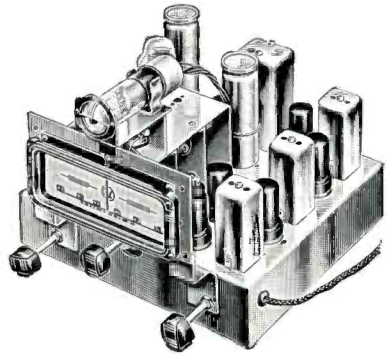
FM

NOVEMBER 1940

HE WINS AGAIN!

DEVOTED TO FREQUENCY MODULATION ★ FOR BROADCASTERS, MANUFACTURERS, DEALERS, SERVICE MEN ★ *Edited by M. B. SLEEPER.*

FIND OUT FOR YOURSELF—
THEN YOU CAN SELL OTHERS!

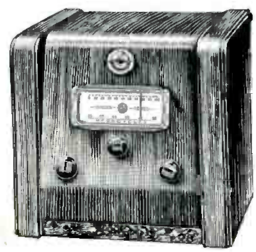


BROWNING F-M ADAPTER

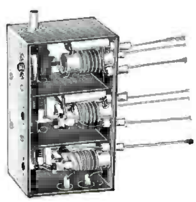
Servicemen — learn how to install f-m converters for operation with standard broadcast receivers. Then you can double your income by selling these units to your customers who have sets or phono combinations capable of high-quality reproduction. The Browning f-m converter, equipped with an RF stage, can be purchased partly assembled, or wired and ready for use. Tunes 42–50 mc. Write for details and net prices.

BROWNING CABINET MODEL ADAPTER

The Browning cabinet model converter can be attached to any standard receiver in a jiffy. In a favorable location, works with simple antenna. Di-pole recommended for distance. 42–50 mc. tuning covers all f-m broadcast channels authorized by FCC. Ideal for use where there is serious interference on standard broadcast band. Has tuned RF stage. Write for details and prices.



BROWNING F-M PARTS FOR SET-BUILDERS



The Browning tuning unit simplifies construction of experimental f-m sets. 3-gang precision condenser for tuned RF stage. Shielded, assembled 3 mc. broad-band IF transformers and air-tuned detection transformers also available for IF amplifier, limiter, and detection system. Write for details and prices.

ORDERS SENT TO THE FACTORY WILL BE FILLED THROUGH YOUR LOCAL JOBBER

F-M BROADCAST TRANSMITTING STATIONS

Inquiries are invited concerning the Browning F-M modulation monitor, for reading instantaneous frequency swing

BROWNING LABORATORIES, Inc.

755 MAIN STREET ▪ WINCHESTER, MASS.

Mr. Serviceman ....

Can you take it, or has your business got you down?

CAN you still use a new idea to get yourself into high gear, or has your enthusiasm for making a real success slowed down until you've got into the habit of dragging along in second gear?

How about that? Have you let yourself get so tangled up with arguments over what you charge for fixing $9.95 junk that you can't see beyond your workbench to ways to make real money? — until the only thing new is the headaches from keeping track of new tube types? — to the point where you think only of how little you can charge for your work without starving to death? — because it seems as if you can't find jobs that pay a decent profit?

Well, if that's the way you feel, maybe you'd better pass this copy of FM Magazine along to one of your competitors — one who is really out to make some money from his service work. He'll thank you for it because FM Magazine is the open door to a whole field of activity for servicemen — the opportunity that's so greatly needed — the chance to get into the chips.

Is that so? — There's no question about it! Why, "frequency modulation" has had so much nation-wide publicity that everyone knows about it. You can make it the magic word for More-Money-in-the-Bank. Climb on the bandwagon and do your part toward making it clear to all the BCL's you know that f-m is the name for finer home entertainment. Then, when you have planted this idea, follow it up with a drive to replace the old arks, which f-m has made definitely obsolete, with new f-m, a-m receivers!

FM Magazine will give you the information you need. Then it's up to you to pass it along to your customers.

Right now, f-m developments are moving swiftly. The more active part you take in getting the f-m ball a-rolling, the bigger will be your share of the profits, and the sooner they will come in.

WHAT THE F-M BROADCASTERS HAVE TO SAY:

A Statement by John Shepard, 3rd, President of the Yankee Network and F-M Pioneer

THE battle for adequate frequencies for the national development of frequency modulation as a superior grade of broadcast service is behind us. Manufacturers are now making available f-m receivers for sale to the public. It is time, therefore, that dealers, jobbers and servicemen familiarize themselves thoroughly with the benefits to be derived from frequency modulation, and to acquaint themselves fully with its operation.

There is a vast market for high quality receivers, now that really high quality service is being transmitted. A receiver of high quality, properly installed, will pay the listener real dividends in interference-free, crystal-clear reception. It will no longer be necessary for a listener to turn off his set because of unbearable noise or cross-talk from other stations.

For over a year the Yankee Network has provided f-m service of 16 hours a day to a large area in New England which never before had satisfactory, full-time reception. The signal from W1XOJ at Paxton is now being increased materially by the completion of the station's permanent antenna.

The Yankee Network is familiarizing the public with this new development in a number of ways. It is, for example, carrying spot announcements at frequent intervals daily over WNAC and WAAB. Sam Curtis, of our technical staff, broadcasts a program every Sunday from 12:15 to 12:30, known as F-M's Information Box, in which he answers listeners' inquiries, requests for explanation of interference problems, and questions about the proper installation of f-m receivers.

We have repeatedly demonstrated the special advantages of f-m to large audiences during the past year, and shall continue to do so in the future.

The public will expect the jobbers, dealers and servicemen to be in a position to answer its questions concerning f-m. As is the case in any other new development, the man who has the answers will reap the benefits in sales.

Accompanying the advantages of clearer and more natural reception are the special programs not available on standard broadcast stations. W1XOJ (as well as other f-m stations) will provide at least two hours of programs daily which are planned specifically to demonstrate the full fidelity of the f-m system. As time goes on and the sponsored programs increase, the wider selection of high calibre programs will result. In the interim, the "hen and egg" dilemma, which held back the broadcasters of the early twenties, will not confront us this time. Broadcasters now entering the f-m field are equipped to render a high grade of service from the beginning and are already giving the public the full advantages of this new system.

HE WINS AGAIN!

THE dream of every inventor is to perfect a means, or a machine, which will merit universal public use. Few achieve this aim. Rare, indeed, are those who then realize commensurate remuneration. Major Edwin H. Armstrong, who gave radio, in successive advancements, the regenerative circuit and the superheterodyne, and then threw in the superregenerative circuit for good measure, has succeeded in both respects.

On the basis of these contributions, he ranks with the No. 1 inventors in all fields. In return, although the only payrolls on which his name has ever appeared are those of the United States Army and Columbia University, radio has made him one of the wealthiest men in this industry.

For those whose inventions have filled some universal demand, and have sold their patent rights for substantial sums, there remains but one higher professional achievement. That is to produce a supplementary or superseding invention, creating a related but independent patent situation with an overlying license set-up.

Now, to his former laurels, Major Armstrong has added this crowning achievement! His latest and greatest contribution, the frequency modulation system of radio transmission and reception, is doubly remarkable in the annals of invention, because it not only supplements his superheterodyne circuit for reception, but it promises far-reaching effects by making obsolete existing equip-

(CONCLUDED ON PAGE 19)

