and hospitals — wherever noise reduction is a problem of prime importance. Sound control has become so accurate that acoustical engineers now can produce any desired auditory effect. The first attempts toward acoustical improvement by haphazard use of sound-absorptive materials have given way to architectural understanding of the problem, with quality and liveness of tone the paramount objective.

This may be observed in broadcasting studios which have gradually developed from conventional rectangular rooms equipped with sound-absorbent material on the ceiling alone. Today studio walls are tilted, never parallel, and broken surfaces jut into the room. Acoustical material is used sparingly on certain walls while others are paneled with plywood to reflect sound and afford resonance.

Sound-absorbing materials have also been used effectively in commercial spaces where the noise of typewriting or telephoning formerly reduced efficiency of workers. Under the pressure of war, factories, too, have found that sound conditioning boosts production and cuts down absenteeism.

Application to Private Homes ★ Because of this increase in the use of sound control, a great variety of good-looking and inexpensive acoustical materials are now on the market. They are the opening wedge for further expansion of sound conditioning. Although non-residential applications have been phenomenally successful, few people have ever thought of using acoustical tile, plaster, metal panels or wallboard in the home. Here noise is often only a minor annoyance, but it can have a direct effect on the nervous system, and it is always the unwanted noise which we hear. In the future, this situation will undoubtedly become more acute, because of the increased use of open plans, and the trend toward bare furnishings and no rugs which create sound problems in modern homes. A definite plan to control noise can contribute much toward increased comfort and livability in postwar construction and remodeling of the family dwelling. It should be possible, for instance, to provide quiet areas in the home which will be unaffected by noise in other portions of the house. With proper planning and the wise use of sound-absorbent materials, this may even be accomplished in different parts of the same room. Better acoustical conditions could also provide greatly improved radio reception, whether for an inexpensive $50 set or for a sensitive $500 machine.

However, since home use of acoustical materials is still mainly in the idea stage, it is not yet certain what home-owners will want to accomplish with sound control. A sparing and experimental use of the materials will constitute no great loss even if results are not completely successful, for acoustical wall finishes cost only a little more than ordinary ones. A knowledge of the principles of sound transmission will eliminate much of the guessing in these

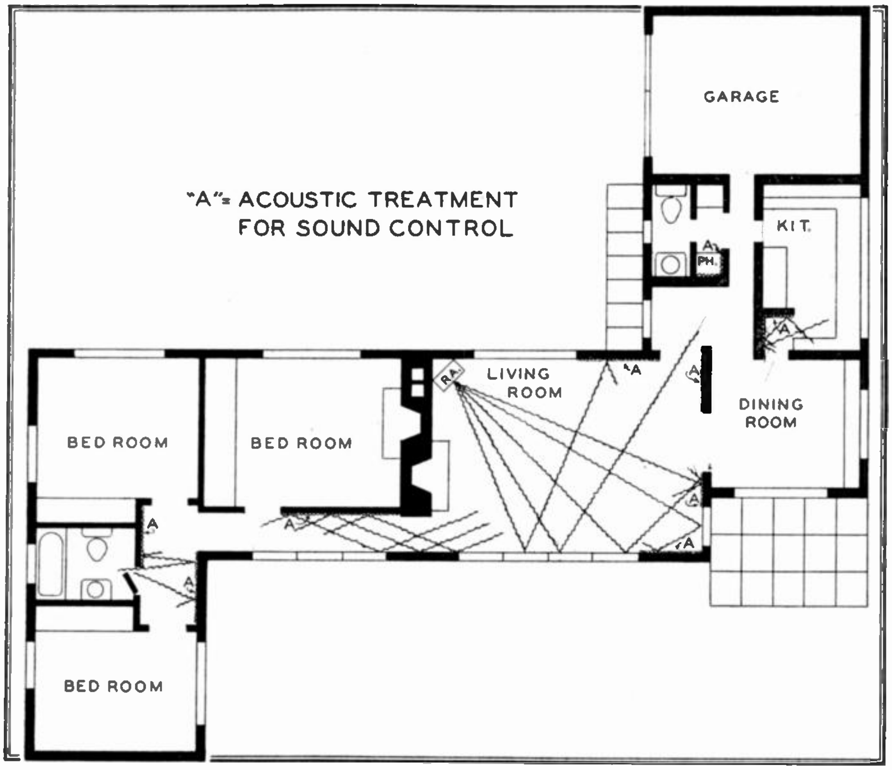


FIG. 1. VARIOUS SOUND-ABSORBING METHODS ARE ILLUSTRATED HERE

experiments. To better understand how acoustics work, therefore, a brief explanation is necessary.

Insulation & Absorption ★ There has always been a certain amount of confusion in this field because of the failure to distinguish clearly between sound insulation and sound absorption. The first deals with transmission of both airborne and impact noises from one space to another. Sound absorption on the other hand is concerned with reducing the general noise level within a space, and with providing more nearly ideal acoustical conditions. This type of sound control deals solely with airborne sound waves which, besides traveling through the air, bounce from any reflective surface.

Without realizing it, everyone knows that talking to a person outdoors and indoors are acoustically two different situations. Outdoors it is necessary to speak *at* a person, perhaps to turn your head towards him because the sound waves, unlimited, go off in all directions. Indoors, where sound is trapped and reflected, you instinctively know the sound will reach a person even if your face is turned away while speaking. When sound-absorbent material is used on a ceiling the acoustical result is almost as though the ceiling had been removed. If this sort of material is also used on walls, it might absorb too much sound, giving the uncomfortable, because unaccustomed, sensation that you are out of doors.

Too great reflection of sound waves, however, produces a booming effect during conversation. This is easily seen in the contrast between a furnished room and an unfurnished one. In an empty apartment, sound reverberates because the waves bounce back and forth reflected by the bare walls, ceiling and floor. Upholstered furniture and rugs act as sound absorbers and produce the tones we are accustomed to hear.

In sound insulation, which combats the transmission of noise from space to space, it must be remembered that airborne sounds can enter through windows, cracks under doors, flaws in masonry or plastering, cracks around ventilating ducts, even pipes and conduits. Careful workmanship, the elimination of cracks, and use of acoustical duct filters will help this situation.

In addition, airborne sounds may be transmitted directly through a building structure which acts as a diaphragm set in motion by the sound waves. This motion is translated back into sound on the other side of the structure. It can be most effectively reduced by heavy construction such as 4-in. to 6-in. masonry walls, nonhomogenous walls, and by walls or ceiling of two or more layers with a sound-absorbing filler like mineral wool. According to tests conducted by the Bureau of Standards, a wall constructed of ½-in. insulating board and plaster on each side of 2- by 4-in. studs reduces noise better than walls made with either gypsum or wood lath as the plaster base. However, a heavy masonry wall is still better and is less expensive than double construction floating floors and ceilings and similar devices.

Impact noises, a completely different type of sound transmission, must also be considered if sound insulation is to be effective. They are caused by structural vibrations from one portion of a building to another. Walking, moving furniture, rattling of water pipes are all examples of impact sounds. They can be effectively reduced at the source by covering the floor with rugs or resilient floor tile, and by proper mounting of pipes and conduits.

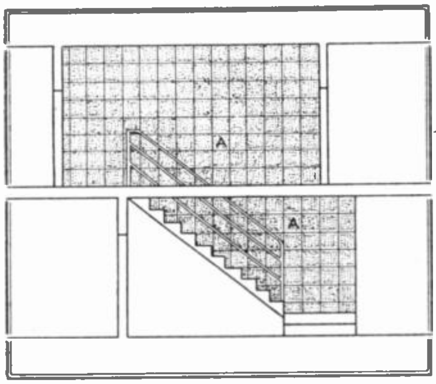


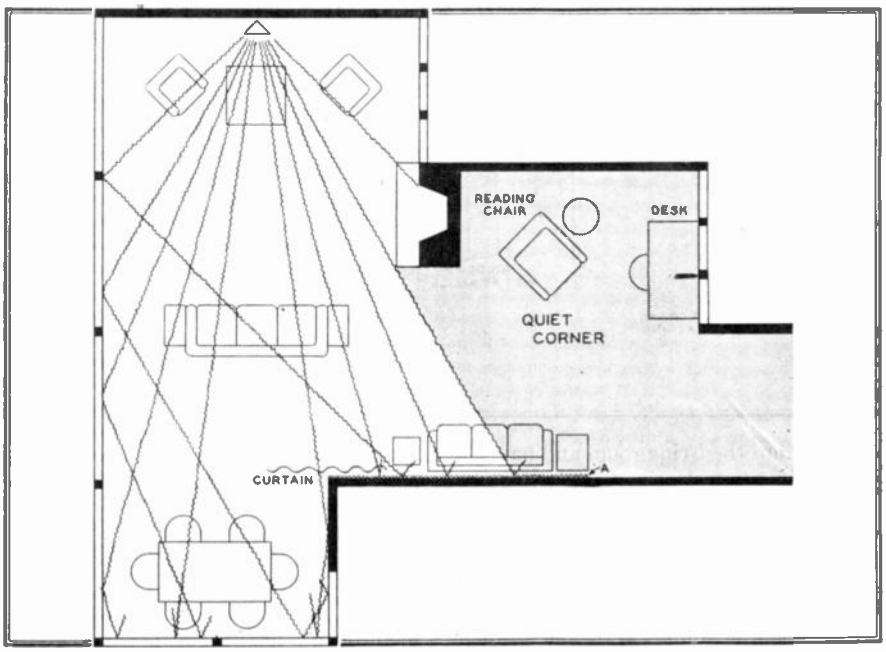
FIG. 2. TREATMENT OF STAIR WALLS

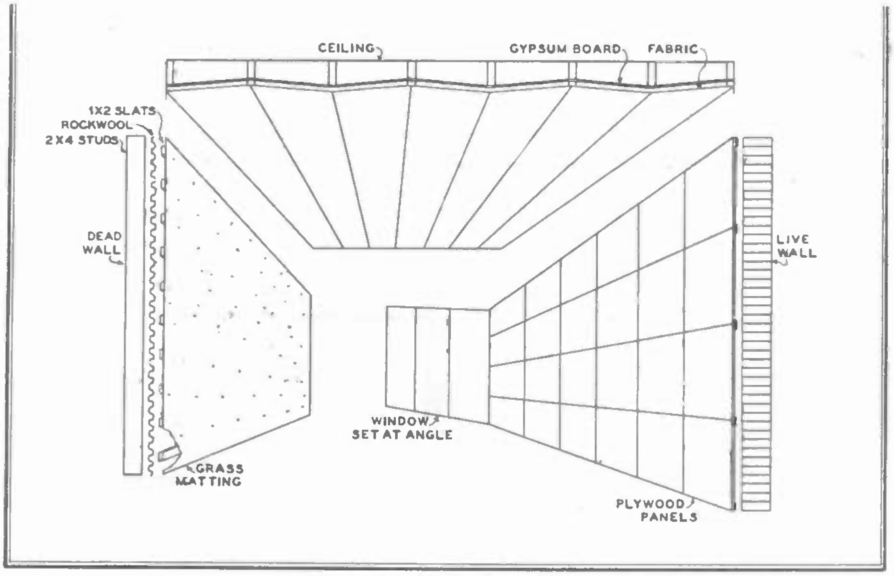
Sound-absorptive material, used mainly to reduce noise within a space, can be applied to the problem of sound transmission in certain cases. A hallway down which sound travels from a living room to a bedroom may be treated in this way. Absorptive materials may also be used to reduce noise transmission from one part of an irregularly-shaped room to another.

Objectives of Sound Conditioning ★ With the distinction clearly made between sound insulation and sound absorption, acoustical treatment of a house boils down to three objectives: preventing the passage of sound from one room to another, absorption of noise at the source, and sound control within rooms. To accomplish these ends, elaborate and expensive devices are unnecessary. Careful thought and the use of certain new design ideas make sound conditioning a relatively simple matter. Houses can be planned to maintain areas of complete quiet, or to accomplish at least a great reduction in sounds which travel from a noisy part of the house to quiet parts. For instance, houses may be planned and built in such a way that children will be able to sleep in the bedroom portion while their parents play the radio or have a party in another part of the house. This is illustrated in Fig. 1.

In a one-story home, this can be accomplished by planning for sound control at the design stage. A bank of fireplaces and chimney flues installed between living room and bedrooms, Fig. 1, makes an excellent sound barrier for this purpose. If the fireplace is not wanted, a masonry wall can be used, finished in the ordinary way or left unfinished as a functional decoration suitable for both modern and traditional homes. Another excellent barrier device is a double row of closets, one row

FIG. 3. WALL MARKED "A" ABSORBS SOUND TO PRODUCE QUIET CORNER





FIGS. 4 AND 5. ARRANGEMENT AND ACOUSTIC CONSTRUCTION IN THE HOME OF SHERMAN FAIRCHILD

opening into the living room and hall, the other into the bedroom. Closets are particularly effective, since clothes are exceptional sound absorbers. If, in addition to the creation of an effective sound barrier, the hall connecting living room and bedrooms is treated with acoustical material, airborne sounds traveling through the corridor will be absorbed and considerable noise control achieved even when doors are left open.

In a two-story house this separation is more difficult because ordinary floor and ceiling construction does not constitute a good sound barrier. Nevertheless, treatment of the side wall of the stairway with sound-absorbent material as shown in Fig. 2, would partially isolate living and sleeping quarters. Living room noises and the sound of the radio would be prevented from going up, and upstairs noise, such as bathroom sounds, could not come down. Actually the noise would not be eliminated, but the substantial reduction in sound flow resulting from this treatment would probably make it worth while.

Similar to the bathroom problem is sound control within a kitchen. Both these rooms are particularly subject to reverberation because, unlike other parts of the house, they do not have sound-absorbent furnishings. Tile, metal, and plaster, the materials most commonly used, are brilliant sound reflectors. The clatter of dishes is therefore intensified and easily penetrates into the dining room as an unpleasant background to dinner. Harsh noises are also an annoyance to the housewife who spends much of her time in the kitchen.

Again the basic treatment should be the absorbing of sound at the source. An acoustical ceiling and resilient floor-covering deaden the noise, but additional reduction can be accomplished by the use of wooden or linoleum work surfaces instead of enameled metal drainboards and tables.

To prevent the transmission of sound from kitchen to dining room, a pantry or utility space between the two rooms can be used as a barrier. This still leaves the problem of noise entering through the door. If the door is placed next to the pantry, and the small section of wall leading into the dining room treated with sound-absorbent material, as indicated in Fig. 1, this problem should be considerably reduced. Sound waves must be reflected from that particular section of wall to go around such a barrier, and when they hit the acoustical material they are in the main absorbed.

Zones of Quiet ★ Conflicting activities in the same room or same part of the house is another problem which can be solved by a moderate use of acoustical material and wit. One of the most annoying sidelights to family living is the problem of using the telephone when everyone else is around. For convenience, the phone is usually located in a central spot. It can be answered quickly, but a conversation cannot be carried on unless other members of the family stop talking and the radio is turned down. Borrowing a trick from the open-front telephone booths in New York's newest subway will help solve the problem. Here acoustical tile lines the three sides of open-front booths, allowing conversation even during the rumble and crash of a passing subway. In the home, a small recess could be built into the wall and lined with a few acoustical tiles. This is also illustrated in Fig. 1. Such a device is needed anyway as a planned location for the telephone and although it might not be 100 per cent effective in isolating sound, it would be a vast improvement over the common variety of telephone table.

Another tricky problem in acoustics is presented by a family whose members all want to use the living room at once. Mother plans to listen to a symphony concert on the radio, Father wants to go over some reports and Junior has homework to do. An acoustically planned L-shaped room, Fig. 3, allows all these things to be done with a minimum of fuss. Mother sits beside the radio which is placed at the top of the "L". Sound waves traveling the length of the room would ordinarily bounce off the wall and into the alcove where father and son are seated. Acoustical material on the end wall, however, would absorb much of this sound, leaving the alcove relatively quiet while the radio plays. If the sound reduction from this treatment is not sufficient, extended bookcases can act as additional baffles.

Improving Radio Quality ★ Quite apart from segregation of sound in the living room is the problem of improving its acoustical quality for better radio reception. Since most living rooms are small, they never capture the true quality of a large orchestra which should be heard in a concert hall to be appreciated. A $500 radio in a small, acoustically bad room is not heard to best advantage. But if the room is acoustically planned for its use, the room seems bigger, the tone much richer.

This device was used to advantage in Sherman Fairchild's Manhattan town house.* Fig. 4 shows a view of the living room, while the acoustic treatment is diagrammed in Fig. 5. The long, low radio cabinet can be seen in Fig. 4, with a detailed sketch in Fig. 6. The loudspeaker is at the opposite end of the room in Fig. 4, and therefore does not appear in this view. Realizing that good radio sounds only as good as the room it is in, Mr. Fairchild demanded an acoustically perfect interior for his specially-built set. In addition to the radio, he had two grand pianos. To obtain the best possible tone from his instruments, the living room was treated to sound like a huge symphony hall. The ceiling was made of wood frames, some areas filled with broken pieces of wallboard, others with rock wool to produce irregular reflections of sound. A second cloth ceiling was stretched over this. Rock wool padded one wall behind a grass matting and the opposite wall was made of plywood. Glazed panels, one of which is set at an angle, formed the other two walls. The construction is shown in Fig. 5. The result in faithful reproduction of sound was extraordinary, and it seems plausible that this technique in varied form could be applied to many situations, although perhaps not in so elaborate a form.

*For detailed description see *Architectural Forum*, April, 1943.

This sort of construction will undoubtedly become more important as the demand for better home acoustics increases. Trends in modern architecture — the openness of design, lavish use of glass, bareness of furnishings and lack of rugs — will also tend to increase demand for acoustical planning where before one could take it or leave it alone. Modern houses will also present a sound transmission problem with their use of lighter materials in place of regular plaster partitions. On the other hand they will offer heretofore unknown acoustic opportunities because sound problems can be solved by the design itself. Walls need not be parallel, glazed panels may be tilted and acoustic materials placed to best advantage. With the development and perfection of such design, sound conditioning can be aimed not only towards remedying the faults of present construction, but towards creating new acoustical opportunities for future homeowners.

The consideration of acoustic treatment for modern homes is particularly appropriate at a time when broadcast engineers who would like to reduce the 15,000-cycle standard of FM fidelity complain that the acoustics in most homes are such that the high-frequency overtones are lost. It may very well be that sound-treatment of postwar homes will be featured along with quick-freeze units and air-conditioning. There is no reason why, with intelligent planning, modern living rooms cannot have the acoustic characteristics of small concert halls.

Since FM standards set now will prevail for years to come, it would be far better to set them high, even though they cannot be utilized to the fullest extent at this time. Eventually, if 15,000-cycle quality is available, progress in materials and home construction will afford its advantages to radio listeners.