FM

THE COMPLETE AND AUTHORITATIVE SOURCE OF INFORMATION ON FREQUENCY MODULATION

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CONTENTS

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M. B. SLEEPER, *Editor*
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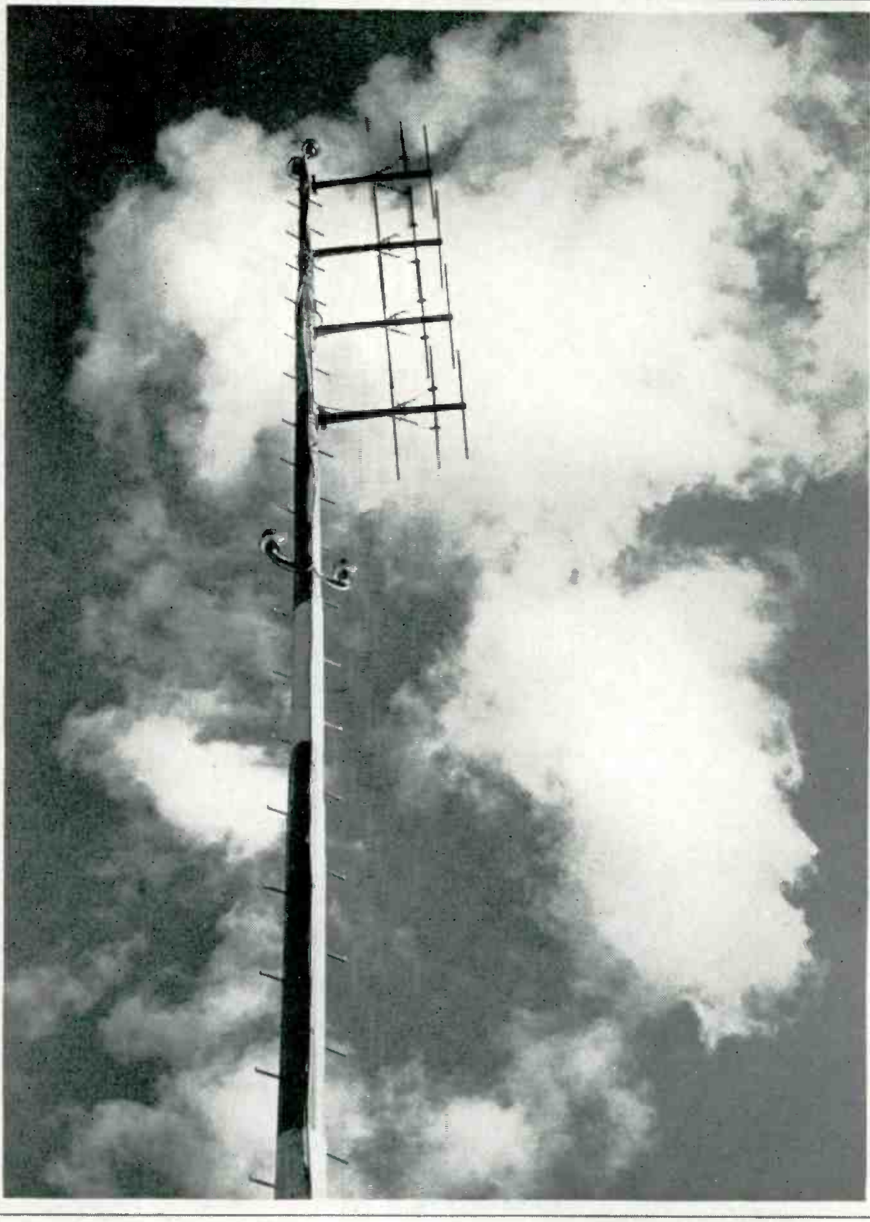
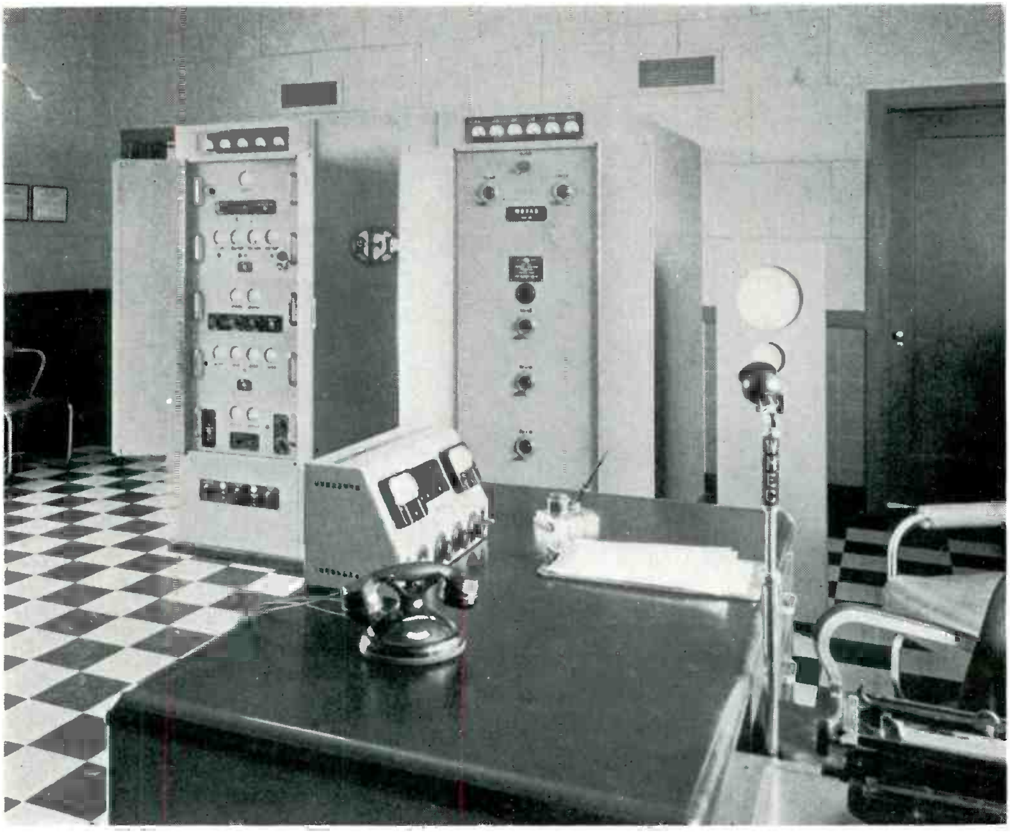


SIGN OF A CHANGE

ANTENNA OF FIRST F-M RELAY TRANSMITTER HERALDS ESTABLISHMENT OF NEW BROADCAST SERVICE TO AMERICAN HOMES. IT BEAMS YANKEE NETWORK PROGRAMS FROM BOSTON STUDIOS 43 MILES TO 50 KW. TRANSMITTER AT PAXTON, MASS. FREQUENCY IS 133.03 MC.



R.E.L. F-M TRANSMITTER WHEC, ROCHESTER, N. Y., ON THE AIR 16 HOURS A DAY SINCE JANUARY

REVOLUTION FOR PROFIT

Need for Reviving Adequate Profits Is Behind Manufacturers' Plans to Push Frequency Modulation Receivers

THE greatest behind-the-scenes activity that the radio industry has known in many years is centered around Major Armstrong's frequency modulation system of radio transmission and reception.

Why is that? You may attribute it to the fact that f-m opens the way to the elimination of natural and man-made static. If so, you haven't the right answer.

Or you may think that it is because a correctly-designed f-m receiver, operating from a properly-installed transmitter, gives a degree of tone realism that cannot be imagined until it is actually heard. In that case, you are wrong again.

As important as they are, these are considered only as contributing factors by which a paramount result will be achieved. What is that? Well, what is the greatest need today of the manufacturers, jobbers, dealers, and servicemen? Obviously, this need is for something that will be a reason for the public to buy radio sets priced high enough to bring back real *profit* to the radio industry.

Price-Competition Headaches ★ Just make a mental picture from these elementary figures, published by the U. S. Department of Commerce:

In 1929, the greatest year the radio industry has ever known, 4,500,000 sets were bought at an average retail price (including tubes) of $162. Then, after a sharp drop, annual production went up and up to a record high of

WESTERN ELECTRIC BUILT THIS F-M STUDIO EQUIPMENT AND TRANSMITTER FOR NEW YORK'S WOR

9,000,000 receivers built in 1939. However, the average retail price of radio sets had declined, by 1939, to a record low of $32!

In other words, the manufacturers produced, and the dealers sold and serviced, twice as many sets in 1939 as in 1929, but the value of each sale had dropped from $162 down to $32 — a decline of 80 per cent. Think of that — a decline of 80 per cent!

If you want to know what has gone wrong with the radio business, you can figure it out from the fact that now twice as many sales are made per day, but five sales are required to put as much money in the cash register as in 1929.

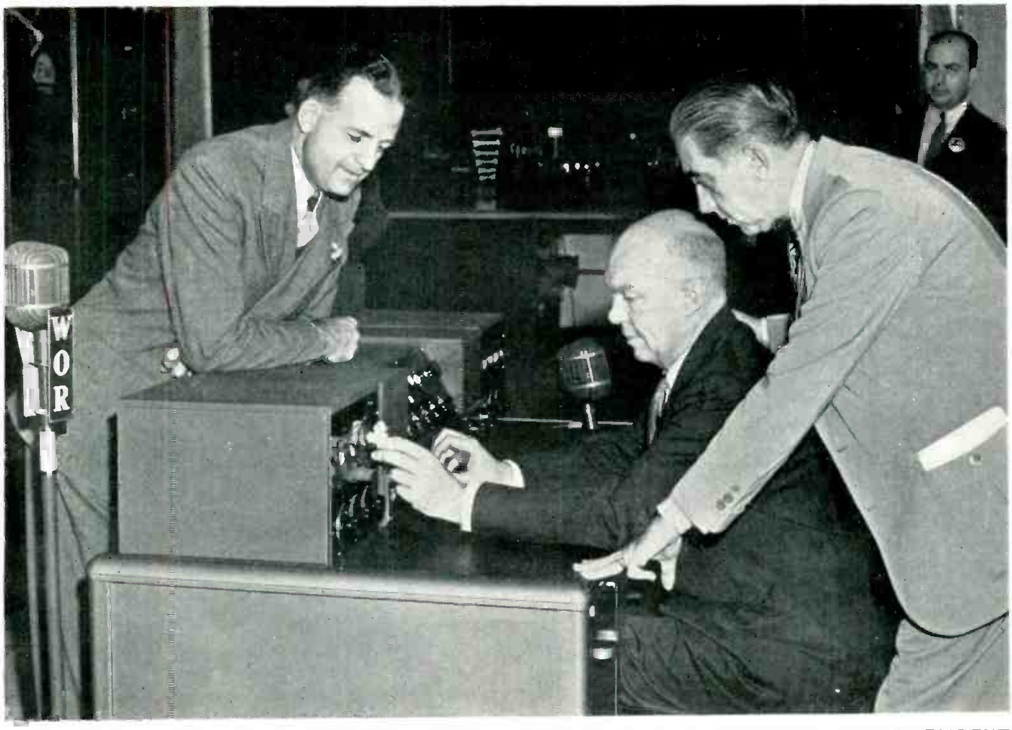
Just to forestall the comment that 1929 figures do not give a true picture of the situation, let's take the figures for 1933, the year when so many people had no money because it had been lost in bank failures. In 1933, only 3,800,000 sets were sold, but the average price was $70, so that the dollar volume was almost equal to 1939.

These figures show the desperate need of something that will make prices move upward from the irreducible minimum of $9.95, to which they have been brought by self-destructive competition.

Old Sets Superior to New ★ The radio industry has shown itself to be doubly shortsighted. Price competition is not necessarily destructive. If better quality and greater service go hand in hand with increased sales resulting from lower prices, then dollar volume and net profits may increase.

Witness the policies of the automotive industry. Over a period of years, production went up, prices went down, and quality was progressively improved. At a certain point, however, prices of the leading makes became stable from year to year, going up or down slightly, but keeping at levels which assured profitable operation. Then, new manufacturing economies were no longer used to lower prices, but to permit improvements in performance at the same prices. Thus, the automotive industry stimulated replacement sales from season to season.

The radio manufacturers have followed the opposite course, with disastrous results. First, they have lowered retail prices as fast as they could find ways to reduce costs. Then, they reduced prices further by cutting performance to the extent that broadcasting stations have had to increase their power to enable the cheapened sets to give adequate reception. Instead of encouraging listeners to own better sets, the sales promotion has been concentrated on cheapened models until today the majority of the sets being bought are in-



J. R. POPPELE, WOR CHIEF ENGINEER, MAJOR ARMSTRONG, A. J. McCOSKER, WOR PRESIDENT

ferior in performance, even under favorable receiving conditions, to the average sets purchased in 1935 and back to 1929. Not only that, but a comparison of prices of 1941 models which can equal 1929 performance shows that there has been practically no reduction in the cost of good reception!

The general public knows this. Radio dealers have been discouraged in their efforts to sell replacement sets by the repeated experience of delivering new models only to have them sent back, ". . . because this new one isn't as good as the one I've been using for the last six (or eight, or ten) years." To be sure, these customers probably paid much more for the old sets, but they were led, by manufacturers' advertising, to expect greatly improved reception from the new ones.

This invidious comparison is emphasized, in areas where receiving conditions are less than completely favorable, by the general use of loop antennas on new sets. Because the loop is not, and cannot be an adequate substitute for a good outside antenna, we have a new radio absurdity: millions of receivers bought because of the expected convenience of the built-in loop, but operating on outside antennas in order to obtain sufficient pick-up!

Finally, the owners of these sets, not realizing that they are improperly designed, blame the broadcasting stations and the FCC because they bring in mostly squeals and cross-talk. Manufacturers, dealers, and servicemen know that when an outside antenna is connected to a loop, the selectivity of the tuning is destroyed. Yet manufacturers have been led into the production of such equipment under the pressure of price competition.

Do you think that this is over-harsh criticism of the models which constitute the greatest part of current production? If so, you should be satisfied with an automobile that cannot equal cars produced ten years ago in speed, pick-up, hill-climbing, mechanical construction, or dependability, and that runs only on good roads under favorable conditions, and you should feel compensated for this poor performance because you spent less money.

Radio's Second Chance ★ It is not often that an industry, having ham-strung itself by its own shortsightedness, ever gets a chance to make a fresh start. Yet this is exactly what Major Armstrong's frequency modulation system means to the radio industry.

It provides everything that manufacturers need to direct public thinking away from price, and to revive interest in high-quality performance. It is not merely a different system.

It furnishes improvements which are powerful merchandising features, to be dramatized in many ways — not merely the "bright ideas" that manufacturers have been trying to use, but vital improvements which engineers and scientists have striven to achieve since the beginning of radio. Most important of these are the elimination of static, the exact reproduction of original speech and music, and release from the annoyance of squeals and cross-talk, all of which add up to what is needed to bring the average unit of sale back to profitable proportions.

Further, f-m, by providing a lever for prying out the millions of sets in use which are six, eight, and ten years old, opens up the enormous field of replacement business, which has been neglected for so long.

Finally, f-m affords a dual service to the listening public by (1) providing a great improvement in the entertainment value of home radio reception and (2) encouraging a renaissance of good engineering practices on the part of receiver manufacturers.

What Price F-M? ★ Currently, two questions are being asked about the prices of f-m, a-m sets. First, there are those who ask: "When most radio sets sold now are table models priced below $20, how do you expect these new sets to sell in console cabinets at $139.50 to $199.50?"

Well, there is about the same difference in price between the old-style ice boxes and the newer electric refrigerators, and they represent the contrast in performance between the little table radios and the new f-m, a-m consoles. There is no problem to selling the new sets that cannot be met by aggressive merchandising such as has been used for refrigerators, since the increase in price represents a proportionate increase in value and service.

"But," the objection is heard, "how can people buy f-m when they haven't the money to spend that they had in 1929, when the average purchase was $162." Haven't they as much money? That point is debatable. Certainly there is more money in savings banks today, to be spent on anything people want enough to draw it out!

However, the important point is this: All the emphasis and effort has been focused, in recent years, on the production and sale of very cheap sets. Meanwhile, the profit-market for the more expensive models has been neglected entirely.

If, in 1941, only half as many people can afford to buy f-m, a-m sets as bought sets of about the same price in 1929, the total dollar volume of radio sales will equal the record level of 1929. You can see from this what f-m can mean to manufacturers, jobbers, dealers, and servicemen if they undertake to make the most of its possibilities.

Will F-M Prices Drop? ★ Some dealers have remarked to me: "Oh, when f-m sets get into production, the manufacturers will cheapen them, and bring down the prices just as they have done on a-m sets."

The facts do not bear out this contention. As long as sets are made with both f-m and a-m circuits, they can't be as cheap as straight a-m receivers. Extra tubes and their associated parts are required when f-m is added. Since f-m is transmitted in the ultra-high frequency band, the same IF amplifier frequency cannot be employed for f-m as for a-m. This means a complete extra IF amplifier and either additional tubes, or switching means to change the circuits.

Cheapened f-m receivers would omit the all-important circuits required for the effective elimination of static — the lack of which would show up sharply in comparison to f-m sets of correct and sound design. And, of course, the tone would be as poor as any cheap a-m receiver. I have been told: "They will have to make low-priced f-m sets in order to take care of the families who cannot afford expensive models." If that is true, then the automobile manufacturers would have found it necessary to make cars to sell at $50 to $100. We know that that has not been the case, for people of limited means have been well satisfied to drive cars turned in when their original owners replaced them with new ones. Why should that not be the case with radio sets? That it is not so today is only because the cheap models have done away with the market for second-hand radios! But just imagine what would have happened to the automobile business if it had undertaken to built $100 cars for the people who now buy the second-hand ones. That is exactly what the radio manufacturers have done.

For the next two or three years, conditions preclude a repetition of the mistakes made on a-m sets. It is to be hoped, and expected, that during this period the revival of profitable operations will establish permanently new, sound methods of planning and merchandising

Standards of Good Engineering Practice ★ The expression "standards of good engineering practice" is familiar to everyone connected with the broadcasting end of radio. In order to establish definite standards of equipment and of service to the public, the FCC has worked out a complete code of acceptable engineering practice for the broadcast stations. Vested with powers to enforce its rulings, the FCC can require every station to maintain these engineering standards.

It has been suggested that Major Armstrong establish a code of good engineering practice for f-m receiver designs, just as the FCC has done already for f-m transmitters. Then, every licensee under the f-m patents would be required to maintain the standards of design thus established.