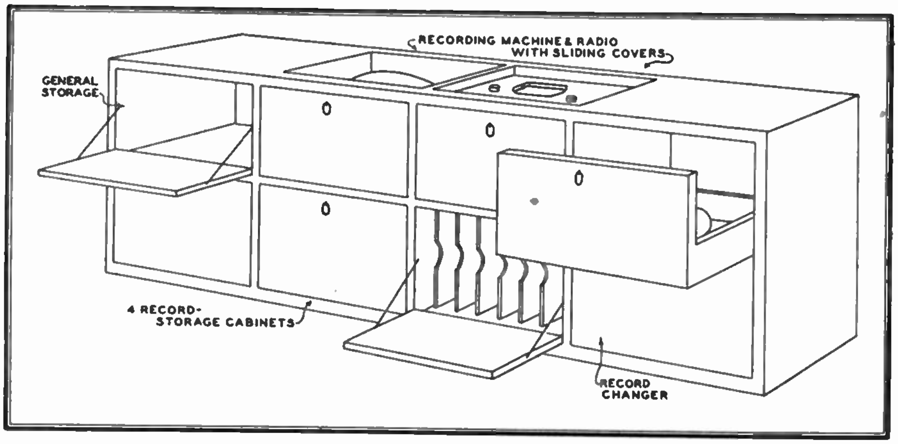


FIG. 6. DETAILS OF THE RADIO, PHONOGRAPH, RECORDER, AND RECORD CABINET SHOWN IN FIG. 4. LOUDSPEAKER IS MOUNTED SEPARATELY

328 FM STATIONS NOW OPERATING OR PROJECTED

With 42 More Applications, 190 Cities in 39 States Are Now Represented Up to October 6, 1944

ALABAMA

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

CALIFORNIA

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

COLORADO

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

CONNECTICUT

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

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

DELAWARE

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

DISTRICT OF COLUMBIA

	Call	Sq. Mi.	Mc.
Washington			
Jansky & Bailey (Exp)	W3XO	1 kw	43.2
N B C Inc (WRC)		.....	44.3
Times Herald		.....	46.3
Capital Bcstg Co (WWDC)		8,020	46.7
Eve Star Bcstg Co (WMAL)		5,600	47.1

FLORIDA

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

GEORGIA

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

ILLINOIS

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

INDIANA

	Call	Sq. Mi.	Mc.
Bloomington			
Indiana Univ (Ed)		.....	42.9
Evansville			
Evansville on the Air[1]	WMLL	.....	44.5
Fort Wayne			
Westinghouse Radio Stations Inc	WOWO-FM	.....	44.9
Farnsworth Tele & Radio Corp		8,500	46.1
Hammond			
WJOB Radio Station (WJOB)		2,241	49.9
Indianapolis			
Indianapolis Bcstg Inc (WIRE)		13,640	45.3
Assoc Broadcasters Inc		.....	47.3
WFBM Inc (WFBM)		15,430	47.7
Capitol Bcstg Corp (WISH)		14,120	48.7
Muncie			
Donald A Burton (WLBC)		9,600	46.5
Shelbyville			
Shelbyville Radio Inc		3,730	46.1
South Bend			
South Bend Tribune	WSBF	.....	47.1
Terre Haute			
Banks of Wabash Inc		7,440	48.7
West Lafayette			
Purdue University (Ed)		.....	42.7

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

IOWA

	Call	Sq. Mi.	Mc.
Cedar Rapids			
Gazette Co		7,400	44.7
Davenport			
Tri-City Bcstg Co		7,400	46.3
Des Moines			
Central Bcstg Co (WHO)		18,200	46.1
Dubuque			
Telegraph Herald (KDTH)		8,060	46.5
Waterloo			
Josh Higgins Bcstg Co (KXEL)		26,943	44.3

KANSAS

	Call	Sq. Mi.	Mc.
Lawrence			
Univ of Kansas (Ed)		1 kw	42.9

KENTUCKY

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

LOUISIANA

	Call	Sq. Mi.	Mc.
Baton Rouge			
Baton Rouge Bcstg Co	WBRL	.....	4.5
New Orleans			
Loyola Univ (WWL)		8,478	44.9
Times Picayune Pub Co		14,000	45.7

MAINE

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

MARYLAND

	Call	Sq. Mi.	Mc.
Baltimore			
Hearst Radio Inc		8,857	43.7
Md Bcstg Corp (WITH)		28,898	44.1
Balt Radio Show Inc (WFBR)		5,500	45.9
Monumental Radio Co (WCAO)		4,520	47.9
Baltimore Bcstg Corp		3,600	48.3
Olney			
FM Devel Foundation		18,844	43.9
Salisbury			
Peninsula Bcstg Co (WBOC)		6,000	48.9

MASSACHUSETTS

	Call	Sq. Mi.	Mc.
Boston			
Filene's Television Inc		21,709	43.1
E Anthony & Sons Inc		19,650	43.3
C B S Inc (WEEI)		20,200	43.5
Yankee Network	WGTR	.....	44.3
Worcester Tele Pub Co		7,000	45.3
Westinghouse Radio Stations Inc (WBZ)	WBZ-FM	.....	46.7
Fidelity Bcstg Corp		3,600	47.1
Matheson Radio Co Inc (WHDH)		3,600	47.7
Fall River			
Doughty & Welch Elec Co		2,120	47.3
Holyoke			
Hampden-Hampshire Corp (WHYN)		14,340	44.1
Lawrence			
Hildreth & Rogers Co (WLAW)		2,970	44.9
New Bedford			
E Anthony & Sons Inc (WNBH)		1,787	45.7
Pittsfield			
Monroe B England (WBRK)		950	45.7
Springfield			
Westinghouse Radio Stations Inc (WBZA)	WBZA-FM	.....	48.1
Worcester			
Worcester Tele Pub Co (WTAG)	WTAG-FM	.....	46.1[1]

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

MICHIGAN

	Call	Sq. Mi.	Mc.
Battle Creek			
Federated Pubs Inc (WELL)		4,100	48.1
Bay City			
Bay City School District		.....	....
Bay Bcstg Co Inc		8,157	46.1
Benton Harbor			
Palladium Pub Co		1,825	46.1
Dearborn			
Herman Radner (WIBM)		.....	49.5
Detroit			
Board of Education (Ed)		1 kw	42.7
Evening News Assn (WWJ)	WENA	.....	44.5
John Lord Booth (WMBC)	WLOU	.....	44.9

	Call	Sq. Mi.	Mc.
WJR Goodwill Station (WJR)		6,800	45.3
James F Hopkins Inc (WJBK)		6,790	46.5
King-Trendle Bcstg Corp.		6,750	47.3
Grand Rapids			
Fetzer Bcstg Co		18,250	43.9
Leonard A Versluis		6,460	46.1
King-Trendel Bcstg Corp.		5,300	46.9
Houghton			
Mich Col of Mining & Tech		.....	42.1
Jackson			
Board of Education (Ed)		.....	....
WIBM Inc (WIBM)		.....	49.5
Kalamazoo			
West Mich Col of Ed (Ed)		.....	42.5
Lansing			
WJIM Inc (WJIM)		3,800	47.7
Mt. Pleasant			
Board of Education (Ed)		.....	....
Muskegon			
Ashbacker Radio Corp (WKBZ)		2,290	45.7
Port Huron			
Times, Herald Co		5,600	47.7
Saginaw			
Saginaw Bcstg Co (WSAM)		2,100	45.5

MINNESOTA

	Call	Sq. Mi.	Mc.
Minneapolis			
Minnesota Bcstg Corp		16,155	45.3
St. Paul			
WMIN Bcstg Co		13,273	45.7

MISSOURI

	Call	Sq. Mi.	Mc.
Clayton			
School District (Ed)		1 kw	....
Kansas City			
School District (Ed)		1 kw	42.5
Commercial Radio Equip Co	KOZY	.....	44.9
Midland Bcstg Co (KMBC)	KMBC-FM	6,700	46.5
WBH Bcstg Co (WBH)		9,200	46.9
St. Joseph			
KFEQ Inc (KFEQ)		.....	46.9
St. Louis			
Star-Times Pub Co (KXOX)		13,083	44.7
St Louis Univ (WEW)		13,000	45.1
Missouri Bcstg Corp		13,200	45.1
Pulitzer Pub Co (KSD)		13,391	45.5
C B S Inc		13,400	45.9
Globe-Democrat Pub Co		13,083	46.3

NEBRASKA

	Call	Sq. Mi.	Mc.
Omaha			
World Pub Co (KOWH)		11,660	45.5

NEVADA

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

NEW HAMPSHIRE

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

NEW JERSEY

	Call	Sq. Mi.	Mc.
Brunswick			
Home News Pub Co		3,420	49.9
Jersey City			
Bremer Bcstg Co		.....	49.5
Newark			
Board of Ed (Ed)		.....	42.5
N J Bcstg Corp (WHOM)		6,200	49.1
Paterson			
N Jersey Bcstg Co Inc		4,928	49.9
Trenton			
Mercer Bcstg Co		3,200	49.9

NEW YORK

	Call	Sq. Mi.	Mc.
Albany			
WOKO Inc (WOKO)		7,164	45.1
Binghamton			
Wylie B Jones Advt Agency (WNBF)	WNBF-FM	.....	44.9
Brooklyn			
Frequency Bcstg Corp		14,400	43.7
Buffalo			
Board of Education (Ed)		.....	42.9
WBEN Inc (WBEN)		21,830	43.3
WEBR Inc (WEBR)		3,420	46.5
Corning			
Evening Leader		5,213	49.7
Floral Park			
Sewanhaka High School (Ed)		.....	....
Ithaca			
Cornell University (WHCU)		15,000	43.3
Jamestown			
James Bcstg Co		.....	46.1
New York			
Board of Education (Ed)	WNYE	.....	42.1
Edwin H Armstrong (Exp)	W2XMN	.....	43.1
Municipal Bcstg Sys (WNYC)	WNYC-FM	.....	43.9
Muzak Corp	WGYN	.....	44.7
NBC Inc (WEAF)		.....	45.1
WGH Finch		.....	45.1
Marcus Loew Bkg Agency (WHN)	WHNF	.....	46.3
C B S Inc (WABC)	WABC-FM	.....	46.7
Bamberger Bcstg Svc (WOR)	WBAM	.....	47.1
Metro Television Inc	WABF	.....	47.5
Blue Network Inc (WJZ)		8,950	47.9
News Syndicate Co Inc		8,500	47.9
WBNX Bcstg Co Inc (WBNX)		8,730	48.3
WMCA Inc (WMCA)		8,550	48.3
Hearst Radio Inc (WINS)		8,570	48.7
Debs Mem Radio Fund Inc		8,600	48.7
Greater N Y Bcstg Corp		8,500	48.7
Ogdensburg			
St Lawrence Bcstg Corp		.....	....
Poughkeepsie			
P'kpsie Newspapers Inc		10,198	44.3
Rochester			
WHEC Inc (WHEC)	WHEF	.....	44.7
Stromberg-Carlson Tel Co (WHAM)	WHFM	.....	45.1
Schenectady			
Capitol Bcstg Co	WBCA	.....	44.7
General Electric Co	WGFM	.....	48.5
Syracuse			
WAGE, Inc (WAGE)		7,780	45.5
Onondaga Radio Bcstg Corp		6,745	45.9
Central N Y Bcstg Corp (WSYR)		6,800	46.3
Utica			
WIBX Inc		10,290	45.7
Watertown			
Brockway Co (WWNY)		4,145	47.3
White Plains			
Westchester Bcstg Corp (WFAS)		435	49.9

NORTH CAROLINA

	Call	Sq. Mi.	Mc.
Durham			
Durham Radio Corp (WDNC)		.....	....
Greensboro			
N C Bcstg Co Inc		13,200	43.9
Raleigh			
WPTF Radio Co (WPTF)		23,343	43.3
Roanoke Rapids			
Telecast Inc		5,198	49.1
Winston-Salem			
Gordon Gray	WMIT	.....	44.1
Piedmont Pub Co (WSJS)		4,600	46.7
Wm Henry Alford		.....	....

NORTH DAKOTA

	Call	Sq. Mi.	Mc.
Grand Forks			
University of N D (Ed)		.....	....

OHIO

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

OKLAHOMA

	Call	Sq. Mi.	Mc.
Oklahoma City			
Plaza Court Bcstg Co (KOCY)		15,394	....
WKY Radiophone Co (WKY)		21,000	44.5
Tulsa			
Fred Jones Bcstg Co		22,000	45.3
World Pub Co, Tulsa Tribune Co		23,850	45.7

OREGON

	Call	Sq. Mi.	Mc.
Portland			
Oregonian Pub Co		13,382	46.1
Bcstrs Oregon Ltd		5,826	48.5

PENNSYLVANIA

	Call	Sq. Mi.	Mc.
Bethlehem			
Associated Bcstrs Inc (WEST)		2,800	48.5
Easton			
Associated Bcstrs Inc		2,800	48.5
Harrisburg			
Keystone Bcstg Corp (WKBO)		4,000	44.7
Johnstown			
WJAC Inc (WJAC)		21,792	45.1
Lancaster			
WGAL Inc (WGAL)		1,200	45.5
Philadelphia			
Penn Bcstg Co (WIP)	WIP-FM	.....	44.9
WFIL Bcstg Co (WFIL)	WFIL-FM	.....	45.3
Westinghouse Radio Stations Inc (KYW)	KYW-FM	.....	45.7
Gibraltar Svc Corp		9,318	46.1
WCAU Bcstg Co (WCAU)	WCAU-FM	.....	46.9
Wm Penn Bcstg Co (WPEN)	WPEN-FM	....	47.3
WDAS Bcstg Station Inc (WDAS)		9,300	47.7
Triangle Pubs (Phila-Inquirer)		12,850	48.1
Pittsburgh			
Liberty Bcstg Co		.....	....
Walker-Downing Corp (WWSW)	WTNT	.....	44.7
WCAE Inc (WCAE)		8,650	45.5
Pitts Radio Sup House (WJAS)		8,400	46.5
Westinghouse Radio Stations Inc (KDKA)	KDKA-FM	.....	47.5
Reading			
Hawley Bcstg Co		4,275	46.5
Scranton			
Scranton Bcstrs Inc		19,557	48.1
Sharon			
Sharon Herald Bcstg Co (WPIC)		11,030	45.9
Uniontown			
Fayette Bcstg Corp		10,240	48.1
Westchester			
State Teachers Col (Ed)		.....	....
Wilkes-Barre			
Louis G Baltimore (WBRE)		.....	....
Williamsport			
WRAK Inc		11,675	47.7
York			
Susquehanna Bcstg Co (WSBA)		3,060	44.5
York Bcstg Co (WORK)		1,550	45.1

RHODE ISLAND

	Call	Sq. Mi.	Mc.
Pawtucket			
Pawtucket Bcstg Co		3,760	45.1
Providence			
A A Schechter		3,950	45.1
Providence Journal Co		7,780	46.9
Cherry & Webb Bcstg Co (WPRO)		6,207	47.5
Outlet Co (WJAR)		6,412	48.5

SOUTH CAROLINA

	Call	Sq. Mi.	Mc.
Charleston			
Atlantic Coast Bcstg Co		6,400	47.7
Greenville			
Greenville News-Piedmont Co		23,678	44.1
Greenwood			
Grenco Inc		5,305	44.7
Spartanburg			
Spartanburg Adv Co (WSPA)		26,600	43.5

TENNESSEE

	Call	Sq. Mi.	Mc.
Jackson			
Sun Pub Co Inc		13,400	47.1
Knoxville			
Amer Bcstg Corp (WBIR)		3,230	45.1
Nashville			
Ntl Life & Acc Ins Co (WSM)	WSM-FM	.....	44.7
Nashville Radio Corp		16,000	46.5

TEXAS

	Call	Sq. Mi.	Mc.
Abilene			
Reporter Bcstg Co		6,936	45.7
Amarillo			
Amarillo Bcstg Corp (KFDA)		5,600	45.1
Beaumont			
KRIC Inc (KRIC)		6,650	43.1
Dallas			
A H Belo Corp		22,700	43.7
KRLD Radio Corp		20,000	45.7
Harlingen			
Harbenito Bcstg Co		2,400	48.9
Houston			
Houston Printing Corp (KPRC)		10,500	46.5
KTRH Bcstg Co		14,300	47.7
San Angelo			
KGKL Inc		6,936	45.3

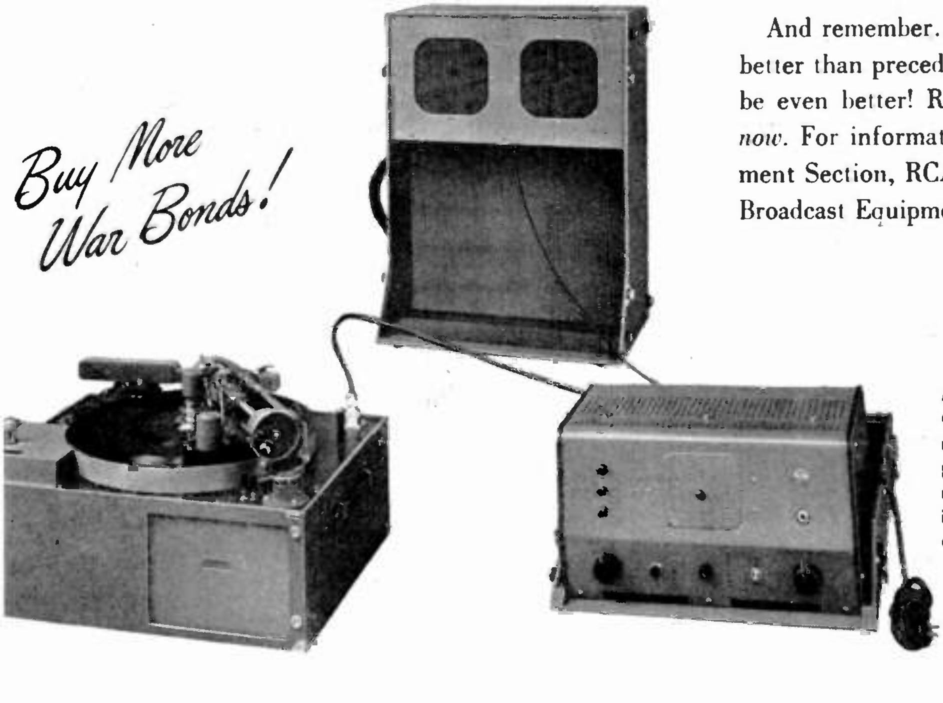
in HIGH FIDELITY recording equipment

RCA produces the finest and most complete line of de luxe recording equipment. Included are units or assemblies for every need . . . . complete "packaged" equipment for field use, a high-quality recording attachment for mounting on standard RCA turntables, and a de luxe recording "lathe" for professional-type installations.

All three are outstanding in several respects: first, they are built to provide quality and durability rather than to meet a price; second, they are designed specifically for the unique requirements of broadcast use; and, third, they are the result of many years of experience in designing and building earlier models.

And remember...as the units shown here were better than preceding models, so will new designs be even better! Reserve your postwar recorders *now*. For information, write to Broadcast Equipment Section, RCA, Camden, N. J. regarding the Broadcast Equipment Priority Plan.

Buy More War Bonds!

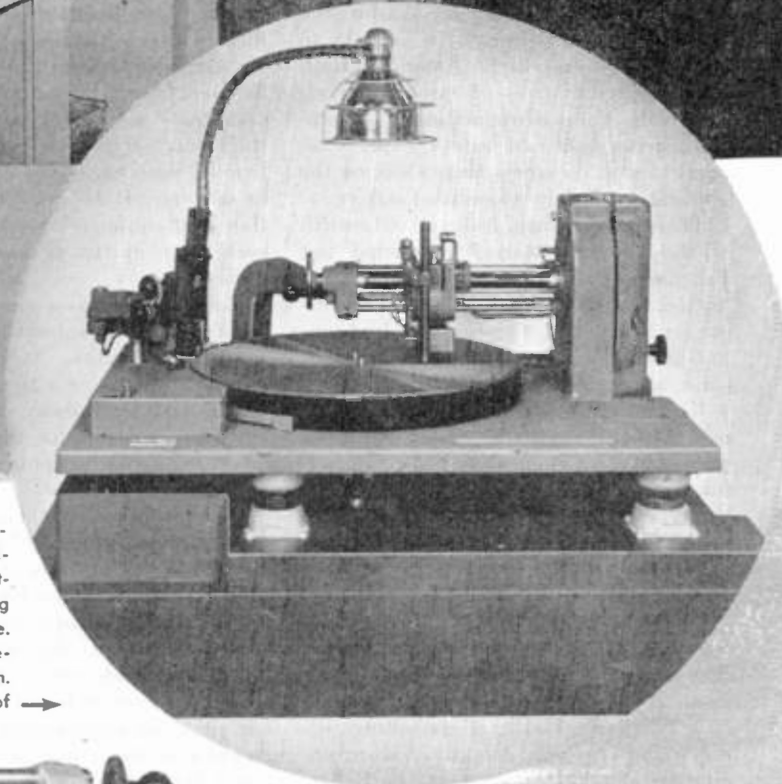


Portable recording equipment. Model OR-1, economical in price, for good recordings in the studio or field. A complete recording channel consisting of a rim-drive turntable with standard recording and reproducing arms, an amplifier chain and a loudspeaker unit.

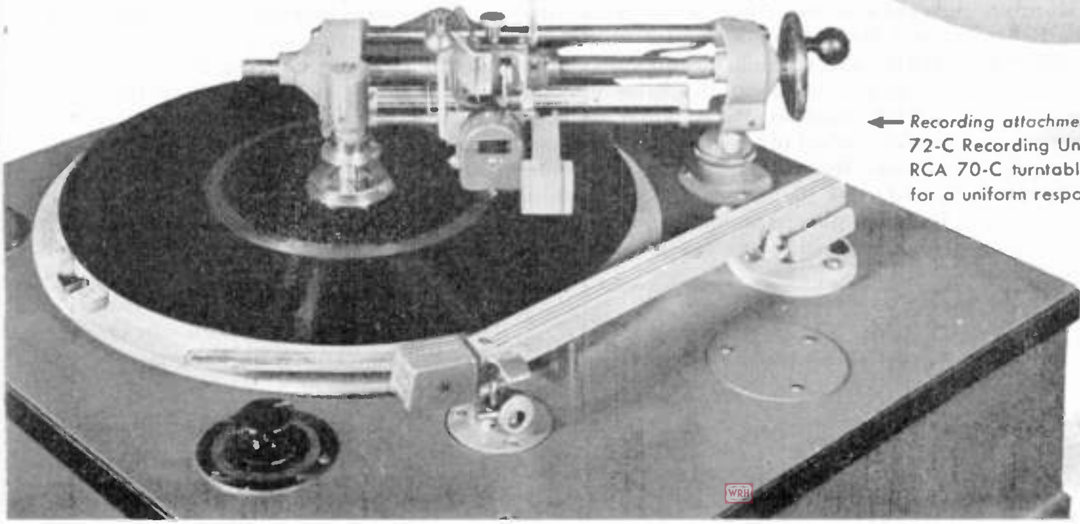
RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

Pictured here is the recording lathe bank at OWI Headquarters, New York City. These RCA recorders are used in making transcriptions of OWI news and entertainment programs for overseas broadcasting.



Close-up view of the RCA recording model employed at OWI Headquarters. A professional-type unit, the 73-AX Recorder provides highest-quality, instantaneous recordings for broadcasting purposes. 30 to 10,000 cycle frequency response. Records at 33⅓ or 78 r.p.m., outside-in or inside-out at 96, 112, 120, 136 or 154 lines per inch. Speed and groove adjustments at the turn of a knob. →



← *Recording attachment for turntable mounting.* The Model 72-C Recording Unit for control room use with standard RCA 70-C turntable equipment. Cutting head provides for a uniform response from 60 to 6000 cycles.

	Call	Sq. Mi.	Mc.
San Antonio			
Southland Industries Inc (WOAI)	....	16,500	44.5
Wichita Falls			
Rhea Howard	....	12,800	46.5
UTAH			
Salt Lake City			
Radio Serv Corp of Utah ▸ (KSL)	....	.....	44.7
Intermountain Bcstg Corp	....	800	46.7
VIRGINIA			
Newport News			
Hampton Roads Bcstg Corp	....	5,950	44.7
Norfolk			
WTAR Radio Corp (WTAR)	....	5,702	46.5
Portsmouth			
Portsmouth Radio Corp..	....	6,000	47.3
Richmond			
Havens & Martin Inc (WMBG)	....	12,130	46.1
Richmond Radio Corp	....	11,269	46.3
WASHINGTON			
Seattle			
Radio Sales Corp	....	8,200	44.5
Spokane			
Louis Wasmer Inc (KHQ)	....	12,609	45.7
WEST VIRGINIA			
Beckley			
Beckley Newspapers Corp	....	8,500	....
Charleston			
Charleston Bcstg Co (WCHS)	....	.....	....
Morgantown			
W Va Radio Corp	....	33,244	43.3
Satellite on 49.9 mc. at Pittsburgh 1,620 sq. mi.			
Satellite on 49.9 mc. at Wheeling 344 sq. mi.			
WISCONSIN			
Green Bay			
Green Bay Newspaper Co	....	.....	....
Madison			
Badger Bcstg Co.	....	31,640	43.3
Milwaukee			
Hearst Radio Inc	....	17,791	43.5
Journal Co (WTMJ).....	WMFM	8,500[1]	45.5[1]
Oshkosh			
Oshkosh Bcstg Co (WOSH)	....	3,810	44.5
Racine			
Racine Bcstg Corp......	....	2,540	49.1
Superior			
Head of the Lakes Bcstg Co (WEBC)	WDUL	.....	44.5
Wausau			
Record Herald	....	.....	46.5

[1] Application filed to change to 17,820 sq. mi., 43.9 mc.

FCC HEARING ON RAILWAY RADIO

Summary of the Review of Radio to Railway Service

AT THE request of Senator Burton K. Wheeler, a three-member committee of the FCC held hearings at Washington on September 13, 14, 15, 16, and 18 to give the Association of American Railroads, representatives of various individual roads, radio manufacturers, Government witnesses, and safety experts an opportunity to express their ideas on the application of radio to railroad service.

These proceedings, a direct outgrowth of the two-day hearing conducted last February 11 and 12 by the Kilgore Committee, to explore use of radio for preventing accidents, were presided over by Commissioners Paul A. Walker, Norman S. Case, and E. K. Jett.

Under the guidance of Jeremiah Courtney, FCC counsel, the 40-odd witnesses presented a comprehensive picture of railroad signalling proceedure and problems, the types of radio equipment available to meet the needs of this service, and the past experience with experimental railroad installations.

Unfortunately, despite the twice-repeated request by Commissioner Walker that the safety aspect of railway radio be given special emphasis in all testimony, only William S. Halstead, consulting railway radio engineer, Albert G. Morrison, director of transportation at the Kingsbury Ordnance Plant, and Herbert A. Friede, chief of Emergency Services, Washington, D. C., all witnesses produced by the FCC, spent any considerable time on this important subject.

The reluctance of the railroad witnesses to discuss the safety potentialities of railway radio was especially surprising in view of the fact that the Terre Haute wreck, with its sizeable toll of life, occurred on the second day of the hearing.

This may have accounted for the very forceful statements by J. G. Tuhrsen, Washington representative of some million Railroad Brotherhood members. The final witness at the hearing, he stated that his members favored the use of radio not as much because it improved efficiency of operations as because it would improve the safety of those operations. Thus the lives of passengers and employees would be safeguarded. He pointed out that many thousand employees are killed or injured each year in the performance of their duties.

The railroads, as a group, had no concrete program to submit for the Commission's consideration. No doubt this was, to a great degree, due to the fact that the use of FM for railway communications, chiefly responsible for the revival of interest in this radio application, has come about during the War.

On the other hand, the opinion has been expressed privately by railway officials that, if they admit now that radio can be used to promote safety, the admission may be used against them in court cases arising from accidents, as showing negligence by not having made use of radio already. It seems, however, to be rather weak reasoning, since the development of suitable FM equipment has come about at a time when the sale of apparatus is still restricted as a wartime measure!

Further confusing the issue was the flat statement by W. R. Triem,[1] general superintendent of telegraphs for the Pennsylvania Railroad, testifying as a representative of the American Association of Railroads, that in his opinion space radio[2] is not required by the roads, since carrier communication of the type his road plans to install on its Pittsburgh-Harrison division meets all requirements for 2-way voice communication on yard and main-line operations.

All the other railroad witnesses disagreed sharply with the all-inclusive Triem statement on this point. Some, notably T. P. Brewster, superintendent of telegraphs of the Sante Fé Railroad, insisted that, because of the wide spacing between their tracks and the wayside wires, only space radio can meet their needs. Others argued that carrier techniques can best be used for some services, such as dispatching, while space radio seemed best fitted for other purposes, such as yard and terminal communications. Underlying all this discussion is the fact that no one, at this time, is in a position to speak with authority born of extensive practical experience.

W. A. Jackson, general superintendent of telegraph and telephone for the New York Central system, expressed the more open-minded and less extreme point of view that "both space and carrier radio have possibilities in their application to railroad uses." He then pointed out that recent radio developments are new in their adaptation to railway communications, and that much experimentation must be done before decisions can be reached. The New York Central, he said, is currently engaged, in association with the Halstead Traffic Communications Corporation, on an exhaustive experimental program at the Central's West Shore division.

Both carrier and space radio equipment, operating at various frequencies from 75 kc. to 3,000 mc., is being tested on yard and mainline operations. When this program is completed, the Central expects to know what types of equipment are best suited to each specific type of railroad service.

The radio manufacturers were also in disagreement as to what type of equipment can best meet the problems of railroad communications. William S. Halstead expressed the belief that both carrier and

(CONCLUDED ON PAGE 71)

[1] See FM for Railroads Highly Successful, *FM and Television*, June, 1944.

[2] This term is used by railroad and public utility engineers to indicate transmission over considerable distances, in contrast to carrier or induction systems.

ANTENNAS FOR FM STATIONS

Relation of Antenna Design to Area of Coverage; Types of Antennas and Their Characteristics

BY JOHN P. TAYLOR*

ASSUMING that a site has been selected, the next step in planning an FM station is to decide on the type of antenna to be used. Considerable importance is attached to this decision because of the increased coverage, for the same transmitter power, which can under some circumstances be obtained by using an FM antenna of one of the so-called *multi-element* or *multi-layer* types.

Advantages of Multi-Layer Antennas ★ The desirability of carefully considering the possibilities of the multi-layer design can hardly be overstressed. An example is probably the best way to illustrate this. Assume a 1-kw. FM transmitter feeding power to an antenna on the top of a 300-ft. building. If this antenna is of simple single-layer design, for instance, a one-bay turnstile, coverage [1] will be approximately 31 miles. Now suppose that there is substituted for this single-layer antenna an antenna of the same type but having six layers. By this substitution, the 50-microvolt line will be moved out to 44 miles and the area covered increased from 3017 square miles to 6,079 square miles. In terms of equivalent power the difference is even more striking. To obtain the same increase in coverage by increasing power while retaining the single-layer antenna would have meant going to a power of 8.6 kw. In terms of cost this makes an interesting comparison. Depending on the mechanical difficulties of installation, a six-bay turnstile installed may cost from three to six or eight thousand dollars more than a single-bay turnstile. But a 10-kw. transmitter installed will cost at least fifteen thousand dollars more than a 1-kw. transmitter. Moreover, the larger transmitter will require more space, involve greater installation problems, and cost more to operate. *Thus, other things being equal, obtaining increased coverage by use of a higher-gain antenna is usually preferable to an increase in power.*

Limitations of Multi-Layer Antennas ★ There are, however, some definite limitations which must be reckoned with in considering the use of high-gain antennas. The most important of these are the mechanical limitations imposed by the supporting structure. A six-bay turnstile, for instance, is approximately 60 ft. high, at FM frequencies. It is mounted on a pole which is 12 ins. in diameter at the base and 5 ins. at the top. The whole antenna weighs about 3,500 lbs. Moreover, it presents considerable wind resistance, so that at high wind velocities the overturning moment is rather large. The supporting structure, whether building or tower, must be able to stand this weight and overturning moment, and must be adaptable to mounting the supporting pole. When these requirements are combined with the desirability of having a high location, a compromise is often required. For instance, it may be found that there is available a 300-ft. building which is ideal in all respects except that it will not support more than a two-bay antenna, whereas the only building on which a six-bay antenna could be located is only 100 feet high. Reference to the coverage curves will show that in this case the first location would be the better even though only the two-bay antenna could be used. The same consideration may apply where an FM antenna is to be mounted on an existing AM tower. Most such towers will not support an FM antenna of more than two bays. However, the extra height afforded by such mounting may be an advantage that outweighs this.

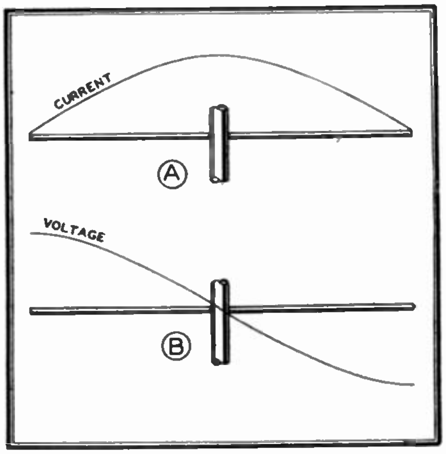


FIG. 2. CURRENT AND VOLTAGE WAVES ON A SINGLE TURNSTILE ELEMENT

Interrelation of Height, Gain, Power ★ Even an elementary consideration such as the above serves to show that it is not always possible to follow the logical course in FM station planning of first, determining coverage required; second, selecting a site; third, deciding on antenna type, and finally, determining the necessary power. In many cases the site and type of antenna must be considered together. In not a few cases transmitter power will also enter into this consideration. And, in a few extreme cases, the limiting conditions may

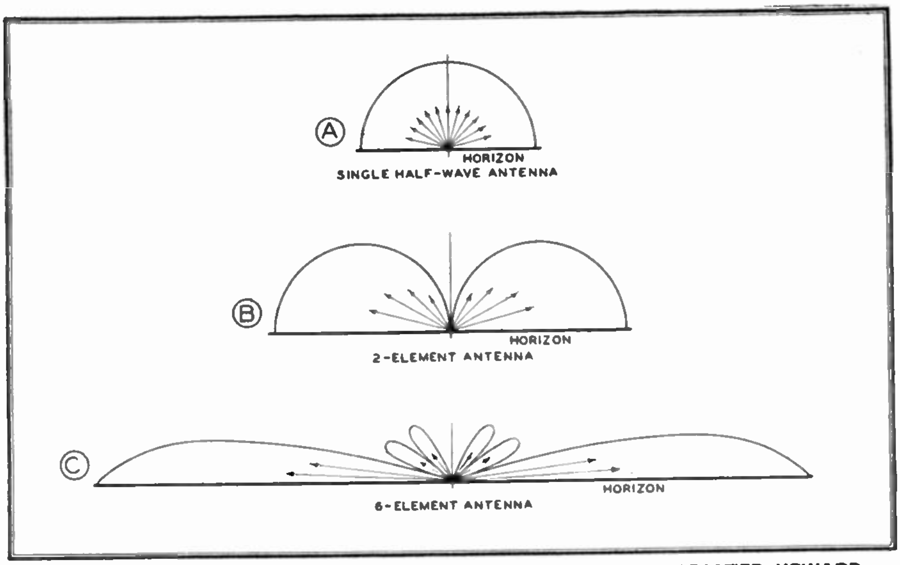


FIG. 1. ANTENNA GAIN IS ACHIEVED BY REDUCING POWER RADIATED UPWARD

* Engineering Products Department, Radio Corporation of America, RCA Victor Division, Camden, N. J.

[1] The distance to the point where the signal has fallen to 50 microvolts per meter.

be such that the coverage originally set up as desirable may have to be scaled down to meet practical conditions. This, in turn, may involve a change in the type or classification of station to be applied for. Thus, considerations of antenna type and design which at first thought seem to be chiefly of engineering interest, may actually turn out to be matters affecting station policy. As such, they are of interest not only to the station engineer but also to the station manager and the station owners.

How Antenna Gain Is Obtained ★ The increased effective power and the increased coverage referred to above are obtained by the use of multi-element antennas. These consist essentially of from two to ten or more separate antenna elements arranged in some fixed configuration and fed power effectively in parallel. Ordinarily, the individual elements are about a half wavelength long and they are usually spaced a half wavelength or more apart. Multi-element antennas have been used for years for radio communications purposes. They have not been used for AM broadcasting, except to obtain special directivity patterns intended to reduce interference, because of the fact that, at AM broadcasting frequencies, a half-wave is from 330 to 1,000 ft. long and it is not practical to use multiples of such distances. At FM broadcast frequencies, however, a wavelength is only about 20 feet, so that multiple configurations up to ten or so are often practical.

It should be noted that the total power radiated is not increased by the use of a multi-element antenna, for obviously this power can be only as great as the transmitter power less whatever small losses may occur in the feed system. Rather, the gain which is achieved is a gain in *effective* or useful power. It is obtained by reducing the power radiated in the upward direction and increasing the power radiated in the horizontal direction, i.e., along the earth's surface. It is the latter which constitutes the useful signal component.

The manner in which extra coverage is obtained by suppressing the *skywave* is illustrated in Fig. 1. Fig. 1A shows the radiation pattern, in the vertical plane from a single half-wave antenna. As the arrows indicate, power is radiated equally at all angles to the horizontal. Of this power only that radiated at the horizontal or at very small angles to the horizontal serves any useful purpose; all the rest travels out into space and is lost. Now consider Fig. 1B, which is an approximation of the vertical radiation patterns from an antenna consisting of two elements stacked vertically. In this case there is no radiation directly upward and that at high angles has been greatly reduced. The radiation at low angles and along the horizon has been increased greatly. Thus the *effective* or useful power is much greater even though the total power radiated is the same. In Fig. 1C is shown the vertical radiation pattern for a six-element antenna. The pattern has been still further squashed down and the radiation along the horizontal still further increased. As more elements are added beyond six, the horizontal radiation continues to increase. However, the amount of increase per added layer decreases so that the diminishing return hardly justifies going beyond ten layers, and in many instances six layers is considered the best practical choice.

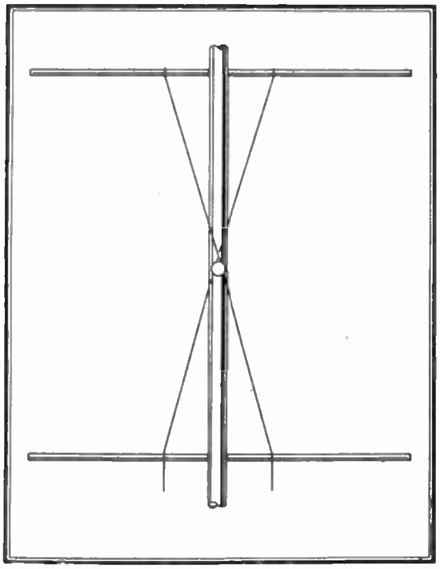


FIG. 3. METHOD OF FEEDING POWER TO THE ELEMENTS OF A TURNSTILE

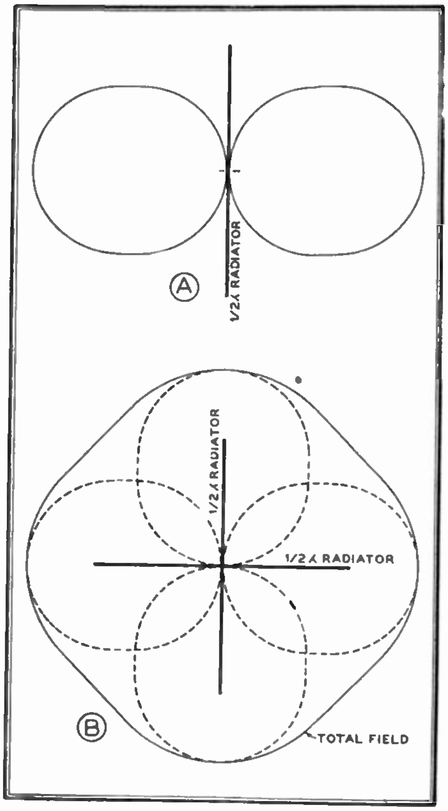


FIG. 4. RADIATION PATTERN FROM TWO TURNSTILE ELEMENTS AT RIGHT ANGLES

Meaning of Field Gain and Power Gain ★ In comparing the advantages of multi-element antennas engineers use the terms *field gain* and *power gain*, and these same terms are used in the Rules and Standards of the FCC.

The field gain is defined as *the ratio of the field intensities*, that is, the signals that would be measured with a field intensity meter, at a point a mile from the antenna. This is clearer, perhaps, if we say simply that the field gain is the increase in field intensity which results when we replace a vertical half-wave antenna with a multi-element antenna. If this happens to be a six-bay turnstile, the increase in field intensity, expressed as a ratio, is 2.07 times.

Thus:

$$\text{Field gain} = \frac{\textit{Field intensity with multi-element antenna}}{\textit{Field intensity with vertical half-wave antenna}}$$

The field intensities are supposed to be measured at a point one mile distant. It can be shown mathematically that a half-wave vertical antenna, fed with a power of 1 kw. will have a signal of 137 millivolts/meter at one mile. Hence, the field gain of any particular antenna can also be expressed as the ratio of the signal it produces per kilowatt at a mile to 137 millivolts/meter.