In the personal opinion of the writer, such an attempt at disciplinary regulation would be neither practical nor advisable. Past experience indicates that, lacking the authority to enforce the maintenance of standards, the whole plan would soon become entangled in an endless wrangle, as was the case in the matter of retail-price fixing.

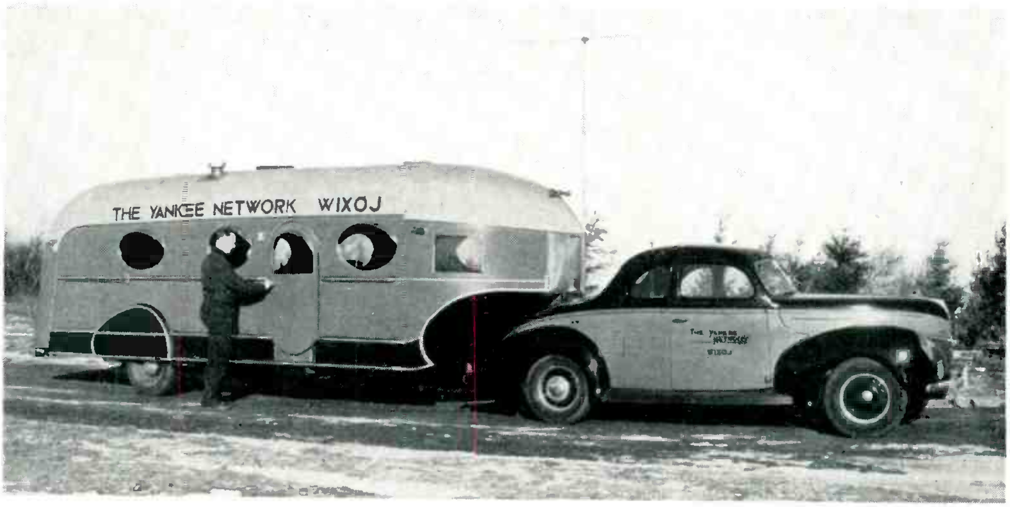
There is a method, however, of permissive regulation which, the writer believes, offers definite usefulness — as similar plans have in other applications. It is this:

Approved Designs ★ The National Board of Fire Underwriters, for example, have established certain safety standards of design for electrical appliances and devices, including radio sets. The manufacturer of any electrical product which passes the tests in the Underwriters Laboratories may affix the U.L. seal of approval to that product.

Such permissive regulation is highly useful in protecting manufacturers of approved devices against cheap, sub-standard competition. Publicity given to the U.L. seal by companies whose products merit it has made the official seal known as a guarantee of safe design and construction.

The same idea can be applied to f-m with even greater effectiveness, if FM Broadcasters, Inc. will set up performance standards relating particularly to sensitivity, effectiveness of noise suppression, and quality of reproduction.

New models would be submitted for test under the direction and supervision of FMBI. Then, manufacturers would be permitted to use the official FMBI seal of approval on such models as passed the tests. In this way, models bearing the seal would be known to provide the improved performance in entertainment quality which is being made available by the f-m broadcasting stations.



W1XOJ'S DEMONSTRATION CAR TAKES F-M QUALITY TO RADIO LISTENERS OF NEW ENGLAND

It is entirely fitting and proper that the broadcasters shall exert such an influence on radio receiving equipment and such a seal, issued from this source, would have a tremendous influence on the merchandising of sets and their purchase by the public. Certainly no group has a greater interest in helping to raise the standard of radio reception, for the millions of dollars spent by sponsors and the stations to furnish better entertainment are wasted unless receiving sets are of commensurate quality.

It might be worth while, in order to highlight types of sets which could be considered as reproducing the maximum quality of f-m reception, to set up specifications on super-standard and standard grade receivers.

Sub-standard f-m sets would, undoubtedly, be produced and sold. However, people would spend their money with their eyes open. A further protection to the public would be afforded by showing on the seal the year or season in which the set was made. That would protect current models from price competition

(CONCLUDED ON PAGE 30)

FMBI Outstanding U. S. Broadcasting Organizations Comprise the National Membership of FM Broadcasters, Inc.—By Dick Dorrance

THE growth of frequency modulation has been swift, but logical. Twelve months ago, only a few particularly well-informed engineers were sufficiently aware of its possibilities to forecast its rapid expansion.

Even last spring, although the broadcasting business began to admit reluctantly that f-m had interesting possibilities, they seemed to be of the indefinite future.

Today—in October, 1940—f-m is spreading like wildfire throughout the country! Scores of the nation's leading broadcasters have applied for licenses to operate in the new f-m band, set aside only last May by the FCC, whose members frankly declared that this new system is ". . . one of the most significant contributions to radio in recent years."

By January 1, 1941, when f-m starts operations on a commercial par with a-m broadcasting, there will be approximately 100 of the new noise-free, full-fidelity stations providing service to the American public in the 42- to 50-mc. band.

This, even in such a country as the U. S. A., noted for swift progress, is an unprecedented, impressive growth. It has resulted from the combination of an existing demand in the radio industry, and a completely new development that fits this demand exactly. But it did not work out all by itself.

Of inestimable importance in effecting the progress of f-m have been the organized efforts of a single group, devoted to the interests of this newest method of broadcasting. Founded on the logical principle that a concerted front is the best way to put across any project, the work of FM Broadcasters, Inc., during its eight months of existence, has been overwhelmingly successful.

FM Broadcasters, Inc., is a national, non-profit organization. Its only reason for existence is to assure the advancement of f-m in a coördinated, sensible, and constructive manner. Founded on January 29, 1940, this group already numbers among its members some sixty of the country's leading f-m exponents.

In its by-laws, you may read that its job is to: "Foster and promote the development of the art of frequency modulation (f-m) broadcasting; to protect its members in every lawful and proper manner; to foster, encourage, and promote laws, rules, regulations, customs, and practices which are in the best interests of the public; to protect the interests of the members of the Association by opposing the enactment or adoption of any laws, rules, regulations, customs, or practices which would discriminate against or in any way injure the members of the Association to any greater degree or in any different manner than licensees of broadcast stations who are ineligible for membership in this Association, it being understood that all problems of a general nature, which affect the broadcasting industry as a whole, should be handled by the National Association of Broadcasters."

All members must be active ones. Those eligible to belong include: "any individual, firm, or corporation who is licensed to operate a frequency modulation sound broadcasting station — or has been granted a construction permit — or who has filed an application with the Federal Communications Commission for authority to construct a frequency modulation broadcast station."

The work of FM Broadcasters, Inc., during its short but active life, has represented the united reactions, requirements, and plans of its associated members. The record tells an interesting story:

Fundamentally, this organization was founded to coördinate the plans of little more than a score of leading broadcasters who saw in f-m something new, highly desirable, economically progressive. To put f-m across as an improved broadcast service, it was first necessary to go before the FCC and request a band of frequencies in which f-m might grow. This, of course, meant a hearing by the Commission.

These f-m pioneers agreed among themselves that if they all went to Washington, each presenting his individual case separately, the possibility of a disorganized, disconcerted impression was uncomfortably certain. So first they met to discuss the situation thoroughly among themselves. At that time, FM Broadcasters, Inc., was formed, based upon the policy that success could be attained most readily by concerted action.

An engineering committee worked out commonly-accepted standards, arrived at with the advice of Major Armstrong, and with the aid of Paul A. deMars, one of the country's leading f-m experts.

Newspapers and magazines were eager to publish articles about f-m, and information concerning the advantages of f-m was made available to congressmen and senators. New members were added to the ranks of FMBI. Well-planned demonstrations were staged. Advertising agencies and educational groups evinced great interest. The public, in the course of a few months, began to know the meaning of the symbol "f-m." All kinds of publications theorized editorially on the significance and future of "static-less" radio.

Meanwhile, applications for transmitter licenses were filed by the dozens at the FCC.

The hearing before the FCC opened on March 18th. On the opening day, interest in this hearing had brought so many people to Washington that it was found necessary to transfer the proceedings to a larger auditorium!

The principal witnesses pleading the case for f-m were Major Armstrong himself and FM Broadcasters, Inc. A wealth of field data, prepared by the FMBI members, answered completely the questions of the Commissioners. A concrete presentation had been prepared — logical and irrefutable.

The FCC was impressed immediately. Its favorable decision, announced on May 19th, flashed a green light to the enthusiastic plans of some 165 groups who had, by that time, filed applications for construction permits.

An exclusive f-m band was established by the Commission — a band providing 40 channels, each 200 kc. wide — that will accommodate all f-m development for years to come. Further, f-m broadcasting was given full commercial status, with the right to sell programs and conduct operations in the same manner as standard broadcasting stations.

Now, FMBI has another, equally important task to perform. This is to serve as an alert liaison group in the service of the public, the manufacturers, and the broadcasters. In this capacity, FMBI provides newspapers and magazines with information of public interest on f-m activities, and circulates a weekly, confidential bulletin among the members of the association.