The power gain is defined as: *The ratio of the powers* that would be required to give the same field intensity at a point one mile distant. Here again it will be more easily understood if we say simply that the power gain is the increased power, expressed as a ratio, which we would have had to feed the vertical half-wave antenna to obtain the same increase in field intensity. Thus:

$$\text{Power gain} = \frac{\textit{Power required with vertical half-wave antenna}}{\textit{Power required with multi-element antenna}}$$

It is obvious that there is a simple relation between the *field gain* and the *power gain* of an antenna. It can be shown that for a given antenna, the increase in field intensity at any point is always equal to the square root of the increase in power. If the power is increased four times over, the signal intensity is increased twice. Thus:

$$\text{Power gain} = (\textit{Field gain})^2$$

and

$$\text{Field gain} = \sqrt{\textit{Power gain}}$$

In studying propagation characteristics, engineers find the field gain the easiest to use in calculations. However, in planning an FM station the power gain is the most useful form since it gives a direct answer to the question of how much transmitter power will be saved by the antenna under consideration.

It should be noted here that the power gain of all multi-element antennas is referred to that of a half-wave vertical antenna and not to a single layer antenna of the type specified. Single layer antennas of the types used for FM broadcasting always have a power gain of less than one for reasons explained below. For instance, a single layer turnstile has a gain of .5. This means that a six-bay turnstile with a power gain of 4.3 over a vertical half-wave actually has a power advantage of 8.6 over a single-bay turnstile.

Practical Types of FM Antennas ★ Originally, both vertically and horizontally polarized transmission were used for FM broadcasting. However, horizontal polarization is now specified and this means that the elements in the antenna must lie in horizontal position. The practical antennas of this type so far devised fall into four general categories: a) the original Brown turnstile and the improved "coaxial" version, b) modifications of the original turnstile such as the deMars turnstile and the ¾-wave spaced turnstile, c) variations of the circular or ring antenna, and d) variations of the square loop antenna.

All of these types are in use today, although the first two are by far the most widely used.

Original Brown Turnstile ★ The first antenna designed specifically to provide directivity in the vertical plane, as contrasted to the earlier communications-type antennas which were designed for directivity in the horizontal plane, was the original turnstile antenna. This antenna, developed by Dr. G. H. Brown of RCA Laboratories, was described in the April 1936 issue of *Electronics*. The striking similarity to the moving element of a turnstile gate, from which it derives its name, is evident.

The first model of the turnstile was of exceedingly simple construction. Metal rods a quarter-wave long were attached directly to the supporting pole. Four such rods, arranged in 90° spacing about the pole, made up each layer or bay. The complete antenna was composed of from two to ten such layers, depending on gain required, supporting structure, etc.

The action of the turnstile antenna may be described in simplified fashion as follows. Each pair of oppositely-placed quarter-wave rods forms a half-wave dipole antenna. Fig. 2A shows the current wave on such a dipole and Fig. 2B the voltage wave. Since the center of the dipole is at zero voltage with respect to ground, the rods can be fastened directly to the grounded pole at this point. Power is fed to the dipole by connections shown in Fig. 3, spaced at the proper distance from the pole to provide an impedance match. The horizontal field of a single one of these dipole antennas is shown in Fig. 4A. Obviously this would not be satisfactory for broadcasting practice where, as a rule, uniform transmission in all directions is desired. This is the reason for the second set of rods in each layer. When this second set is fed an equal amount of power which is, however, of opposite phase, the patterns of the two radiating dipoles are as shown by the dotted lines of Fig. 5B and the combined field is the solid line. The latter, it will be noted, is very nearly a circle.

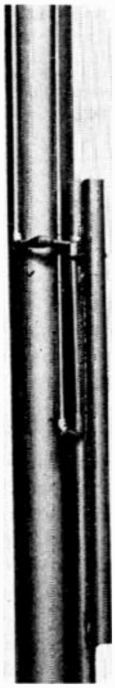


FIG. 6. PHASING UNIT AT THE BASE OF THE IMPROVED ARRAY

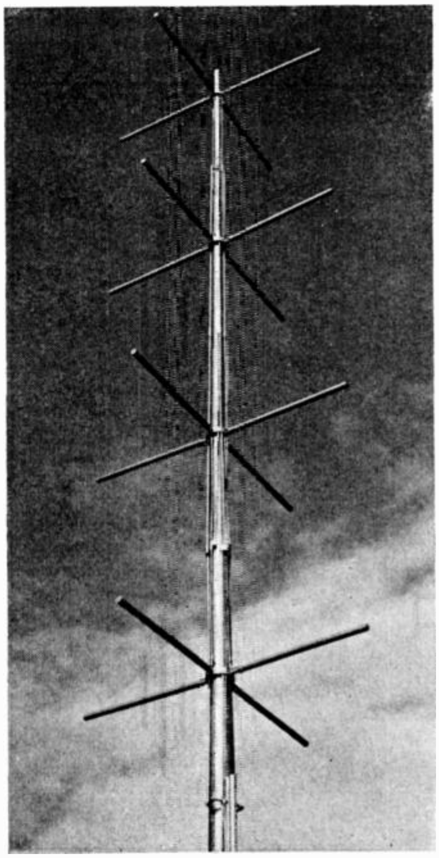


FIG. 5. IMPROVED BROWN TURNSTILE

In order to achieve the kind of horizontal directivity noted in Fig. 5, all of the dipoles in one plane must be fed equal amounts of the same phase. If the layers are spaced a half-wave apart, this can be conveniently done with a transmission line which is crossed over between each layer, thereby counter-balancing the phase shift that occurs along this line between layers. Two such lines, one for each set of dipoles, run up the tower, twisting around it as they go and being set off from the tower by stand-off insulators. At the base of the tower, the two lines are fed oppositely phased currents by one of several methods.

The first model of the turnstile antenna was carefully tested and a large number of field measurements made of signals transmitted with it. These tests indicated that the turnstile met the primary requirements of a good high-frequency broadcast antenna in that it had a uniform directivity pattern in the horizontal plane (i.e., the same signal strength in all directions), and offered a convenient and easy means of obtaining high directivity in the vertical plane (i.e., high-gain in useful signal strength). In addition, it was obvious that such an antenna had the other necessary qualities of simple mounting and rugged construction.

Because of its unique qualities, the turnstile was adopted by almost all of the pioneer FM broadcast stations and its familiar contour has become a symbol of FM to engineers and laymen alike.

Improved Brown Turnstile ★ Field experience with the original turnstile antennas, as shown in Fig. 3, brought out two minor drawbacks. One of these was that the matching of the feeder lines was extremely critical and required that adjustments be made in the field. As most stations lacked experienced personnel, this was a major difficulty. The second was that the open wire transmission lines invited the formation of ice which tended to increase the wind resistance of the antenna and to detune the radiating system.

To overcome these difficulties, Dr.

FIG. 7. CHARACTERISTICS OF THE COAXIAL TURNSTILE

Number of Layers	*Power Gain*	*Field Gain*	*Maximum Pole Height Above Tower or Roof*	*Minimum Distance in Tower or Roof*	*Outside Diameter Pole Butt*	*Estimated Complete Weight of Pole, Elements, Transmission Lines on Turnstile, Etc.*
2	1.25	1.12	20 ft.	4 ft.	5 ins.	725 lbs.
4	2.75	1.64	42	8	8⅝	2,100
6	4.24	2.037	64	10	11¾	3,500
8	5.75	2.38	87	13	14	6,000
10	6.70	2.6	110	18	16	8,700

Brown and his associates at RCA Laboratories developed a modification of the original turnstile in which coaxial transmission lines replaced the open wire lines previously used.

A photograph of the newest turnstile antenna, using coaxial feed lines, is shown in Fig. 5. Four coaxial lines, phased progressively 90° apart, run up the tower from a phasing unit at the base of the array, Fig. 6. All of the quarter-wave radiators pointing north are fed from one of these lines, all those pointing east from another, and so on. The radiators in layers 1 and 2 are fed from a point in between layers. Similarly, radiators in layers 3 and 4 are fed from a point between these. In this way, balanced power distribution is assured.

The arrangement of radiators and lines in the new turnstile has several advantages. The first is that the antenna can be completely "pre-tuned" during fabrication. It comes as a finished assembly, with no engineering required in its erection. The second is that since phasing is accomplished at the radiators, there are no phasing adjustments to be made at the bottom of the tower, all line impedances are exactly matched and there are no standing waves on the lines. The third is that the frequency range, both as to line termination and field intensity, is much wider than is required for wide-band FM, so that the system is not critical in any respect.

Insofar as the radiating properties of the new turnstile are concerned, these are the same as in the original design. The field is very nearly symmetrical; the gains achieved compare favorably with the theoretical values. In the gain that can be achieved within practical limits, the new turnstile exceeds any FM antenna yet devised. RCA engineers believe that wherever the supporting structure will allow the use of a multiple-layer turnstile, this antenna is to be preferred over all other types.

The new turnstile is furnished as a "package" item, including pole, radiators, transmission lines and, if desired, lights, steps, and sleet-melting units. This is of great advantage since the cost and labor of cutting and fabricating all the necessary parts of an FM antenna is one which few stations will wish to undertake. This new design was introduced just previous to the war, and hence not many were built. Nevertheless, the some half-dozen which were installed have given excellent performance.

Some of the characteristics of the new turnstile as manufactured by John E. Lingo & Son are shown in the table of Fig. 7. Power gains of the turnstile as compared to other types are shown in Fig. 8.

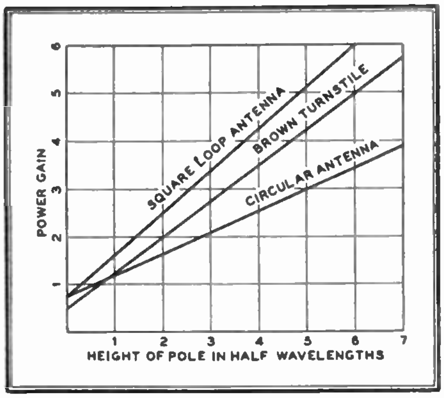


FIG. 8. POWER GAIN PLOTTED AGAINST REQUIRED HEIGHT OF SUPPORTING POLE

Modifications of the Turnstile ★ A number of variations of the original turnstile are in use and deserve to be mentioned briefly. The best known of these is the deMars turnstile used by the Yankee Network and others. The essential difference between this antenna and the turnstile is in the use of a separate coaxial feed line for each radiator. Thus, for a six-bay antenna there are 24 feed lines. These lines run all the way down the tower to a phasing room at the base. The advantages claimed for this system are that it enables the phasing to be done at a sheltered and convenient point and a more accurate match is obtained. As compared to the original turnstile, these were quite important advantages. It is believed, however, that they represent no advantage over the new design. On the side of disadvantage there is the cost and work of installing the greater number of lines and the extra wind resistance and ice hazard which they form.

The antennas designed by deMars also incorporate a number of structural innovations. The most notable of these is the antenna on Mt. Washington in which, because of the extreme weather conditions and continued ice formation, truck springs were used as the radiating elements.

Another variation of the turnstile which had a short vogue employed a between-layer spacing of three-quarters of a wavelength, instead of the half-wavelength spacing of the original. It can be shown mathematically that a three-quarter wave spacing gives a slightly greater gain than the half-wave spacing and, therefore, an

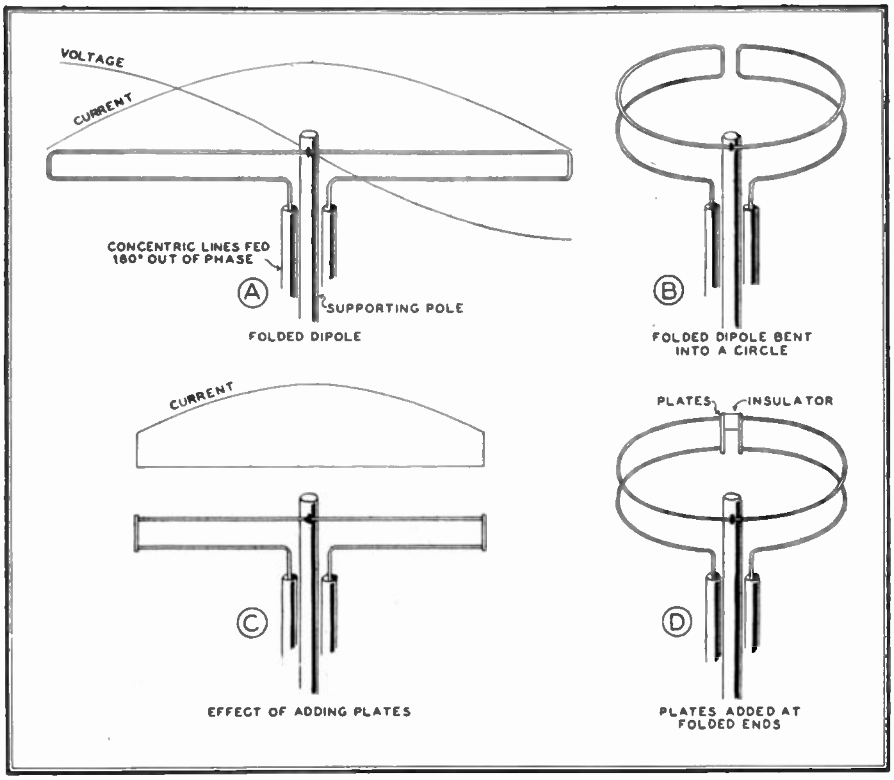


FIG. 9. DESIGN DETAILS ILLUSTRATING EVOLUTION OF THE CIRCULAR ANTENNA

antenna of this type has more *gain per layer*.

It should be noted, however, that gain per layer is not the true criterion of worth. Actually, extra layers add little to cost or weight; what is most important is the overall height of the supporting pole, since it is the weight of this pole and the means of mounting it that determine what can and what cannot be used on a given structure. In this respect, the three-quarter wave spacing offers no advantage. For instance, a three-layer antenna of this type

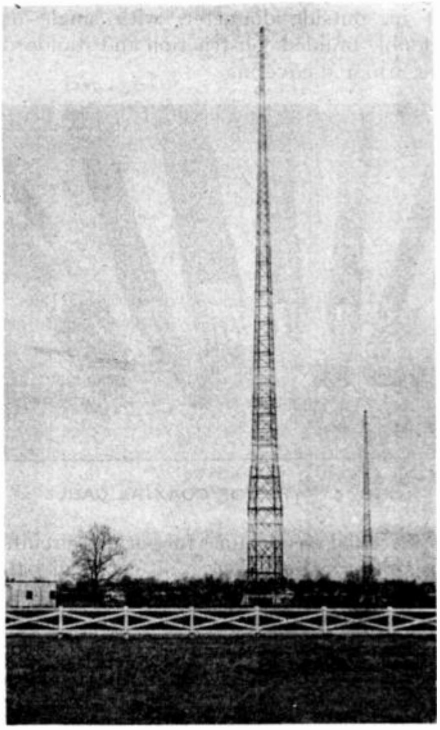


FIG. 10. SIX-LAYER FM ANTENNA AT WBRL, BATON ROUGE, ON AM TOWER

requires a total pole length of one and one-half wavelengths (30 feet at 45 mc.) and has a gain of 1.6, whereas a four-layer antenna of one-half wave spacing also requires one and one-half wavelengths and has a gain of 1.65. Moreover, the three-quarter wave spacing requires either separate feed lines for each radiator, as in the deMars antenna, or else a full wavelength of line between layers, which is an unwieldy alternative. For these reasons this type of antenna is not widely used.

Circular or Ring Antennas ★ The circular or ring antenna which has recently achieved some prominence is essentially a folded dipole antenna bent around into a circle.

Folded dipole antennas have been used for some time for communications purposes. They have been used for a number of years for television transmission at the Empire State Building.[2] The general advantages of this type of antenna have been discussed by P. S. Carter [3] of RCA Communications in an article entitled "Simple Television Antennas" published in the *RCA Review* for October 1939. In Fig. 9A the folded dipole is shown in its simplest form. Essentially it consists of two half-wave radiators, one of which is broken at the center and the system fed at this point. Since the two radiators are mounted very close together, the currents in them flow in the same direction and the current distribution on both is a sine wave as shown by the light line. As the voltage to ground at the center is zero, the unbroken radiator can be attached directly to the supporting pole at this point. The ends of the lower radiator can be fed power by an open balanced line or by a pair of concentric lines, oppositely phased as shown in Fig. 9A.

The radiation characteristics of the dipole as shown in Fig. 9A are the same as that of one pair of radiators on the turnstile. The pattern in the horizontal plane is a figure 8 which, of course, is undesirable for broadcast purposes. To overcome this and attain an approach to uniformity of transmission in all directions, the dipole is bent around into a circle as shown in Fig. 9B. This, however, will not of itself give a circular pattern as the current distribution is not uniform around the radiator. To improve on this situation, a pair of large metal plates is fastened at the folded points as shown in Fig. 9C. These plates have the effect of adding end capacity to the radiators and change the current distribution something as shown in Fig. 9C. The current is now approximately uniform around the loop and the signal radiated approaches a circular pattern to the same degree.

The circular antenna presents a neat appearance and has a higher gain per layer than the turnstile. However, in order to keep down the mutual impedance, the layers must be placed a full wavelength apart. Thus, the ***gain per height*** is less than with the turnstile for cases when more than one layer is used. For instance, a three-bay circular antenna which is two wavelengths high, 40 feet at 45 mc., has a power gain of 2.6, whereas a five-bay turnstile having the same height has a power gain of 3.5. As noted before, it is the height which is the important parameter, since it is the weight and upsetting moment of the supporting pole which determine the practicality of a given design.

The off-center mounting of the rings is also a disadvantage in that it makes for mechanical and electrical dissymmetry. Thus, while the loops are of the same approximate weight as the turnstile elements, the fact that they are off-center requires a stronger supporting pole. The dissymmetry also affects the electrical properties in that currents are induced in the pole which are opposite in phase to those in the radiators. Because of these mechanical and electrical difficulties, it is believed impractical to go beyond three or four layers in this type of antenna.

[2] Lindenblad, *RCA Review*, April, 1939.
[3] Simple Television Antennas, *RCA Review*, October, 1939.

Square-Loop Antennas ★ The antennas previously described are all mounted on supporting poles of the flagpole variety. Where such a pole can be mounted on an existing structure or where the ground height is in itself sufficient, one of these standard types of antenna should definitely be used.

In some cases, it will not be possible to mount a flagpole on the building chosen — either because the building structure will not support it, or because of the configuration of the building itself. Similar difficulties sometimes arise when it is desired to mount an FM antenna on an existing AM tower. Most such towers were not built for and will not support the heavy pole used with multi-element turnstiles or ring antennas. In such cases, several variations of what, for want of a better term, may be called a square-loop antenna have been used with some success.

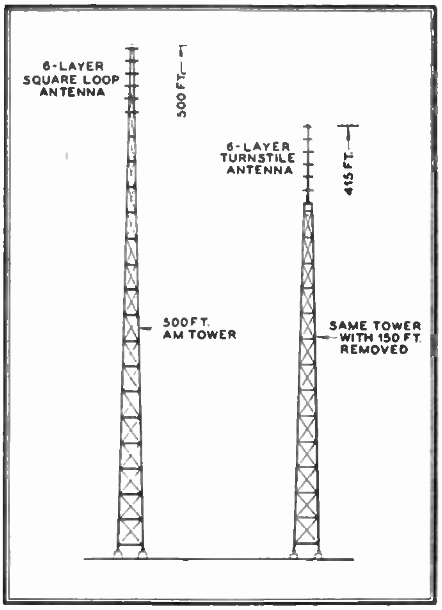


FIG. 11. HOW 85 FT. IN HEIGHT WERE SAVED BY USE OF SQUARE LOOPS

The square loop antenna consists of four dipole radiators arranged in the form of a square which may or may not be closed at the corners. In the case of a large building tower, the dipoles may project from the four sides. They may take the form of folded dipoles or of simple dipoles fed at the center, according to the method used to obtain impedance matching. Several antennas of this type have been designed by RCA engineers and are now in operation.