FM Broadcasters, Inc., is headed by an elected board of directors, which currently includes the following:

John Shepard, 3rd, President — The Yankee Network, Boston

John V. L. Hogan, Vice-President — WQXR, New York City

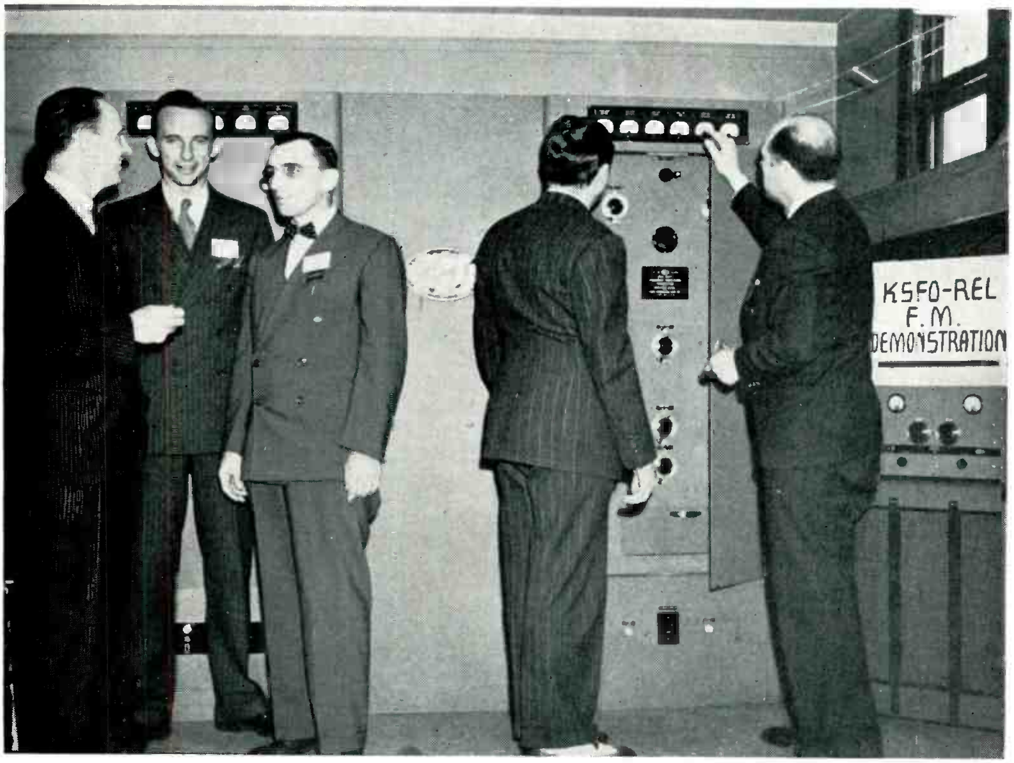
Robert T. Bartley, Secretary and Treasurer — 21 Brookline Ave., Boston

Walter J. Damm — WTMJ, The Milwaukee Journal, Milwaukee, Wis.

Franklin M. Doolittle — WDRC, Hartford, Conn.

C. M. Jansky — Jansky & Bailey, Washington, D. C.

Ray H. Manson — Stromberg-Carlson Tel. Mfg. Co., Rochester, N. Y.



AT SAN FRANCISCO, N.A.B. MEMBERS WERE GIVEN FM DEMONSTRATION BY FMBI, WITH COOPERATION OF R.E.L. AND STATION KSFO. LEFT TO RIGHT: ROYAL V. HOWARD, KSFO CHIEF ENGINEER — FRANK A. GUNTHER, V.P. OF R.E.L. — PAUL A. DE MARS, V.P. OF YANKEE NETWORK — CLIFTON HOWELL, KSFO PROGRAM MANAGER — COL. GUSTAVUS REINIGER, R.E.L. SALES EXECUTIVE

Carl Meyers — WGN, The Chicago Tribune, Chicago, Ill.

Paul W. Morency — WTIC, Hartford, Conn.

Theodore C. Streibert — WOR, Newark, N. J.

Active members as of September 20, 1940, included:

American Broadcasting Corp. of Ky. (WLAP)
Gilmore N. Nunn
Radio Building, Lexington, Ky.

Bamberger Broadcasting Service, Inc. (WOR)
Alfred J. McCosker
1440 Broadway, New York City

Boston Edison Company (WEEI)
J. V. Toner
182 Tremont Street, Boston, Mass.

Central Broadcasting Company (WHO)
Paul A. Loyet
914 Walnut Street, Des Moines, Iowa

Central New York Broadcasting Co. (WSYR)
H. C. Wilder
Starrett-Syracuse Building, Syracuse, N. Y.

Cherry & Webb Broadcasting Co. (WPRO)
William S. Cherry, Jr.
15 Chestnut Street, Providence, R. I.

The Cincinnati Times-Star Co. (WKRC)
Hulbert Taft, Jr.
Alms Hotel, Cincinnati, Ohio

The Crosley Corporation (WLW)
J. D. Shouse
1329 Arlington Street, Cincinnati, Ohio

Doughty & Welch Electric Co., Inc. (WSAR)
William T. Welch
102 South Main Street, Fall River, Mass.

The Evening News Association (WWJ)
W. J. Scripps
The Detroit News, Detroit, Mich.

William G. H. Finch
1819 Broadway, New York City

Frequency Broadcasting Corp.
Thomas E. Murray
1250 Atlantic Avenue, Brooklyn, N. Y.

General Electric Company (WGY)
G. W. Henyan
Radio & Television Dept., Schenectady, N. Y.

General Electric Company
(for transmitter at New Scotland, N. Y.)

Greater New York Broadcasting Corp. (WOV)
Harold A. Lafount
630 Fifth Avenue, New York City

Head of the Lakes Broadcasting Co. (WEBC)
W. C. Bridges
WEBC Building, Duluth, Minn.

John V. L. Hogan (WQXR)
3104 Northern Boulevard, Long Island City, N. Y.

James F. Hopkins, Inc. (WJBK)
James F. Hopkins
6559 Hamilton Avenue, Detroit, Mich.

Howitt-Wood Radio Co., Inc. (WNBF)
Cecil D. Mastin
Station WNBF, Binghamton, N. Y.

Jansky & Bailey
C. M. Jansky, Jr.
Room 970
National Press Building, Washington, D. C.

The Journal Company (WTMJ)
Walter J. Damm
333 West State Street, Milwaukee, Wis.

Marcus Loew Booking Agency (WHN)
Herbert L. Pettey
1540 Broadway, New York City

McNary & Chambers
Joseph A. Chambers
National Press Building, Washington, D. C.

The Metropolis Company (WJHP)
H. G. Wells, Jr.
500 Laura Street, Jacksonville, Fla.

Midland Broadcasting Co., Inc. (KMBC)
Arthur B. Church
Pickwick Hotel, Kansas City, Mo.

Moody Bible Institute of Chicago (WMBI)
Henry C. Crowell
153 Institute Place, Chicago, Ill.

Muzak Corporation
Waddill Catchings
229 Fourth Avenue, New York City

National Broadcasting Company (WEAF-WJZ)
Niles Trammell
30 Rockefeller Plaza, New York City

National Life & Accident Insurance Co. (WSM)
John DeWitt, Jr.
7th & Union Streets, Nashville, Tenn.

North Carolina Broadcasting Co., Inc. (WBIG)
Edney Ridge, Greensboro, N. C.

The Ohio Broadcasting Co. (WHBC)
Felix Hinkle
500 Market South, Canton, Ohio

Onondaga Radio Broadcasting Corp. (WFBL)
Samuel Woodworth
Onondaga Hotel, Syracuse, N. Y.

The Outlet Company (WJAR)
Mortimer L. Burbank
176 Weybosset Street, Providence, R. I.

Pennsylvania Broadcasting Co. (WIP)
Benedict Gimbel, Jr.
35 South 9th Street, Philadelphia, Pa.

J. R. Popkin-Clurman
154 Merrick Road
Rockville Center, Long Island, N. Y.

Portland Broadcasting System, Inc. (WGAN)
Creighton E. Gatchell
645A Congress Street, Portland, Maine

Carman R. Runyon, Jr.
544 North Broadway, Yonkers, N. Y.

Scranton Broadcasters, Inc. (WGBI)
Frank Megargee
1000 Wyoming Avenue, Scranton, Pa.

Stromberg-Carlson Telephone Mfg. Co. (WHAM)
E. A. Hanover
89 East Avenue, Rochester, N. Y.

Travelers Broadcasting Service Corp. (WTIC)
Paul W. Morency
26 Grove Street, Hartford, Conn.

WBNS, Incorporated
R. A. Borel
33 North High Street, Columbus, Ohio

WDRC, Incorporated
Franklin M. Doolittle
750 Main Street, Hartford, Conn.

WFIL Broadcasting Company
Roger Clipp
Widener Building, Philadelphia, Pa.

WFMJ
William F. Maag, Jr.
101 West Boardman Street, Youngstown, Ohio

WGN, Incorporated
Carl J. Meyers
Room 1133
Tribune Tower, Chicago, Ill.

WHEC, Incorporated
Clarence Wheeler
40 Franklin Street, Rochester, N. Y.

WIBX, Incorporated
Scott Howe Bowen
First Bank Building, Utica, N. Y.

WJJD, Incorporated
Ralph L. Atlass
201 North Wells Street, Chicago, Ill.

WJR, The Goodwill Station
Leo Fitzpatrick
Fisher Building, Detroit, Mich.

WOKO, Incorporated
Harold E. Smith
Radio Centre, Albany, N. Y.

Worcester Telegram Publishing Co., Inc. (WTAG)
Edward E. Hill
18 Franklin Street, Worcester, Mass.

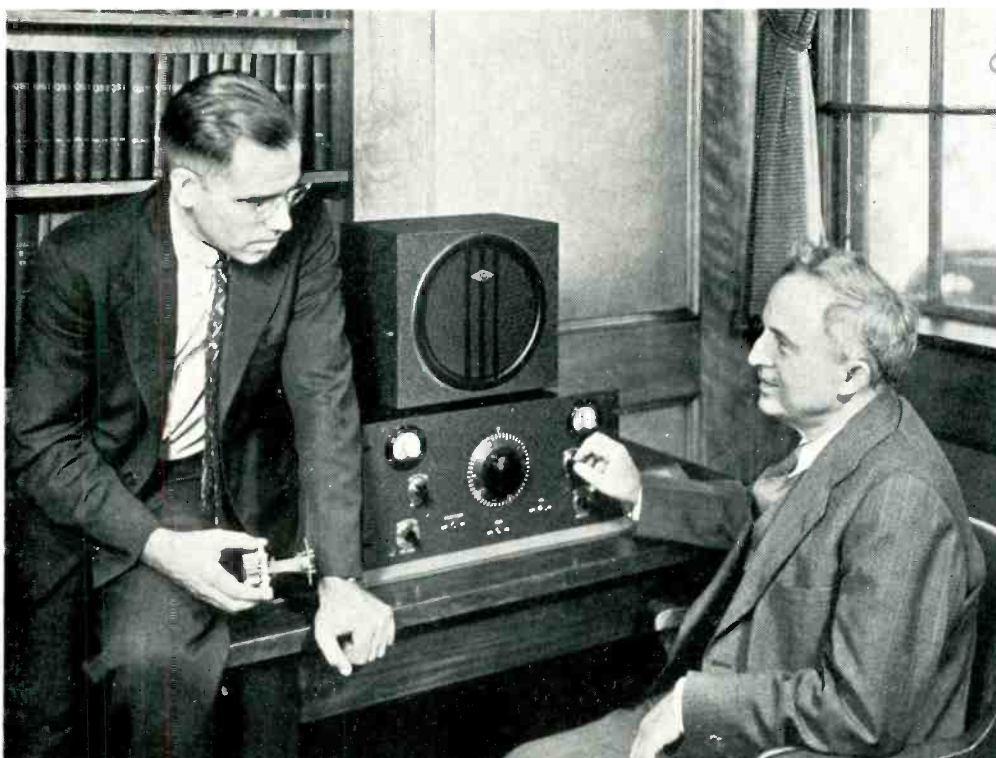
World Broadcasting System
Percy L. Deutsch
711 Fifth Avenue, New York City

WPTF Radio Company
Richard H. Mason
324 Fayetteville Street, Raleigh, N. C.

The Yankee Network, Inc.
(for transmitter near Alpine, New Jersey)
John Shepard, 3rd
21 Brookline Avenue, Boston, Mass.

The Yankee Network, Inc.
(for transmitter at Paxton, Mass.)

The Yankee Network, Inc.
(for transmitter at Sargents Purchase, atop Mt. Washington, N. H.)



A FAMOUS PIONEER MANUFACTURER STARTS PRODUCTION OF PRECISION-TYPE F-M RECEIVER. WILLIAM A. READY, RIGHT, PRESIDENT OF NATIONAL COMPANY, MALDEN, MASS., AND HIS CHIEF ENGINEER, DANA BACON, WHO IS PREPARING A TECHNICAL ARTICLE ON THIS F-M SET FOR THE FORTHCOMING ISSUE OF FM MAGAZINE

PERFORMANCE OF THIS F-M TRANSMITTER EARNED R.E.L. AN ORDER FOR 200 LIKE IT

POLICE RADIO

WITH THIS F-M TRANSMITTER, R. E. L. MADE POLICE RADIO HISTORY IN CHICAGO

ANYONE who has had experience in going after contracts for police radio equipment knows that it's hopeless to ask for changes in specifications after they have been sent out and all the bids have come in. Hopeless? Well, most anyone would consider it so — except Frank A. Gunther, vice president of Radio Engineering Laboratories, at Long Island City, N. Y.

That was the situation confronting him when, last March, he took off for Chicago, a newly developed prowl-car transmitter under one arm, figuratively, and a headquarters receiver under the other. Specifications had been sent out for 200 car transmitters, and the bids were all in when he reached the Chicago police headquarters.

It was fortunate for the City of Chicago, and for Frank Gunther, that police radio is under the technical direction of such an able man as Fred H. Schnell. A dyed-in-the-wool operator and experimenter who had come up through the ARRL ranks, Schnell just couldn't resist the temptation to find out what f-m could do on prowl-car service.

Accordingly, the R.E.L. transmitter, of 25 watts, was installed in a police car, as shown in the illustration above. The receiver and antenna were set up on the top of the Field Building. Receiving conditions were difficult in the extreme, due to interference from adjacent elevator motors, controls, and other electrical equipment.

The purpose of the tests was to determine the relative reliability of a-m and f-m reception. Fred Schnell supervised these tests himself. The illustration on the opposite page shows him at the test receiver. At the right, on the second shelf, is a changeover switch for cutting in one receiver or the other. Test conversations were held between headquarters and various points in the City where communication was known to be difficult, first on one system, and then on the other.

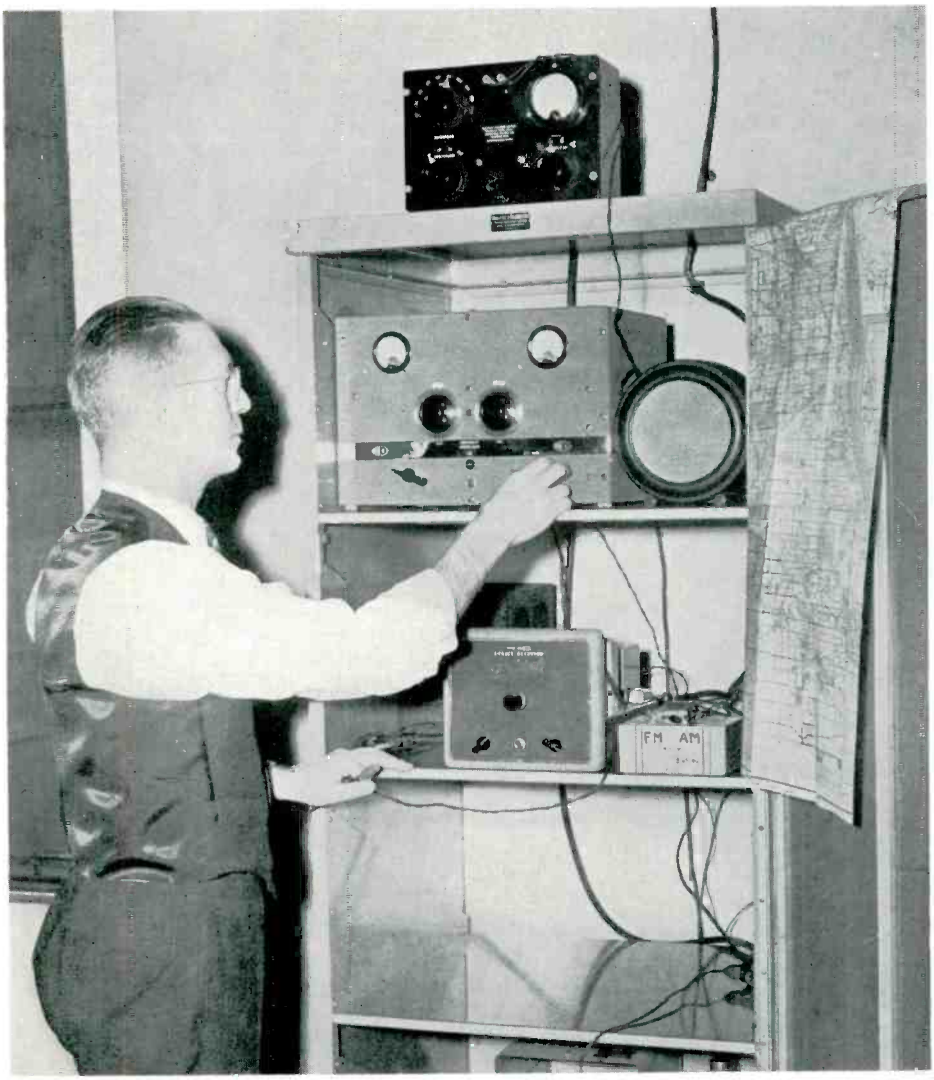
The difference between f-m and a-m performance was decidedly in favor of f-m. In fact, after reviewing the advantages of f-m which were demonstrated in these tests, a way was found to reject all the bids on a-m transmitters, and to award the contract for 200 transmitters to R.E.L.