(CONTINUED ON PAGE 63)

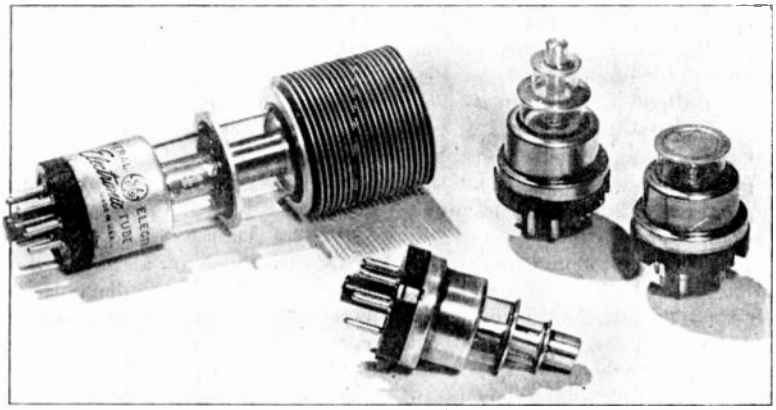


FIG. 1. THREE DIFFERENT TYPES OF LIGHTHOUSE TUBES FOR VERY HIGH FREQUENCIES

RADIO DESIGNERS' ITEMS

Notes on Methods and Products of Importance to Design Engineers

Lighthouse Tubes: Although disclosure of operating frequencies and circuit details of General Electric's lighthouse tubes are still being withheld for security reasons, permission has been given to publish the cross-section picture in Fig. 2, and to show some of the different types in Fig. 1. Also known as megatrons or disk-seal tubes, they are suitable for television broadcasting and FM and television relay transmitters operating at frequencies far above those employed for prewar commercial service. In fact, these tubes, widely used in military equipment, open a new vista of postwar developments.

The elements, instead of being arranged concentrically, are in flat planes, as Fig. 2 shows. The envelope is assembled of glass tubes fused to metal disks, making a rugged structure. With very low plate-to-cathode capacity, high output is obtained at very high frequencies. It is expected that these tubes will find many applications as soon as they can be released for non-military use.

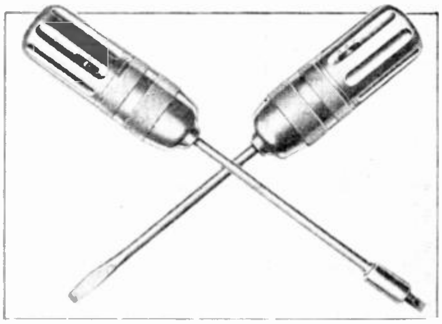


FIG. 3. SMALL BUTTON ADJUSTS TORQUE

Adjustable-Torque Screwdriver: The use of torque screwdrivers, to limit the tightening of small screws, has been required on many types of military radio equipment. Many of these have been made in factory tool rooms, and some have been decidedly Rube Goldberg in design.

A very simple commercial type is shown in Fig. 3. A calibrated adjustment in the handle varies the torque from 1 to 25 inch-pounds. It is claimed that the mechanism, employing a new spring principle, is superior to clutch, cam, and friction designs, and that the very close torque tolerance is not affected by excessive oil, foreign matter, or the manner in which it is used by the operator.

The illustration shows the solid shank and replaceable blade models. Sold under the name *Livermore Roto-Torq*, these screwdrivers are manufactured by Richmont, Inc.

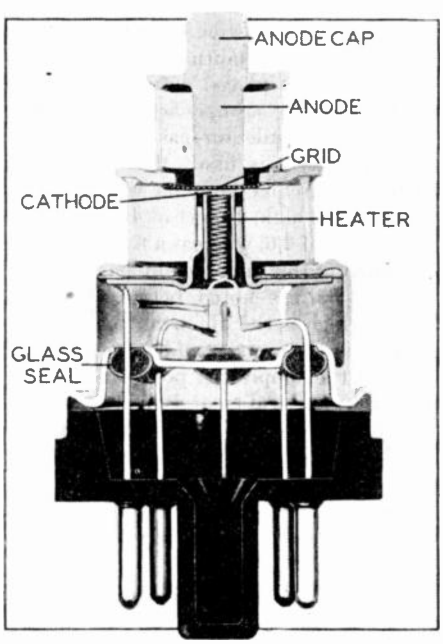


FIG. 2. LIGHTHOUSE TUBE CONSTRUCTION

Coaxial Cables: New demands for solid-dielectric coaxial cable suited to new high-frequency equipment have resulted in the development of the various types shown in Fig. 4. These cables, manufactured by the Intelin Products Division of Federal Telephone and Radio Corporation, are:

1. Coaxial lines from 3/16 to more than 1 in. outside diameter, with single or double-braided construction and standard or armored covering.

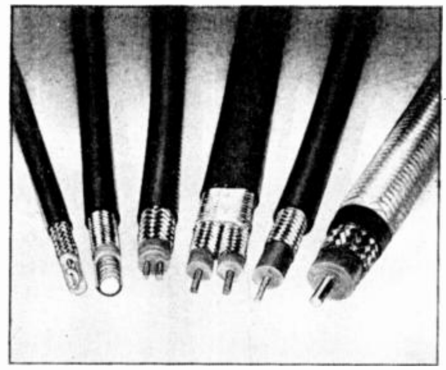
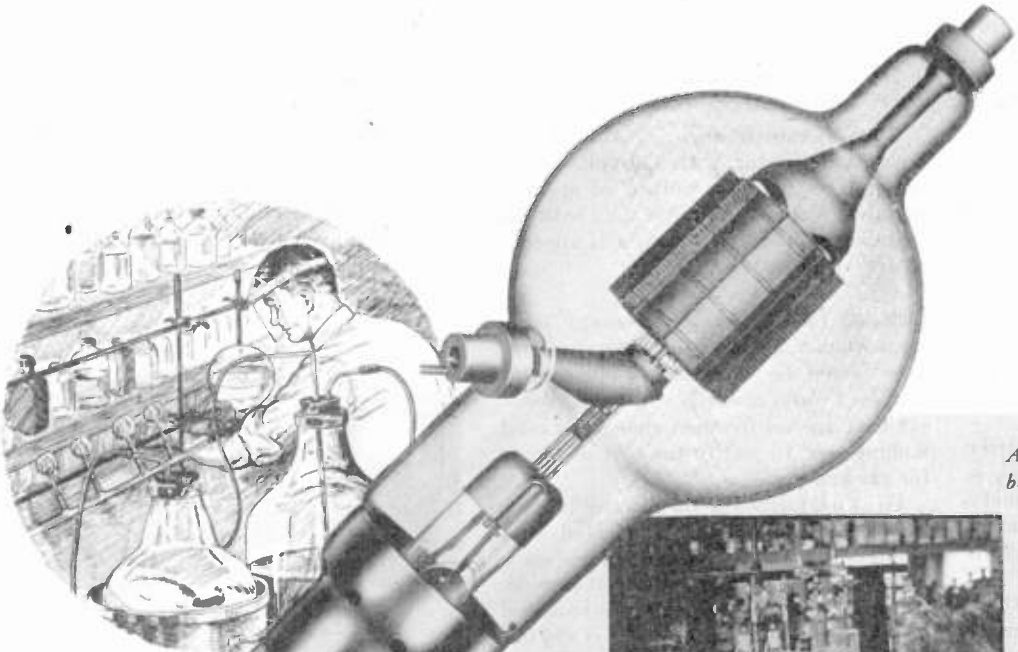


FIG. 4. TYPES OF COAXIAL CABLE

2. Dual-coaxial lines for parallel circuits requiring a high degree of electrical balance.
3. Twin-conductor lines, sometimes called *Twinex*, which have balanced, shielded pairs, usually somewhat smaller than dual-coaxial lines, and provide nearly as good electrical balance.
4. Coaxial air-spaced cables, produced in any required lengths, for service requiring capacity as low as 8 mmf. per foot.
5. Spiral delay lines used on special test sets which require an appreciable delay, or very high impedance. Such lines have in 1 ft. the electrical equivalent of as much as 15 ft. of coaxial cable.

Treated Switches & Resistors: To meet the growing demand for components treated to meet Signal Corps tropic treatment spec 71-2202-A, Shallcross Mfg. Company, Collingdale, Pa., is now supplying treated precision wire-wound resistors and switches. Complete details are available on request.

Permanent Magnets: The amazingly specialized technique involved in the design of permanent magnets, the choice of alloys for specific purposes, and manufacturing methods which must be considered by designers are set forth in a pamphlet issued by The Arnold Engineering Company. Data presented covers Alnico I, II, III, IV, and V, as well as chromium and 36%



the *Science* behind the science of electronics

The pattern of progress in the science of electronics is determined by the achievements in creating and developing new and more efficient electron vacuum tubes. Therefore, the whole complex task of vacuum tube development – involving the intelligent application of many sciences – comprises the real science behind the science of electronics.

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Eimac Engineering is devoted solely to the development and production of electron vacuum tubes. However, since the electron vacuum tube is the heart of all electronic devices it is advisable for users and prospective users of electronics to look first to the vacuum tubes required. A note outlining your problem will bring advice and assistance without cost or obligation.

• • •

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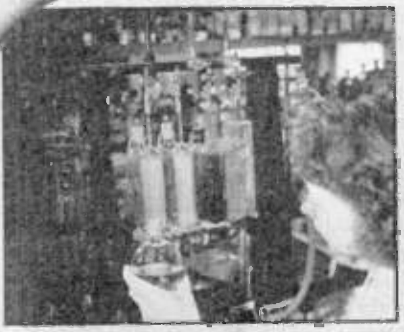
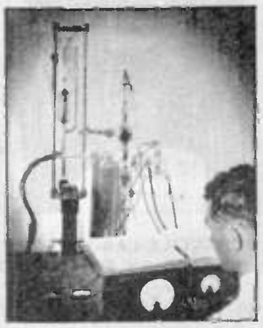


CHEMISTRY – *Making Gas Analysis in the Eimac Laboratory*

METALLURGY – *Spectrographic Analysis of the Rare Metals Used in Vacuum Tubes*



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cobalt. Reference is also made to sintered Alnico which can be pressed into shapes which are impractical to machine.

Frequency Meters: A new series of Bakelite-case vibrating reed frequency meters in standard 2½-in. cases has been announced by J-B-T Instruments, Inc. These meters have 5 reeds, centered on 60, 120, or 400 cycles. Increments indicated by the adjacent reeds are 1, 2, and 10 cycles for the three ratings, with corresponding accuracy of .2%, .2%, and .25%. Other frequency ratings are available.

The flanged case, 2¹¹⁄₁₆ ins. in diameter, fits flush on the panel through a 2⁵⁄₃₂-in. hole. Depth from the front of the panel is 1⅜ ins., plus ¹¹⁄₁₆ in. for the terminal studs. Weight of complete meter is .3 lb.

6F4: This is a new RCA heater-cathode type of acorn triode, Fig. 5, intended primarily for use as an oscillator up to 1,200 mc. Operation at such frequencies is made possible by a closely-spaced electrode structure and the use of a radial 7-pin base with 2 terminals for the plate and 2 for the grid. Close spacing results in high pevrance, and the double leads reduce lead inductance, both of which features are essential for operation at the rated frequencies. Insulating material in the socket must not have a loss factor exceeding .035. The manufacturers warn that connections must not be soldered to the base pins of the tube, as it is almost certain to crack the bulb seal. Furthermore, to obtain most satisfactory performance and maximum life the design-center maximum

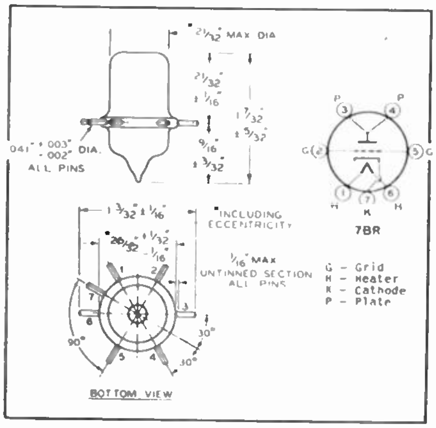


FIG. 5. DETAILS OF TYPE 6F4 TUBE

ratings must not be exceeded. Following are design-center maximum ratings:

Heater voltage, AC or DC....6.3 volts
Heater current..............225 amp.
Plate voltage, max..........150 volts
Plate current, max......15 milliamps.
Plate dissipation, max........2 watts

As an RF power amplifier and oscillator

DC grid voltage, max........50 volts
DC plate current, max...20 milliamps.
DC grid current, max.....8 milliamps.
DC heater-cathode potential..80 volts

At moderate frequencies, the 6F4, as a class C oscillator, with 150 volts on the plate, gives a power output of approximately 1.8 watts. At 1,200 mc., with 100 volts on the plate, the output is approximately .045 watt.

Laboratory Furnace: There are many occasions when a small, high-temperature furnace would be extremely useful in the course of radio research and model work, yet they are not frequent enough, in most laboratories, to justify the cost of piping for gas and air.

For such purposes, the electric furnace shown in Fig. 6 is ideal. Heated with Globar units, the operating temperature is 2,500° F. The muffle is of silicon carbide. Either a plug closure or a counterbalanced door is available. Chamber size is 2⅝ ins. high, 3½ ins. wide, and 5 ins. deep, or 5½ ins. high, 6 ins. wide, and 18 ins. deep.

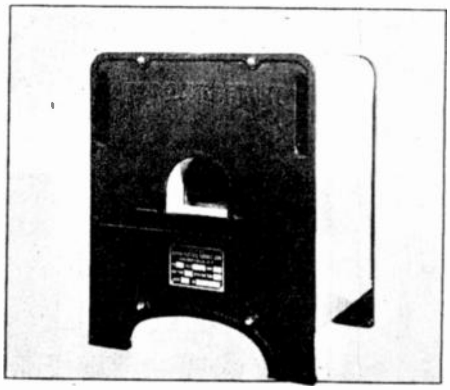


FIG. 6. VERSATILE LABORATORY FURNACE, HEATED BY ELECTRICITY

Legs for floor mounting can be supplied. These furnaces are manufactured by Harper Electric Furnace Company.

Side-Molded Iron Cores: The conventional method of molding powdered iron cores has been to apply the pressure to the ends. The Stackpole Carbon Company, finding that this resulted in more dense grouping of the particles at the ends than at the center, is now using the side-molding method, so that any effect of molding pressure extends evenly over the entire length. This, it is claimed, gives superior performance on cores used for tuning applications in broadcast, FM, and television receiver circuits.

Bridge for Production Tests: The AC slidewire bridge shown in Fig. 7 employs a vacuum tube null indicator for testing resistors, condensers, or inductances. Employing external standards, the ranges are 2,000 ohms to 20 megohms, .0001 to 1. mfd., and 5 to 50,000 henries.

Test limits are set up above and below the null point on the meter, thus providing great flexibility of plus and minus tolerances. Operation is fast because, once the bridge is set, tests are made without the need of rotating dials or pressing buttons, but merely connecting the components to the X terminals of the bridge. This instrument is manufactured by Industrial Instruments, Inc.

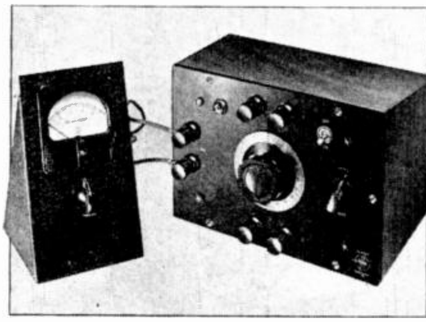


FIG. 7. AC SLIDE-WIRE BRIDGE FOR FACTORY PRODUCTION TESTING

Noise Suppressor: The General Electric Pyranol noise-suppression condenser, Fig. 8, combines the convenience of small size (3⅜ ins. long by 1¼ ins. diameter) with excellent performance characteristics at frequencies up to and above 40 mc.

The condenser is inserted in the ungrounded side of the line as close as possible to the source of noise. Thus the feed-thru stud carries the line current, while the mounting bracket is grounded. The stud is designed to carry 100 amps., and the insulation is rated at 250 volts DC or 250 volts AC RMS, 60 cycles. Operation at frequencies up to 400 cycles is possible, but at some reduction of voltage and current. When the line is grounded, one of these units must be used on each side of the line.

If the condenser cannot be inserted directly at the noise source, it may be necessary to shield the lead to the input side of the stud.

Capacity to ground is .55 mfd. Insulation resistance from stud to grounded

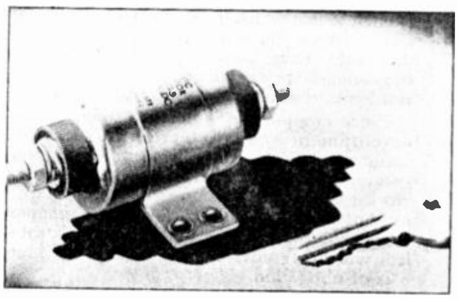
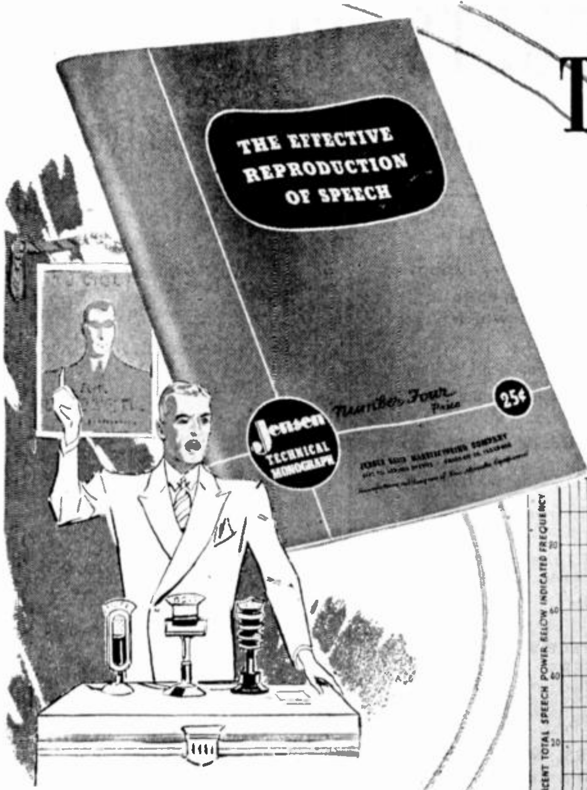
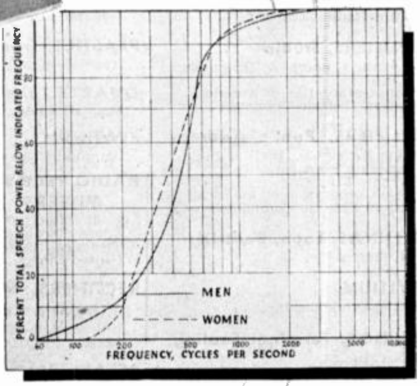


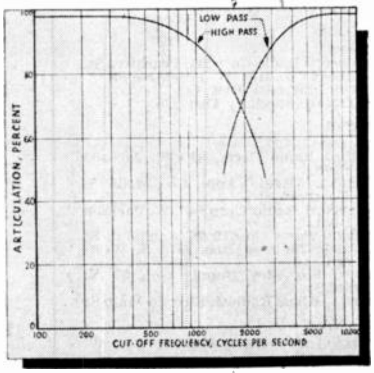
FIG. 8. NOISE SUPPRESSION CONDENSER

bracket is 1,800 megohms at 25° C. Ambient temperature rating for continuous service is − 50° to + 50° C. Each unit is factory tested at 1,300 volts DC for 15 seconds.



THE EFFECTIVE REPRODUCTION OF SPEECH...





When casually considered, the reproduction of speech may appear to present less exacting requirements than the reproduction of music. Yet *faithful* speech reproduction requires a frequency band almost as wide as for music. Amplified speech for strictly *communication* purposes usually presents a different requirement. Here, such matters as articulation, loudness, masking, power requirements and the ability to deliver the message through noise, become the more important considerations.

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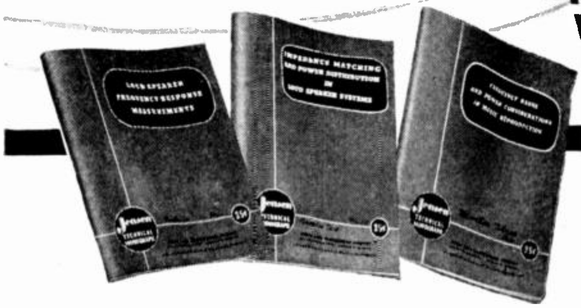

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SAN FRANCISCO, Zack Radio Supply Co., 1426 Market St.

CONNECTICUT

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

DISTRICT OF COLUMBIA

WASHINGTON, Southern Wholesalers, Inc., 1519 L St. N. W.

GEORGIA

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

ILLINOIS

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

INDIANA

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

IOWA

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

KENTUCKY

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

MARYLAND

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

MASSACHUSETTS

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

MICHIGAN

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

MISSOURI

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

NEW JERSEY

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

NEW YORK

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

NORTH CAROLINA

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

OHIO

CLEVELAND, Goldhamer Inc Huron Rd

PENNSYLVANIA

HARRISBURG, D & H Distributing Co., 3115 Cameron St.
PHILADELPHIA, Radio Elec. Service Co., 7th & Arch Sts.
PITTSBURGH, Cameradio Co., 963 Liberty St.
WILLIAMSPORT, Williamsport Auto Parts Co.

RHODE ISLAND

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

NEW LISTINGS ADDED THIS MONTH

Company addresses will be found in the Directory listings

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

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

AIRPORT RADIO Installations
Collins Radio Company

AMPLIFIERS, Studio
Fairchild Camera & Instrument Corp.
Radio Corporation of America
Western Electric Company

AMPLIFIERS, Public Address
David Bogen Co., Inc.
Langevin Company
Operadio Mfg. Co.
Radio Corporation of America
Western Electric Company

ANTENNAS, Loop, Built-in
DX Crystal Co.

BERYLLIUM
Clifton Products, Inc.

BUSHINGS, Terminal Sealing
Lenox, Inc.

CABINETS, Metal
Cole Steel Equipment Co.
Karp Metal Products Co., Inc.

CABLE, Coaxial, Fittings
Andrew Co.
Communication Products Co.
Johnson Co., E. F.

CABLES, Preformed
Whitaker Cable Corp.

CONDENSERS, Fixed
General Electric Company

CONDENSERS, Gas-Filled
Johnson Co., E. F.

CONDENSERS, Transmitter Neutralizing
Hammarlund Mfg. Co.
Johnson Co., E. F.
National Company, Inc.
Millen Mfg. Co., Inc

CONNECTORS, Cable
International Resistance Co.
Diamond Instrument Co.

DIALS, Instrument
Gordon Specialty Co.

FILTERS, Electrical Noise
General Electric Company

GENERATORS, Beat Frequency
Boonton Radio Corp.
General Radio Company

HEADPHONES
Telex Products Co.

INDUCTORS, Transmitting
Johnson Co., E. F.

INSULATORS, Ceramic Standoff, Lead-in, Rod Types
Stupakoff Ceramic & Mfg. Co.
General Ceramics & Steatite Corp.

METERS, Ammeters, Voltmeters, Small Panel
J-B-T Instruments, Inc.
Norton Electrical Instrument Co.

METERS, Frequency
J-B-T Instruments, Inc.
Radio Corporation of America

METERS, Vacuum Tube Volt
Barber Laboratories, A. W.

MOUNTINGS, Shock Absorbing
General Tire & Rubber Co.

PLASTICS, Transparent
Acadia Synthetic Products

QUARTZ Tubes, Rods, Plates
Hanovia Chem. & Mfg. Co.

PLATINUM
Sigmund Cohn & Co.

RADIO RECEIVERS & TRANSMITTERS
Collins Radio Company
Foote Pierson & Co., Inc.
Technical Radio Co.
United Cinephone Corp.

RECTIFIERS, Metallic Instrument & Relay
Bradley Laboratories, Inc.
Conant Electrical Laboratories

RELAYS, Hermetically Sealed
Clare & Co., C. P.
Sigma Instruments, Inc.
Allied Control Co., Inc.

RELAYS, Plug-in
Clare & Co., C. P.
Leach Relay Co.
Sigma Instruments, Inc.

RELAYS, Transmitter Switching & Keying
Gordon Specialty Co.
Johnson Co., E. F.

RESISTORS, Fixed
Elco Resistors Co.
Groves Corp.

RESISTORS, Fixed Precision
General Radio Company

RESISTORS, Variable Laboratory Type
General Radio Company

SHIELDS, Tube
Cinch Mfg. Corp.

SPEAKERS, Outdoor Type
Langevin Company

SWITCHES, Midget Snap
General Electric Company
Spencer Thermostat Co.

TERMINAL STRIPS
Cook Electric Co.

THERMISTORS
Western Electric Company

TRANSFORMERS, Receiver Audio & Power
Consolidated Radio Products Co.
Foster Co., A. P.
Hercules Electric & Mfg. Co.

TUBES, Cathode Ray
Electronic Tube Corp.

TUBES, Transmitting
General Electronics, Inc.
Machlett Laboratories, Inc.

Tubes, X-Ray
General Electric X-Ray Corp.
Machlett Laboratories, Inc.
North America Philips Co., Inc.
Picker X-Ray Corp.
Westinghouse Electric & Mfg. Co.

VARNISHES, Fungus Resistant
Communication Prod. Co., Inc.
Insl X Co., Inc.
Maas & Waldstein Co.

SOUTH DAKOTA

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

TENNESSEE

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

TEXAS

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

UTAH

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

VIRGINIA

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

WASHINGTON

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

WEST VIRGINIA

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

WISCONSIN

RACINE, Standard Radio Parts Co., State St.

AIRPORT RADIO Installations

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

AMPLIFIERS, Public Address

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

AMPLIFIERS, Studio

Fairchild Camera & Inst Corp Jamaica 1 N Y
Radio Corp. of Amer. Camden N J
Western Electric Co 195 Bway N Y C

ANTENNAS, Loop, Built-in

DX Crystal Co 1200 N Claremont Ave Chicago 22

ANTENNAS, Mobile Whip & Collapsible

Air Associates, Inc., Los Angeles
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Bendix Aviation Corp., Pacific Div., 116 Sherman Way, N. Hollywood
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Brach Mfg. Corp., L. S., Newark, N. J.
Camburn Elec. Co., 484 Broome St., N. Y. C.
Galvin Mfg. Corp., Chicago, Ill.
Link, F. M., 125 W. 17th St., N. Y. C.
Premax Products, 4214 Highland Ave., Niagara Falls, N. Y.
Radio Eng. Labs., Inc., L. I. City, N. Y.
Snyder Mfg. Co., 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.
Intl. Resistance Co 429 Broad St Phila
Mallory & Co., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Remler Co., Ltd., 2101 Bryant St., San Francisco
Shallcross Mfg. Co., Collingdale, Pa.
Tech Labs. Lincoln St Jersey City N J
Utah Radio Prod. Co., 842 Orleans St., Chicago

BEADS, Insulating

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

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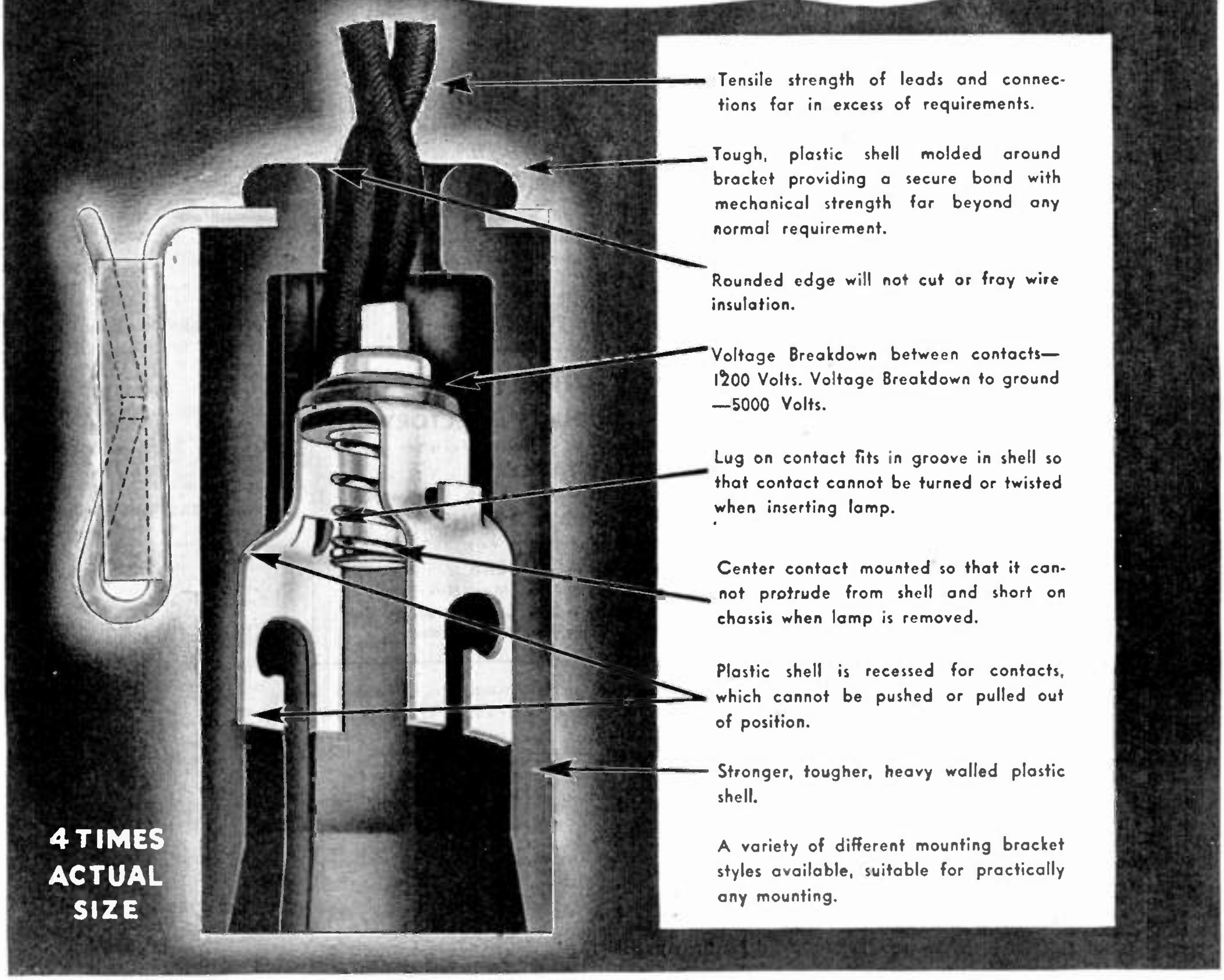

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ELECTRIC CORDS, WIRES AND CABLES

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

BERYLLIUM
Clifton Products Inc Painesville O

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

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

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

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

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

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

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

CABINETS, Metal
Cole Steel Equip. Co 349 Bway N Y C
Karp Metal Prod. Co Inc 126 30th St Bklyn 31
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
Comm. Prods. Co., 744 Broad, Newark, 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.
Lens Electrical Mfg. Co.
Radex Corp., 1308 Elston Ave., Chicago
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Coaxial, Fittings
Andrew Co, Victor J. 363 E 75 St Chicago
Comm. Prod. Co 744 Broad St Newark N J
Johnson Co, E. F. Waseca Minn

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

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

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

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

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

CERAMICS, Bushings, Washers, Special Shapes
Akron Porcelain Co., Akron, O.
Amer. Lava Corp., Chattanooga, Tenn.
Centralab, Div. of Globe-Union Inc., Milwaukee, Wis.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Paterson, N. J.
Gen'l Ceramics & Steatite Corp., Keasbey, N. J.
Isolantite, Inc., Belleville, N. J.
Lapp Insulator Co., Leroy, N. Y.
Lenox, Inc., Trenton, N. J.
Louthan Mfg. Co., E. Liverpool, O.
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, AF
Hadley Co., R. M., 707 E. 61 St., Los Angeles

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

CLIPS, Connector
Mueller Electric Co., Cleveland, O.

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

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

COIL FORMS, Glass
Corning Glass Works, Corning, N. Y.

COIL FORMS, Phenolic
Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.
Northeastern Molding, Inc., 534 Commonwealth Ave., Boston 15, Mass.

COILS, Radio
See Transformers, IF, RF

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

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

CONDENSERS, Gas-filled
Johnson Co, E. F. Waseca Minn
Lapp Insulator Co., Inc., Leroy, N. Y.

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

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

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

CONDENSERS, 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
Amer. Radio Hdware Co., Mt. Vernon, N. Y.
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
Diamond Inst. Co Wakefield Mass
Eby, Inc., Hugh H., Philadelphia
Electro Voice Mfg. Co., South Bend, Indiana
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass.
Intl. Resistance Co 401 N Broad St Phila 8
Harwood Co., 5405 S. La Brea, Los Angeles 36
Insuline Corp. of Amer., L. I. City, N. Y.
Jones, Howard B., 2432 W. George, Chicago
Mallory & Co., P. R., Indianapolis, Ind.
Monowatt Electric Co., Providence, R. I.
Northam Warren Corp., Stamford, Conn.
Radio City Products Co., 127 W. 26 St., N. Y. C.
Remler Co., Ltd., 2101 Bryant St., San Francisco
Schott Co., W. L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Selectar Mfg. Co., L. I. City, N. Y.
Universal Microphone Co., Ltd., Inglewood, Calif.

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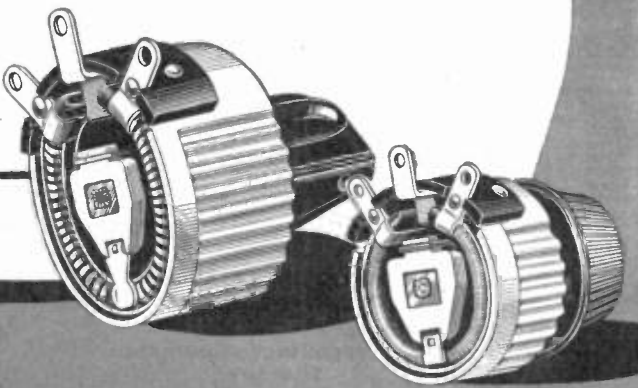

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Built to surpass rigid Army-Navy "specs," IRC Resistors will offer greater values than ever because of modern mass production methods and greatly increased plant capacity.

INQUIRIES INVITED

It's none too soon for manufacturers of electronic equipment to survey their immediate post-war resistor needs. If you anticipate design or engineering problems involving resistances, we may be able to help in their solution. Feel free to call upon us and be assured your confidence will be respected.

QUALITY FEATURES OF IRC RHEOSTATS

1. All metal *shatter and vibration-proof construction.*
2. *Design provides almost 50% less temperature rise than other types for equal wattage rating and size.*
3. *Aluminum construction provides light weight.*
4. *Uniform spacing and tight winding of resistance element.*
5. *Enclosed construction as protection against dust, dirt and damage to the moving parts.*
6. *Clock spring between central terminal and slide eliminates one wiping contact and spring.*

INTERNATIONAL RESISTANCE CO.

401 N. Broad St. Philadelphia 8, Pa.

IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.

CONTACT POINTS

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

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.
Howard Mfg. Co., Council Bluffs, Ia.

CRYSTALS, Quartz

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

DIAL LIGHTS

See PILOT LIGHTS

DIALS, Instrument

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

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, Small

ENAMELS, Wood & Metal Finish

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

ETCHING, Metal

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

FACSIMILE EQUIPMENT

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

FASTENERS, Separable

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

FELT

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

FIBRE, Vulcanized

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

FILTERS, Electrical Noise

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

FINISHES, Metal

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

FREQUENCY STANDARDS, Primary

General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Secondary

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

FUSES, Enclosed

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

GEARS & PINIONS, Metal

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

GEARS & PINIONS, Non-Metallic

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

GENERATORS, Beat Frequency

Boonton Radio Corp Boonton N J
General Radio Co Cambridge Mass

GENERATORS, Electronic AC

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

GENERATORS, Gas Engine Driven

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

GENERATORS, Hand Driven

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

GENERATORS, Standard Signal

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

GENERATORS, Wind-Driven, Aircraft

General Armature Corp., Lock Haven, Pa.

GLASS, Electrical

Corning Glass Works, Corning, N. Y.

GREASE, for Electrical Contacts & Bearings

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

HANDSETS, Telephone

Automatic Electric Co., 1033 W. Van Buren, Chicago
Western Electric Co., 195 B'way, N. Y. C.

HEADPHONES

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

HORNS, Outdoor

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

INDUCTION HEATING EQUIPMENT

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

INDUCTORS, Transmitter

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

INDUCTORS, Variable Tuning

Barker & Williamson, Darby, Upper 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.
Gen. Ceramics & Steatite Corp Keasbey N J
Isolantite, Inc., Belleville, N. J.
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.
Stupakoff Ceramic & Mfg Co Latrobe Pa

INTERFERENCE SUPPRESSORS

See FILTERS, Electrical Noise

IRON CORES, Powdered

Aladdin Radio Industries, Inc, 501 W. 35 St., Chicago
Crowley & Co., Henry, W. Orange, N. J.
Ferrocart Corp. of Amer., Hastings-on-Hudson, N. Y.
Genl. Aniline Wks., 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.
Sound Equipment Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Ungar, Inc., Harry A., 615 Ducommun St., Los Angeles 12
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles
Vulcan Electric Co., Lynn, Mass.

JACKS, Telephone

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

KEYS, Telegraph

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

KNOBS, Radio & Instrument

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

LABELS, Coding

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

LABELS, Removable

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

LABELS, Stick-to-Metal

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

LABORATORIES, Electronic

Browning Labs., Inc., Winchester, Mass.
Electronic Corp. of Amer., 45 W. 18 St., N. Y. C.
Hazeltine Electronics Corp., 1775 B'way, N. Y. C.
Sherron Metallic Corp., Flushing Ave., Brooklyn, N. Y.
Worner Electronic Devices, 848 N. Noble St., Chicago 22

LACQUERS, Wood & Metal Finish

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

LOCKWASHERS, Spring Type

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

LUGS, Soldering

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

LUGS, Solderless

Aircraft Marine Prod., Inc., Harrisburg, Pa.

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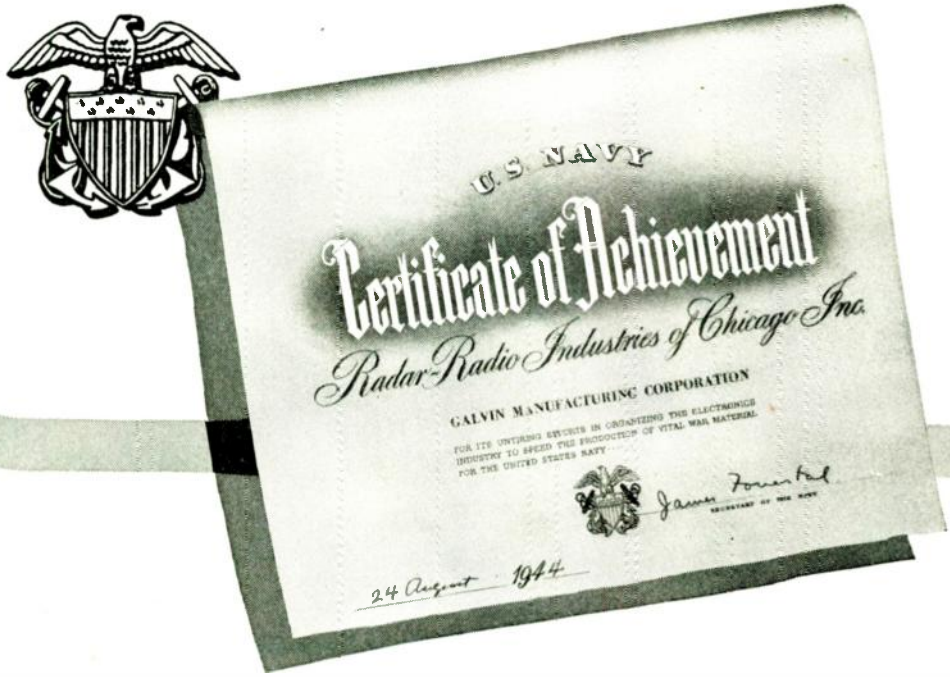

The United States Navy has created a special award of merit. This certificate of achievement was presented to the Radar-Radio Industries of Chicago in a colorful ceremony at Wrigley Field on Sunday, September 10th, for their extraordinary contribution to the successful prosecution of the war. The Galvin Mfg. Corporation, manufacturers of Motorola F-M radio for home and car, is proud of its membership in the Radar-Radio Industries of Chicago . . . and also proud of the part it has been privileged to play in the winning of this signal honor.

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Thomas & Betts Co., Elizabeth 1, N. J.

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

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

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

MAIL ORDER SUPPLY HOUSES
See listing at head of Directory

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

MARKING MACHINES, Letters, Numbers
Marken Machine Co., Keene, N. H.