With the new f-m car transmitters in operation, the Chicago police are still using a-m for talking from headquarters to the cars. That is a matter of economics, however, rather than radio performance. That a-m equipment is not yet scheduled for replacement, but as soon as it can be declared obsolete Chicago will be f-m all the way.

There is already evidence of a general shift to f-m for police service. The state police of Connecticut are currently installing the first state-wide f-m system in the country. Under the guidance of Professor D. E. Noble of the University of Connecticut, who is consulting engineer for the Connecticut State Police, the new set-up has been designed and is now being installed. It will comprise 10 fixed location f-m transmitters, 250 watts each, at various headquarters stations, and a total of 225 two-way mobile units in patrol cars.

Tests have been underway for more than a year, with Professor Noble covering 20,000 miles by automobile to every corner of the state. It is estimated that actual f-m transmission took place during more than 2000 miles of travel while the car was in motion.

The fixed station in these tests was operated by Sidney Warner, supervisor of radio maintenance for the Connecticut Department of State Police.



FRED SCHNELL, CHECKING THE COMPARATIVE PERFORMANCE OF F-M AND A-M PROWL-CAR TRANSMITTERS FOR USE BY CHICAGO POLICE. RESULTS WERE STRONGLY IN FAVOR OF R.E.L.'S F-M EQUIPMENT, AND ALL BIDS FOR THE 200 A-M TRANSMITTERS WERE REJECTED

HOW TO DEMONSTRATE F-M

Details of Public Demonstration at R. H. White Department Store, with Complete Radio Script of Program Transmitted by W1XOJ—By Benjamin Gross

WHEN Aaron Goldberg, manager of the radio department at R. H. White's, in Boston, made up his mind to use Stromberg-Carlson receivers to push up his fall volume of radio sales, he determined to get the idea of extra-quality home entertainment across to his customers in a way that would wow them. And wow them he certainly did!

His primary purpose, of course, was to launch f-m sales. There were other things he wanted to accomplish, also. He wanted to gain the prestige for his radio department of taking the lead in promoting a new radio development, and to bring radio-minded people to the R. H. White store. Obviously, to address two groups, one in the afternoon and the other in the evening, would take less man-hours than talking to several hundred people individually. And finally, he wanted to get the names and addresses of those who, after hearing an f-m demonstration, were definitely prospects for f-m sets.

Accordingly, the coöperation of The Yankee Network was enlisted. While their program department laid out the plan of a special demonstration to be broadcast from Paxton, and wrote the script, a di-pole antenna of the conventional sort was erected on the roof of the store, and connected with EO1 cable to the auditorium. This gave perfect, noise-free reception of W1XOJ, 43 miles distant, despite the fact that the store is in the DC section of Boston, where receiving conditions are unfavorable in the extreme.

Announcements were run in the R. H. White newspaper advertisements, inviting the public to attend the demonstration in the afternoon or in the evening, when the radio and furniture departments are open until 9:00 P.M. On the stage of the auditorium, three Stromberg-Carlson f-m, a-m consoles and a converter were put on display, marked with prices and brief descriptions large enough to be read by the audience.

A piano was set up at the center of the stage, and a microphone, connected by telephone wires to the broadcast studio, was located where it could pick up the piano. This completed the arrangement.

At both demonstrations, the auditorium, holding about 400 people, was filled. After brief remarks of introduction, one of the receivers was turned on, and frequency modulation spoke dramatically for itself.

The continuity used by the studio is given here for the benefit of those who want to arrange similar demonstrations. The use of sound effects led up to the high spot of the performance: the magic piano. The announcement, "Now we return you to the auditorium of the R. H. White Company," was the cue for Harry DeAngelus, seated at the piano, to play "Stardust." Suddenly, in the middle of the piece, a stir went through the audience. People leaned forward in their seats, and others rose to see what had happened on the stage for, while the music seemed to be coming from the piano, Mr. DeAngelus was not playing. In fact, he had turned around and was looking into the wings. Then he swung back to the keyboard, and his hands picked up the music again.

The audience was mystified. Apparently this was a player piano, and he had been only making the motions of striking the notes. Again he stopped playing, and the music continued. The next time he resumed, a spotlight was turned on him, and when he stopped, the spot was shifted to one of the f-m receivers. Some of the people knew then what had been going on, but others did not understand until, at the end of the second selection, the announcer explained.

The set-up was this: the pianist at the studio listened to the piano in the auditorium through the microphone wire connections. When he picked up the tune, the pianist at the auditorium stopped. Thus they alternated their playing without a pause. So perfect was the reproduction by f-m, and the piano is a most difficult instrument to reproduce by radio, that the only way it was possible to determine the origin of the music was to watch the pianist on the stage.

The script which follows is presented through the courtesy of The Yankee Network. It can be changed readily and adapted to suit any similar occasion!

(Organ Crescendo)

ANNOUNCER:

Nights shall be filled with music — with song and words, words, words, millions of them — bringing you news, drama, education, information, syncopation. . . . Radio — culmination of man's desire to conquer space. Radio — that leaps around the earth on waves of light — and brings the world within your touch. . . . Radio — that's everywhere at every time. . . . Radio — moving always forward, widening its scope — spreading its illuminating influence.

The story of radio is the story of man's progress, the story of his unending search for knowledge and expression. From the time of primitive smoke signals and the code of jungle drums to the red blast of trumpets heralding the approach of kings, to the time of Marconi and the first rude wireless key, radio has developed and perfected itself into a precious instrument of rare beauty.

Tonight, for the first time in Boston, Frequency Modulation is being demonstrated to the retail public. Tonight, The Yankee Network, in coöperation with the R. H. White Company, brings you a graphic demonstration of radio's newest and greatest achievement — frequency modulation. Signalizing this new era in the science and art of broadcasting, The Yankee Network and the R. H. White Company of Boston present to the general public and the retail trade a demonstration of this marvel called — frequency modulation. A glowing testimonial to man's mastery of the elements — for this great new frequency modulation conquers nature — eliminating static, minimizing interference — radio in its perfection — listen, as frequency modulation proves its birthright.

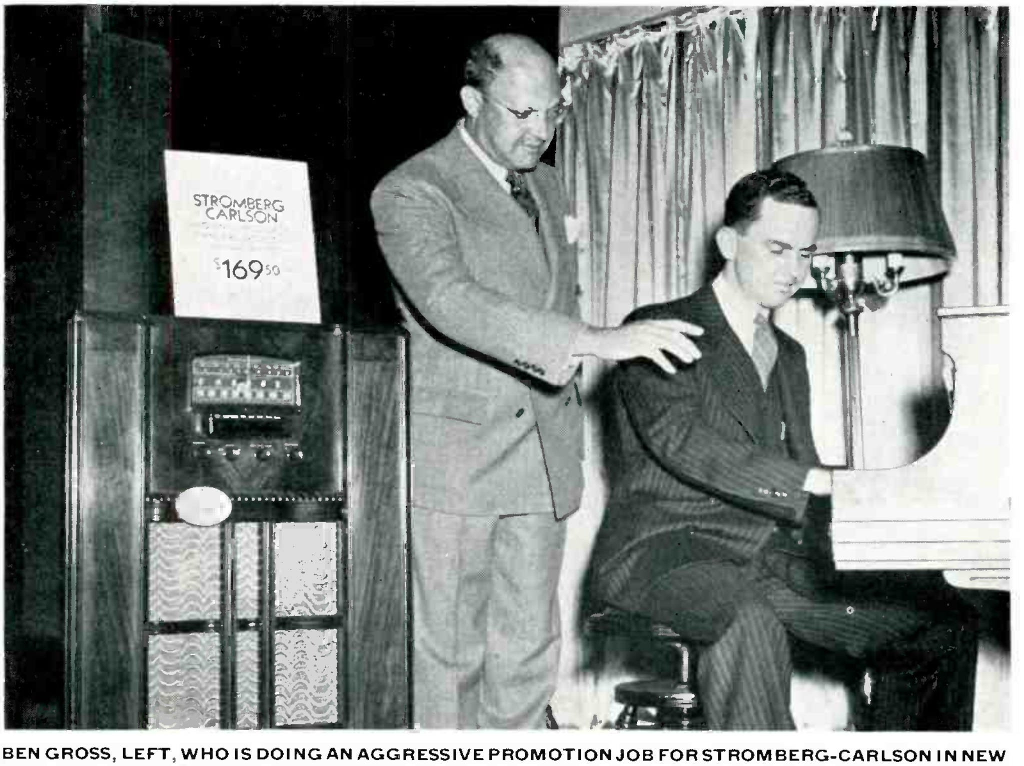
Clotilda Zappala, charming young New England coloratura soprano, sings one of the loveliest and most colorful arias in all of the world's great operatic literature — enjoy the complete perfection of reproduction afforded by f-m as Miss Zappala, accompanied by Francis J. Cronin, sings — (*The Bell Song from the Opera "Lakme" by Delibes*)