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

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

METERS, Frequency
Bendix Radio, Towson, Md.
Browning Labs., Inc., Winchester, Mass.
General Radio Co., Cambridge, Mass.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
J-B-T Instruments Inc New Haven Conn
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.
Radio Corp. of Amer. Camden N J

METERS, Q
Boonton Radio Corp., Boonton, N. J.

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

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

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

MICROPHONES
Amer. Microphone Co., 1015 Western Av., Los Angeles
Amperite Co., 561 B'way, N. Y. C.
Astatic Corp., Youngstown, O.
Brush Development Co., Cleveland, O.
Electro Voice Mfg. Co., South Bend, Ind.
Kellogg Switchboard & Supply Co., 6650 S. Cicero, Chicago

Philmore Mfg. Co., 113 University Pl., N. Y. C.
Permoflux Corp., 4916 W. Grand Av., Chicago
Radio Corp. of Amer., Camden, N. J.
Radio Speakers, Inc., 221 E. Cullerton, Chicago
Rowe Industries, Inc., Toledo, O.
Shure Bros., 225 W. Huron St., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Turner Co., Cedar Rapids, Ia.
Universal Microphone Co., Inglewood, Cal.

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

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

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

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

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

NAME PLATES, Etched Metal
See ETCHING, Metal

NAME PLATES, Plastic
Crowe Name Plate & Mfg. Co., 3700 Ravenswood Ave., Chicago
Hopp Press, Inc., 460 W. 34 St., N. Y. C.
Parisian Novelty Co., 3502 S. Western Ave., Chicago
Virginia Plate Co., 270 Madison Ave., N. Y. C. 16

NICKEL, Sheet, Rod, Tubes
Eagle Metals Co., Seattle, Wash.
Pacific Metals Co., Ltd., San Francisco, Calif.
Steel Sales Corp., 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.

NOISE FILTERS
See FILTERS, Electrical Noise

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

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

OSCILLOSCOPES, Cathode Ray
Du Mont Laboratories, Inc., Allen B., Passaic, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Millen Mfg. Co., Malden, Mass.
Panoramic Radio Corp., 242 W. 55 St., N. Y. C.

Reiner Electronics Co., 152 W. 25 St., N. Y. C.
RCA Mfg. Co., Inc., Camden, N. J.
Radio City Products Co., Inc., 127 W. 26 St., N. Y. C.

OVENS, Industrial & Laboratory
General Elec. Co., Schenectady, N. Y.
Trent Co., Harold E., Philadelphia

PANELS, Metal Etched (See Etching, Metal)

PANELS, Phenolic, Cast without Molds
Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.

PHONOGRAPH RECORDING BLANKS
See DISCS, Recording

PHONOGRAPH RECORD PLAYERS
See TURNTABLES, Phonograph

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

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

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

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

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

Surprenant Elec. Ins. Co., Boston
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

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

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

PLATING, Metal on Molded Parts
Metaplast Corp., 205 W. 19 St., N. Y. C.

PLATINUM
Sigmund Cohn & Co 44 Goldt St N Y C

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

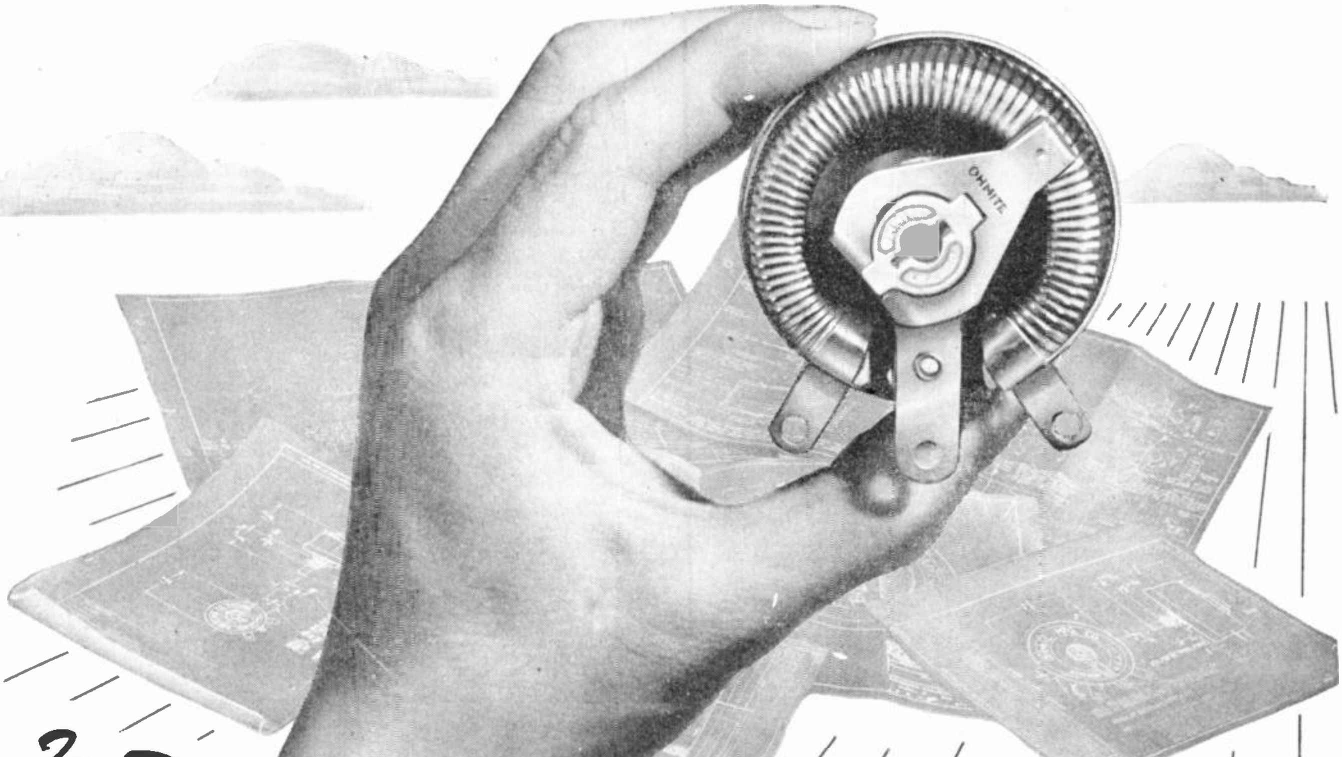
PLUGS, Telephone Type
Alden Prods. Co., Brockton, Mass.
American Molded Prods. Co., 1753 N. Honore, Chicago
Chicago Tel. Supply Co., Elkhart, Ind.
Guardian Elec. Mfg. Co., 1400 W. Wash. Blvd., Chicago
Insuline Corp. of Amer., L. I. City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, H. B., 2300 Wabansia, 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

QUARTZ, Rods, Tubes, Plates
Hanovia Chem. & Mfg Co Newark 5 N J

RACKS & PANELS, Metal
See STAMPINGS, Metal

RADIO RECEIVERS & TRANSMITTERS
Abbott Instrument, Inc., 8 W. 18 St., N. Y. C. 3
Air Associates, Inc., Los Angeles
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Aircraft Radio Corp., Boonton, N. J.
Aircraft Radio Equip. Corp., 6244 Lex. Ave., Hollywood, Calif.
Air Communications, Inc., 2233 Grant Ave., Kansas City, Mo.
Air King Products Co., 1523 63rd Ave., Brooklyn, N. Y.
Airplane & Marine Inst., Inc., Clearfield, Pa.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Amplex Engineering, Inc., New Castle, Ind.
Arnessen Electric Co., 116 Broad St., N. Y. C.
Automatic Radio Mfg. Co., 122 Brookline Ave., Boston, Mass.
Bassett, Inc., Rex, Ft. Lauderdale, Fla.
Belmont Radio Corp., 5921 Dickens Ave., Chicago
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Boes Co., The W. W., Dayton, O.
Browning Laboratories, Inc., Winchester Mass.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Burnett Radio Lab., 4814 Idaho St., San Diego, Calif.
Collins Radio Co Cedar Rapids Ia
Colonial Radio Corp., Rano St., Buffalo, N. Y.
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



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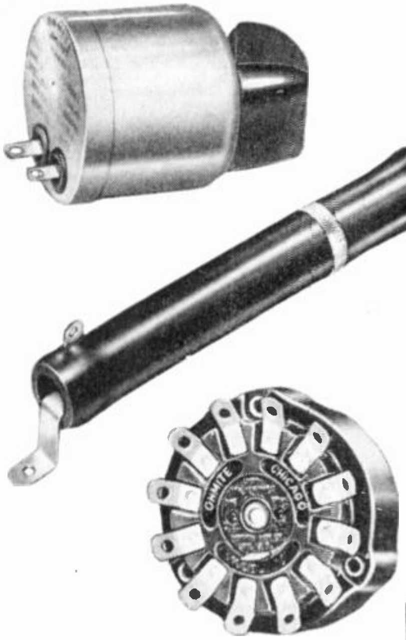

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Detrola Corp., 1501 Beard Ave., Detroit, Mich.
De Wald Radio Mfg. Corp., 436 Lafayette St., N. Y. C.
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DuMont Labs., Inc., Allen B., Passaic, N. J.
Echophone Radio Co., 201 E. 26 St., Chicago
Eckstein Radio & Telev. Co., Inc., 1400 Harmon Pl., Minneapolis, Minn.
Electrical Ind. Mfg. Co., Red Bank, N. J.
Elect. Research Lab., Inc., Evanston, Ill.
Electronic Communications Co., 36 N. W. B'way, Portland, Ore.
Electronic Corp. of Amer., 45 W. 18 St., N. Y. C.
Electronic Specialty Co., Glendale, Calif.
Emerson Radio & Phone Corp., 111 8th Ave., N. Y. C.
Erco Radio Labs., Inc., Hempstead, N. Y.
Espey Mfg. Co., Inc., 305 E. 63 St., N. Y. C.
Fada Radio & Elec. Corp. 30–20 Thomson Ave., Long Island City, N. Y.
Farnsworth Tele. & Radio Corp., Ft. Wayne 1, Ind.
Federal Electronics Div., 209 Steuben St., B'klyn, N. Y.
Federal Tel. & Radio Corp., Newark, N. J.
Finch Telecommunications, Inc., Passaic, N. J.
Fisher Research Lab., Palo Alto, Calif.
Foote Pierson & Co Inc 75 Hudson St Newark 5 N J
Freed Radio Corp., 200 Hudson St., N. Y. C.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago
Garod Radio Corp., 70 Washington St., B'klyn, N. Y.
Gates Radio & Supply Co., Quincy, Ill.
General Communication Co., 681 Beacon St., Boston, Mass.
General Electric Co., Schenectady, N. Y.
General Telev. & Radio Corp., 1240 N Homan Ave., Chicago
Gibbs & Co., Thomas B., Delavan, Wis.
Gilfillen Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Girdler Corp., Louisville, Ky.
Gray Mfg. Co., Hartford, Conn.
Gray Radio Co., West Palm Beach, Fla.
Grenby Mfg. Co., Plainville, Conn.
Guided Radio Corp., 161 6th Ave., N. Y. C.
Hallicrafters Co., 2611 Indiana Ave., Chicago
Halstead Traffic Com. Corp., 155 E. 44 St., N. Y. C.
Hamilton Radio Corp., 510 Sixth Ave., N. Y. C.
Hammarlund Mfg. Co., 460 W. 34th St., N. Y. C.
Harrel, D. H., 1527 E. 74 Pl., Chicago
Harvey Machine Co., Inc., 6200 Avalon Blvd., Los Angeles
Harvey Radio Labs, Inc., Cambridge, Mass.
Harvey-Wells Com., Inc., Southbridge, Mass.
Hazeltine Electronics Corp., Great Neck, N. Y.
Herbach & Rademan Co., 522 Market St., Phila.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles
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.
Noblitt-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.
Radiation Products, Inc., 1142 S. Wall, Los Angeles 15
Radio Corp. of Amer., Camden, N. J.
Radio Craftsmen, 1340 S. Mich. Ave., Chicago
Radio Engineering Labs., 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.
Tech. Radio Co 275 9th St San Francisco 3
Templetone Radio Co., Mystic, Conn.
Transmitter Equip. Mfg. Co., 345 Hudson St., N. Y. C.
United Cinephone Corp Torrington Conn
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Waugh Laboratories, 420 Lexington Ave., N. Y. C.
Western Electric Co 195 B'way N Y C
Westinghouse Elec. & Mfg. Co., Wilkens Ave., Baltimore, Md.
Wilcox Electric Co., 14th & Chestnut Sts., Kansas City, Mo.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECTIFIERS, Metallic Current

Benwood Linze Co., St. Louis, Mo.
Continental Elec. Co., 903 Merchandise Mart, Chicago
Electronics Labs., Indianapolis, Ind.
Fansteel Metallurgical Corp., N. Chicago, Ill.
Federal Tel. & Radio Corp Newark 1 N J
General Electric Co., Bridgeport, Conn.
Green Elect. Co., Inc., 130 Cedar St., N. Y. C.
Mallory & Co., P. R., Indianapolis, Ind.
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, Metallic Instrument & Relay

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

REGULATORS, Temperature

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

REGULATORS, Voltage

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

RELAYS, Hermetically Sealed

Allied Control Co Inc 2 E End Ave N Y C
Clare & Co, C. P. 4719 Sunnyside Ave Chicago 30
Sigma Instruments Inc 70 Ceylon St Boston 21

RELAYS, Plug-in

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

RELAYS, Small Switching

Advance Elec. Co., 1260 W. 2nd, Los Angeles
Allied Control Co Inc 2 W End Ave N Y C
Amperite Co., 561 Broadway, N. Y. C.
Automatic Elec. Co., 1033 W. Van Buren, Chicago
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Birtcher Corp., 5087 Huntington Dr., Los Angeles 32
Cook Elec. Co., 2700 Southport Ave., Chicago

Electrical Prod. Supply Co., 1140 Venice Blvd., Los Angeles 15
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago
Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Potter & Brumfield Co., Princeton, Ind.
Sigma Instruments, Inc., 76 Freeport St., Boston, Mass.
Struthers Dunn, Inc., 1326 Cherry St., Philadelphia
Ward-Leonard Elec. Co Mt Vernon N Y

RELAYS, Small Telephone Type

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

RELAYS, Stepping

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

RELAYS, Time Delay

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

RELAYS, Transmitter Switching and Keying

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

RELAY TESTERS, Vibration

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

RESISTORS, Fixed

Acme Elec. Heating Co., Boston, Mass.
Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., N. Y. C.
Carborundum Co., Niagara Falls, N. Y.
Centralab, Milwaukee, Wisconsin
Clarostat Mfg. Co., 130 Clinton St., Bklyn, N. Y.
Cont'l Carbon, Inc., Cleveland, O.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Jersey City, N. J.
Elco Resistors Co 114 W 18 St N Y C
Erie Resistor Corp., Erie, Pa.
Globar Div. Carborundum Co., Niagara Falls, N. Y.
Groves Corp Cape Girardeau Mo
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
Intern'l 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

General Radio Co Cambridge Mass
Inst. 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.
General Radio Co Cambridge Mass
Sticht Co., Inc., H. H., 27 Park Pl., N. Y. C.

RESISTORS, Variable

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

RESISTORS, Variable, Ceramic Base

Lectrohm, Inc., 5125 W. 25th, Cicero, Ill.
Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SCREW MACHINE PARTS, Brass, Steel

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

SCREW MACHINE PARTS, Non-Metallic

Continental-Diamond Fibre Co., Newark, Del.

SCREWS, Clutch Head

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

SCREWS, Recessed Head

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

SCREWS, Self-Tapping

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

SCREWS, Set and Cap

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

SCREWS, Hollow & Socket Head

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

SELENIUM

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

SHAFTING, Flexible

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

ANTENNAS FOR FM STATIONS

(CONTINUED FROM PAGE 23)

A type of square loop antenna which can conveniently be mounted *around* a standard AM broadcast tower has been designed by Dr. G. H. Brown of RCA Laboratories (U. S. Patent No. 2,207,781). While various configurations are possible, including a three-sided type, the most usual arrangement is to employ 4 sides.

The radiators are half-wavelength sections supported at the ends by pieces of tubing which run diagonally across the square and are attached near the center to the framework of the AM tower. These supports have shorting bars placed at points a quarterwave in from the corners. Since the points where the shorting bars are located represent voltage nodes, the supports can be at ground potential.

Several one- and two-layer arrays of this kind have been built, and at WBRL, Baton Rouge, La., there has been in operation for the past three years a six-layer antenna of this type. In this case, the FM antenna is mounted at the top of a 500-ft. AM tower, as shown in Fig. 10. The original intention had been to put a six-bay turnstile at the top of this tower. However, querying the tower manufacturer brought out the fact that to provide adequate support for the turnstile, some 150 ft. of the tower would have had to be removed. The saving in tower height effected by this use of the square-loop antenna is illustrated in Fig. 11.

The *gain per layer* of the square-loop antenna is greater than that of either the turnstile or the ring antenna. The reason will be evident when it is noted that each layer has effectively twice as many radiators as the turnstile. Moreover, because the vertical radiation is very low, the layers can be mounted at half-wave intervals. Comparative gains of the several types of antenna are shown in Fig. 8.

Despite its high gain and mounting advantages, however, the square-loop antenna should be considered only when the other types cannot possibly be used. There are three reasons for this statement. First, such an antenna must be laid out and probably built on the location. This is because each one will be slightly different as to arrangement and mounting details. Second, the tuning is quite critical and must be done with the radiators in place. In the case of WBRL the top section of the tower was set up on the ground and preliminary adjustments made before it was raised to the top of the tower. Third, it is very difficult to design such an antenna to withstand a heavy ice load — although this, of course, does not mitigate against its use in the South.

Summary ★ In summing up the information on FM antennas developed out of experience to date, the best advice that can be given to station engineers setting out to plan an FM station is:

1. Choose an antenna which can be purchased complete — a packaged item.

2. Select an antenna type which can be pretuned so that engineering adjustments will not have to be made at the time of installation.

3. Get as much antenna gain as possible, but remember that the building or structure on which the antenna is to go may set a definite limit.

4. Note that it is the height of the supporting pole which determines the type of antenna that can be erected — hence *gain per height of pole* is the true figure of merit.

5. Remember that adequate provision must be made for wind-resistance and icing conditions, where they exist.

Editor's Note: A second article on FM antennas, giving further quantitative design data, will appear in an early issue of FM AND TELEVISION.

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.
Cinch Mfg Corp 2335 W Van Buren St Chicago 12

SHOCK ABSORBERS

See MOUNTINGS, Shock Absorbing

SIGNAL GENERATORS

See GENERATORS, Standard Signal

SOCKETS, Cathode Ray Tube

Franklin Mfg. Corp., 175 Varick St., N. Y. C.

SOCKETS, Tube

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

SOCKETS, Tube, Ceramic Base

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.
Sound Equip. Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

SPEAKERS, Cabinet Mounting

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

SPEAKERS, Outdoor Type

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

SPRINGS

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

STAMPINGS, Metal

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

STEATITE, See Ceramics

SUPPRESSORS, Parasitic

Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SWITCHES, Aircraft Push

Square D Co., Kollsman Inst. Div., Elmhurst, N. Y.
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, Midget Snap

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

SWITCHES, Rotary, Bakelite Wafer

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

SWITCHES, Rotary, Ceramic Wafer

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

SWITCHES, Time Delay

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

SYNTHETICS, Wood & Metal Finish

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

TERMINALS, Hermetically Sealed

See BUSHINGS, Terminal Sealing

TERMINALS, Soldered or Solderless

See LUGS, Soldering and Solderless

TERMINALS (Turret Lugs)

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

TERMINAL STRIPS

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

TEST CHAMBERS, Temperature, Humidity, Altitude, Salt Spray

American Coils Co., 25 Lexington St., Newark, N. J.

POSTWAR FM BROADCASTING

(CONTINUED FROM PAGE 25)

a totally new design and have a totally different characteristic.

Mr. Adair: Referring again to the 100-megacycle band, I understood the receiver designers to say that they could easily produce a receiver that would cover from 80 to 108 megacycles, which would give you a potentially much broader band.

Major Armstrong: I will agree with the exception of the word "easily" for the manufacturers. I have no doubt that in time what you say would be so.

Commissioner Walker: You spoke of your prediction that FM would supersede AM. Is that prediction taking into consideration the economic factors in serving long distances, for example, in thinly or sparsely settled western territory?

Major Armstrong: In the main, yes, I think so, Commissioner Walker. I have great hopes of what can be done with automatic relays, and while there probably will be places where high power AM stations will run for a long time, I think that in the main the prediction is going to come true, even in those areas.

The Chairman: Do you think there is anything to be achieved by limiting the power of FM stations and precluding the establishment of the large stations to cover extensive areas?

Major Armstrong: A rather negative one so far as a man who lives in the extensive area could be concerned. Technically, I think it would be a step in the wrong direction. In the field of economics, I beg off on the ground that that is too complicated a subject for me to enter into.

Commissioner Durr: Major, in going along with the recommendation of approximately 75 channels, do you have in mind any number of stations to be accommodated on each channel?

Major Armstrong: A large number of duplications could be made and the number of duplications would, of course, depend on how much distance is assigned to each particular type of station.

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

progress that has been made in the fields of FM and television (or radar) is found to be so tremendous that the FCC is conducting hearings to provide frequencies for all the new radio services which will be afforded by these wartime developments.

Some idea of the magnitude of new FM and television services can be gained from the fact that, in 1939, the frequency spectrum above 30 mc. was a sort of unexplored continent, sampled experimentally, but commercially unexploited. Frequencies from about .06 to 30 mc. were ample to accommodate all the established services.

The FCC hearings now in progress will apportion frequencies to new services all the way up to 30,000 mc. This opens up new space in the radio spectrum 1,000 times as wide as was in use 5 years ago! And what seems almost unbelievable, yet it is true: Demands for assignments in this new ether territory already threaten to exceed available channels!

But to get back to developments in FM and television since the time these fields were "frozen" — the facts are that a considerable part of the new frequency assignments will go to television broadcasting, and nearly all the rest will be used for services employing FM for one purpose or another. These appear in the agenda of the FCC hearing. They are:

1. FM broadcasting
2. FM non-commercial, educational broadcasting
3. Television (FM for the sound channel)
4. Facsimile broadcasting (on FM)
5. Police and public utility communications, including radio teletype and facsimile (on FM)
6. Fire and Forestry communications (on FM)
7. Special services (chiefly on FM)
8. Railroad radio (on FM)
9. Highway radio communications (on FM)
10. Intercity bus communications (on FM)
11. Dispatching taxis and trucks (on FM)
12. Television relay networks (on FM)
13. FM broadcasting networks (on FM)

(CONTINUED ON PAGE 67)

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

THERMISTERS

Western Electric Co 195 Bway N Y C

TRACING PAPERS, CLOTH, CELLOPHANE

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

TRANSFORMERS, Constant-Voltage

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

TRANSFORMERS, IF, RF

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

TRANSFORMERS, Receiver Audio & Power

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

TRANSFORMERS, Variable Voltage

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

TUBE MANUFACTURING MACHINES

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

TUBES, Cathode Ray

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

TUBES, Current Regulating

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

TUBES, Photo-Electric

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

TUBES, Receiving

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

TUBES, Transmitting

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

TUBES, Voltage-Regulating

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

TUBES, X-Ray

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

TUBING, Laminated Phenolic

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

TUBING, Precision Metal

Superior Tube Co., Norristown, Pa.

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

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

TURNTABLES, Phonograph

Fairchild Camera & Inst. Co., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.
General Industries Co., Elyria, O.
General Inst. Corp., Elizabeth 3, N. J.
Presto Recording Corp., 242 W. 45 St., N. Y. C.
R C A Mfg. Co., Camden, N. J.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago
Webster Products, 3825 Armitage Ave., Chicago
Western Electric Co., 125 B'way, N. Y. C.

VARNISHES, Fungus Resistant

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

VARNISHES, Insulating, Air-Drying & Baking

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

VARNISHES, Wrinkle Finish

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

VIBRATION TEST EQUIPMENT

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

VIBRATORS, Power Supply

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

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

WELDING, Gas, Aluminum & Steel

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

WIRE, Bare

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

WIRE, Glass Insulated

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

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 65)

14. Telephone and teletype relays (on FM)
15. Government and military services (largely on FM)
16. Aviation communications (now headed toward FM)

This tabulation reveals the startling fact that the enormous expansion of radio services now planned for the immediate postwar period is almost entirely built around FM and television!

If such expansion in two fields that were supposedly put away in mothballs three years ago is surprising, it simply proves that radio is still full of surprises, and it shows how the war has accelerated research and development.

It is impossible to estimate the ratio of postwar to prewar radio equipment sales, but we do know that the thousandfold increase of available frequencies will be taken up rapidly by services already projected, and that they will be used almost entirely for services employing FM and for television.

That's why those who know say the change from war to peace will not be *reconversion*, but *expansion in new fields on a scale the radio industry has never known before.*

2. A great number of people have asked the very reasonable question: "Has wartime research and development brought about the use of some other system of radio transmission and reception that represents an improvement over FM comparable to advantages of FM over AM?"

If such a system exists under cover of military secrecy, it would be a serious mistake for the FCC to make definite postwar plans now for the application of FM to new services.

Because of the broad implications of this question, it was listed as the first item on the agenda of the Radio Technical Planning Board's FM Panel. In his statement to the FCC at the frequency allocations hearing, Panel Chairman C. M. Jansky, Jr., stated:

"The first issue appearing upon the panel's agenda dealt with the formulation of a recommendation respecting the type of modulation to be used for public service broadcasting in any band which might be assigned to this service lying between the limits 30,000 to 300,000 kilocycles, that is, 30 to 300 megacycles, commonly referred to as the very high frequency, that is, the VHF band. The panel felt that it should give objective consideration to all possible types of modulation known to the art including amplitude modulation, that is AM; frequency modulation, that is FM; and any other types of modulation which might conceivably grow out of the extensive developments and discoveries in the past few years in the radio art.

(CONCLUDED ON PAGE 68)

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 67)

"Since many of these developments and discoveries have taken place in connection with military research, it was the opinion of the panel that this issue should be considered by a group of men who, collectively, would have available to them the latest and best knowledge regardless of the fact that such knowledge might be highly classified in character.

"Therefore, this question was referred to the panel's committee on the State of the Art. The membership of this committee had been carefully selected to include a group known to have access to all available information.

"The committee reported to the panel that there are no systems of modulation, classified or otherwise, which show any indication of being either as good as or better than the Frequency Modulation system now in use. When the report of the committee was considered by the panel at its meeting on April 11, 1944, it was adopted unanimously by vote of all those present."

FM IN THE HURRICANE

(CONTINUED FROM PAGE 21)

the Jersey coast and headed for the tip of Long Island. Its ferocity was waning.

Sydney E. Warner, Supervisor of Radio for the Connecticut State Police reported modestly: "The operation of our radio system was not upset by the storm, and routine operation was maintained. We did provide numerous services to the State Highway Department and the New Haven Railroad Company." As pioneers in the use of state-wide FM communications, this department seems to have met this emergency in a routine manner.

The only report so far received from public utilities in the affected area came from the Connecticut Light and Power Company. William H. Wells, assistant engineer, said: "During the emergency incident to the recent hurricane, our radio served a vital need in maintaining communication with one important hydro plant where normally-used facilities failed. It was also a decided aid in expediting repair work on transmission and distribution lines, thereby aiding in restoring service to the public."

In the Cape Cod area of Massachusetts, there was very extensive damage, to the point where it was necessary to stop all cars entering that area unless the driver could show that he was a property owner. Only a few highways serve the great length of the Cape, and traffic congestion quickly became severe. No report on the use of the state-wide FM system has been received from Massachusetts at this time, but there is no question that it rendered vital public service.

Altogether, it is clear that the reduction in property damage and the recovery of property made possible by coördinated efforts through the use of 2-way FM state

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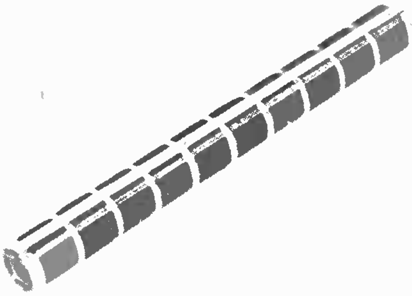
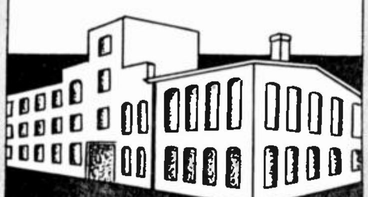




(CONTINUED FROM PAGE 68)

and municipal systems during this storm, not only covered the initial cost of the equipment but the maintenance expense for years to come. No price can be put on the work of the police in saving lives, without which the toll might have approached the 600 deaths resulting from the 1938 storm.

CHANNEL WIDTH AND FM SERVICE

(CONTINUED FROM PAGE 29)

willing to sacrifice performance to some extent, in order to conserve channel space, we can cut down the swing to 75 kc., which reduces the area of full noise-free reception and increases the outer limit of the service area. In this case, about half the area would receive truly noise-free service, and the other half would have service which would fall below this desirable value by an amount as much as 7 db. Any further decrease in transmitter swing, although it would increase the area out to the receiver threshold point, would decrease the area within which the full transmitter capabilities can be utilized to a small percentage of the total service area, and the receivers at the outer edge of the service area would obtain still further degraded service.

Of course, narrowing the swing of a transmitter reduces the channel space required, and thus permits more stations to operate in a given band. However, if we consider that the primary purpose of FM is to provide the possibility of truly noise-free reception, examination of Fig. 2 shows that below a swing of 125 kc. the truly noise-free service area decreases in proportion to the decrease in swing and there will be no increase in total area served by a given band of frequencies. In fact it is possible that there may be a decrease in total service, since the channel required by a transmitter must exceed a value of twice the transmitter swing somewhat in order to allow for receiver oscillator drift and to provide a reasonable amount of adjacent-channel selectivity. The receiver oscillator drift is a fixed quantity which will not vary as transmitter swing is changed, and the allowance for adjacent-channel selectivity is probably not directly proportional to swing. Therefore, it will not be possible to increase the number of channels in a given band of frequencies quite in proportion to the decrease in transmitter swing.

In conclusion, it appears that the present standard of 75 kc. transmitter swing is below the most desirable value, and results in some degradation of the signal-to-noise ratio over about half the service area of a transmitter. Any appreciable reduction of swing below this present value would degrade the service which can be provided to such an extent that the fundamental advantages of FM would be seriously jeopardized.

HEARING ON RAILWAY RADIO

(CONTINUED FROM PAGE 38)

space radio will be used, depending upon the terrain, conditions along the right-of-way, and types of service to be provided. He described combination induction and space radio equipment which his Company has been manufacturing for the Armed Forces.

Dr. L. E. Grondahl, director of engineering and research for the Union Switch and Signal Company, insisted that carrier systems alone would meet all railroad requirements. Bendix spokesmen, however, asserted that space radio provides the answer.

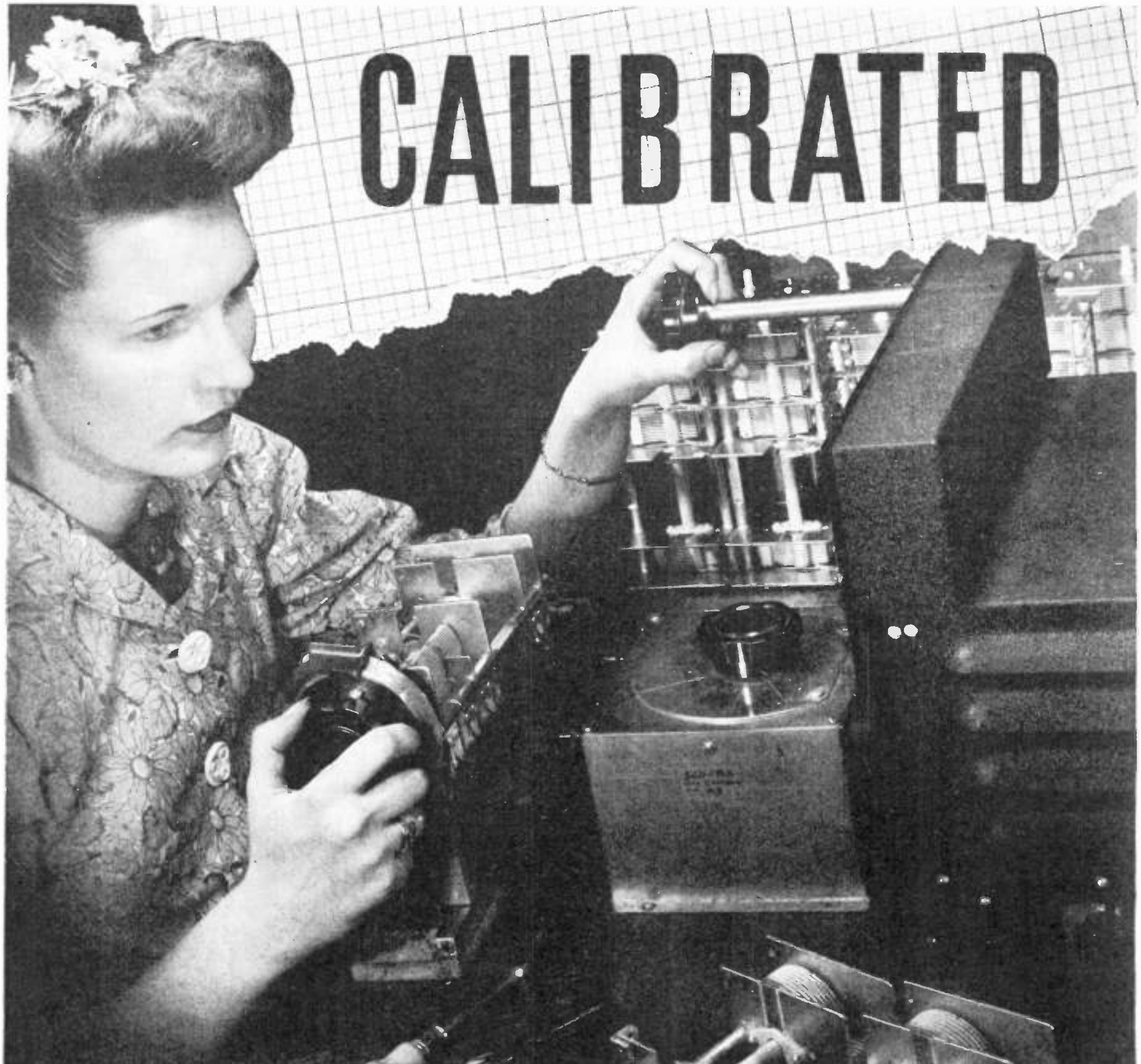
Practically all witnesses agreed on one point: Frequency Modulation is needed to reduce the interference from high noise levels incident to railroad operations. Even the Union Switch and Signal carrier system will, in the future, employ Frequency Modulation, according to Dr. Grondahl. Only the Bendix engineers appeared to consider FM unnecessary.

Ernest Dahl, radio engineer of the Rock Island, testified that even if FM were not needed at the higher frequencies to eliminate noise, it is useful to eliminate the "flutter effect" experienced on the high frequency tests he has been conducting.

Despite the wide differences of opinion expressed at the hearing, the case for railroad radio has been put into the record, and at least basic data is now in the hands of the FCC. At this time of writing, the requests for railroad communications frequencies have not been presented at the FCC's allocations hearing. They were reviewed at the September inquiry by John L. Niesse, assistant superintendent of telegraphs for the New York Central, and chairman of Committee 7 of the RTPB Panel on emergency services. They are:

For yard, terminal, front-to-rear, wayside, and maintenance communications 109 channels between 100 and 175 mc.; 18 consecutive channels between 1,000 and 1,009 mc. for railroad relay networks; 18 consecutive channels between 1,040 and 1,049 mc. for remote control communications; 3 channels in the band between 2 and 4 mc. for portable wayside use and for bridging gaps when metallic lines are down; 3 channels between 400 and 500 kc. for ship-to-shore radio; and 2 channels in the 375 kc. region for direction-finding systems on the Great Lakes and other inland waters where the railroads operate ships.

The FCC was asked to relax the operators' license requirements to the extent that only employees who install and repair radio equipment would have to pass examinations. Consideration was also given to the possibility of increasing the present field-strength limit of wavelength over 2π, for the benefit of railroad carrier systems.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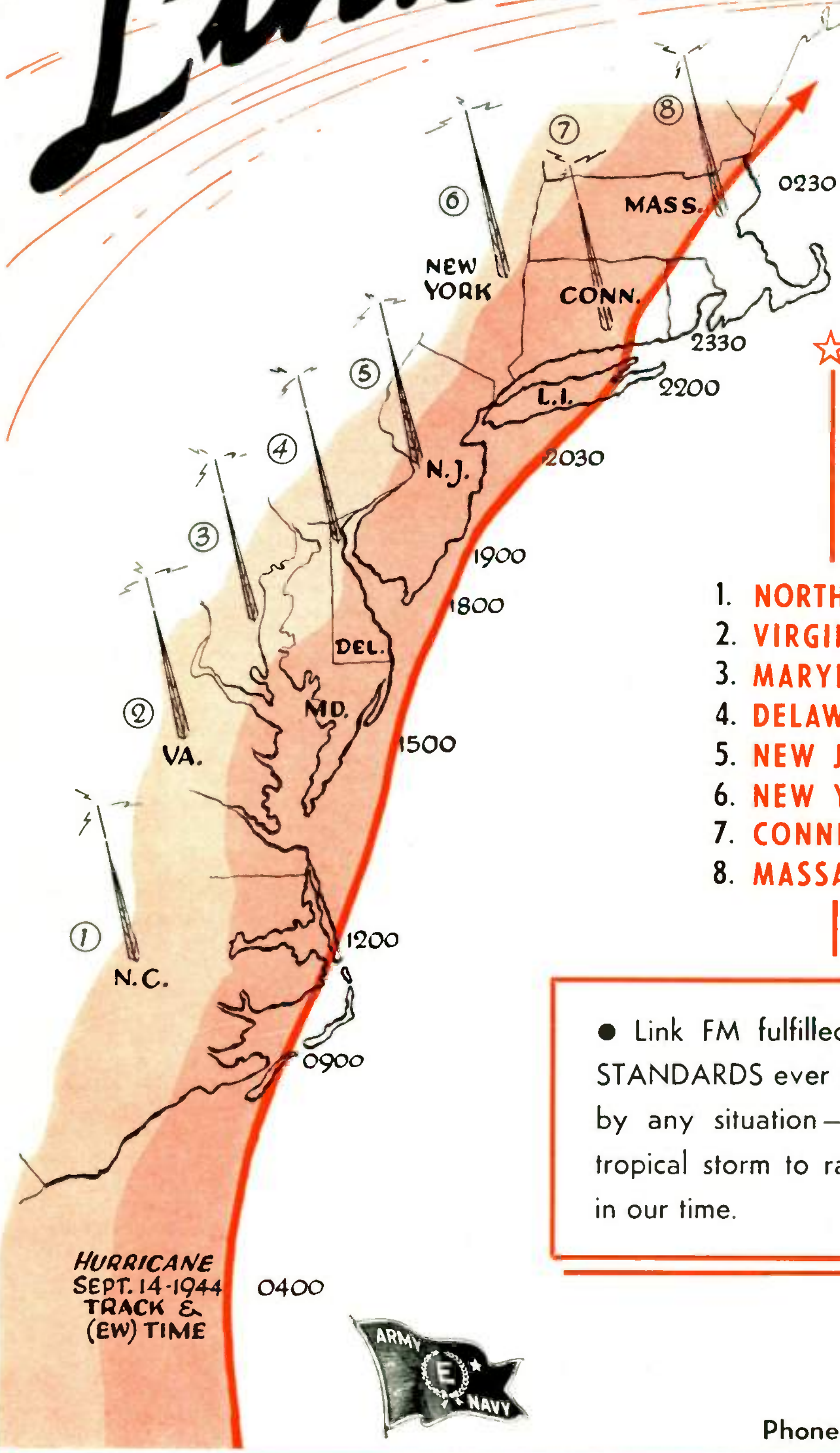
Link FM OUTRIDES MOST SEVERE HURRICANE



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