This afternoon it is our pleasure to present to you a man who has contributed much to the development and perfection of frequency modulation. Speaking from the auditorium on the third floor of the R. H. White Company store in Boston, where four hundred people have assembled to see as well as hear this demonstration, we present one of radio's pioneers, Paul A. deMars, Vice President in charge of Engineering for The Yankee Network. Mr. deMars.

MR. DEMARS:

Ladies and Gentlemen —

In the fall of 1935, Major Edwin H. Armstrong, the scientific genius who had previously contributed the three outstanding inventions in radio, demonstrated his latest development to the Institute of Radio Engineers in New



BEN GROSS, LEFT, WHO IS DOING AN AGGRESSIVE PROMOTION JOB FOR STROMBERG-CARLSON IN NEW ENGLAND AND NEW YORK, DIRECTING THE "MAGIC PIANO" AT R. H. WHITE'S F-M DEMONSTRATION

York City. Terminating a lifelong study to eliminate static from the radio, he disclosed a system of broadcasting virtually free from static and interference and capable of transmitting programs with quality heretofore undreamed of. Called frequency modulation, as distinguished from the present method known as amplitude modulation, the system is now familiarly known as f-m.

How f-m differs in principle of operation from the present system is mainly of interest and concern to engineers and scientists and is too technical to discuss here. It is sufficient to say that new type transmitters and receivers are required.

Recognizing the outstanding capabilities of f-m, the Federal Communications Commission, in May of this year, authorized commercial broadcasting on 40 new wave-lengths in the high frequencies.

New f-m broadcasting stations are under construction, or are being planned all over the country, and there are already about 20 in operation.

In this auditorium, you are listening to John Shepard, 3rd's pioneer f-m station of New England. This station is the most powerful of its kind in the world and is located in the town of Paxton, Mass. — beyond Worcester — and broadcasts programs 16 hours daily from The Yankee Network, The Colonial Network, The Mutual Broadcasting System and NBC.

Although this is the only f-m station that at present serves all of Massachusetts and Boston, other f-m stations are planned for this region and there is no question that f-m will not only broadcast present programs, but will also provide new services in this area.

The number of new stations technically possible is virtually unlimited, and the owner of an f-m receiver is assured of not only better reception, but a greater variety of entertainment.

Now then, what specifically is offered to the owner of an f-m receiver?

Reception without static — without noise — without interference.

Reception unmarred by crashing roars when lightning streaks the sky.

Reception free from the all too-familiar buzzes, crackles and frying occasioned by your own or your neighbor's electric razor, oil burner, kitchen mixer or vacuum cleaner.

Reception without the chattering, the squawking, the unwanted programs in the background of your favorite station.

Reception with a naturalness and realism in the reproduction of music, speech and sounds beyond the capabilities of the present methods.

The program in the demonstration that follows originates in the studios of The Yankee Network in Boston, where it is transmitted by frequency modulation to Paxton and then broadcast to the listening audience.

You are listening here in this auditorium to reception of radio transmission transmitted twice over a distance of about 45 miles and received in one of the noisiest areas of Boston for broadcast reception.

But note the crystal-clear tone, despite the adverse local conditions. This is the quality of service that the owner of an f-m receiver can expect in his own home.

The following demonstration is intended to convince you here in this auditorium of the merits of f-m in the best way we know how. That is — by letting f-m speak for itself.

ANNOUNCER:

Thank you, Mr. deMars.

The perfection in the reproduction of sounds that is made possible through transmission by frequency modulation can perhaps best be demonstrated by producing a series of sounds frequently used in everyday radio programs. Notice in the following series of reproductions the great clarity of tone and the full range of sound that is clearly audible. First, the sound effects engineer will ring a ship's bell — the type in common use on sailing vessels — it is made of cast brass, is twelve inches in diameter, and will be struck with a clapper seven inches long. Listen —

(*Strike Ship's Bell*)

Our next sound effect is perhaps one of the most difficult in the sound engineer's entire repertoire to reproduce. Only through frequency modulation is it possible to recreate the wide tonal range of the common everyday sound of sawing wood.

(*Effect*)

Perhaps the next most difficult effect to convey over the radio is the accurate reproduction of a carpenter's hammer striking a three-inch flat headed nail. Listen for the ping of the hammer — a sound which only frequency modulation can reproduce in all its naturalness.

(*Effect*)

We'll let you guess at this one!

(*Effect: Pouring Drink*)

Perhaps the smallest and most infrequently used instrument, yet one whose sound is most difficult to produce, is the triangle. Listen to it now.

(*Effect*)

Listen now to the rich tones of a large Chinese gong — made of hammered brass. Note particularly how long the aftertones hang on. Frequency modulation recreates this for you now.

(*Effect*)

The colorful and lively bolero, "Le Sevillana," by Guiseppe Ferraro, is a vertical transcription, made especially for broadcast purposes. It is a composition of brilliant tone patterns that, in unrestrained good spirits, employ the full instrumental range of Harry Horlick's orchestra. Listen to it now and notice the perfect reproduction of the full tonal range.

(*Le Sevillana 60–098*)

We now return you to the auditorium of the R. H. White Company store, where Harry DeAngelus is waiting to play a piano medley.

(*Stardust — Beer Barrel Polka*)

(*Piano at R. H. White auditorium and at studio alternate in playing this music.*)

Those in the R. H. White Company's auditorium have just witnessed a remarkable demonstration. We might have called those numbers the marvel of the "magic piano," for the pianist in the auditorium and a pianist here in the studio alternated in playing the medley just completed — yet so wonderful is the reproduction made possible through transmission by frequency modulation that the studio audience could not tell whether they were listening to radio reception from the studio piano or to the piano on the stage before them, except by watching the pianist's hands — a further tribute to the perfection of this marvelous new system of broadcasting.

This evening's presentation is concluded as Francis J. Cronin, New England's premier organist, employs the full resources of the grand studio organ in playing a skillfully arranged medley of familiar overtures —

(*Medley of Overtures, organ*)

And so we conclude another "famous first" in the history of broadcasting. This afternoon, for the first time in Boston, The Yankee Network, in coöperation with the R. H. White Company, has presented this broadcast, marking a new milestone in the development of radio — frequency modulation. And marking also, the first time that frequency modulation has been demonstrated to the retail trade and the general public through a retail outlet — the R. H. White Company. Frequency modulation, the sensational new perfection in radio reception, is the newest and greatest achievement of radio science — another forward step in man's mastery of the elements.

Noiseless, staticless, free from interference, frequency modulation brings you radio at its perfect best — doubling your enjoyment, ever widening and increasing the scope of your best form of entertainment — Radio!

You may see a complete line of the amazing new Frequency Modulation receivers on display at the R. H. White Company in Boston. Remember that the world is at your finger tips when a radio is at arm's length and in radio reception, Frequency Modulation means perfection.

He Wins Again!

(CONTINUED FROM PAGE 3)

ment in which his inventions are employed.

Although official confirmation is lacking, there are obvious reasons why Major Armstrong will not follow his previous course by selling his frequency modulation patents outright. Rather, it seems logical that he will extend his already-established license-royalty set-up because (1) if he sold the patents for a lump sum, the Government would take a very large part of the payment and, (2) judging from the revenue produced by licenses under the other Armstrong patents, it is reasonable to expect that the returns from frequency modulation royalties will far exceed any lump-sum payment that might be made in an outright purchase.

Certainly the entire radio industry applauds the recognition accorded Major Armstrong by the FCC. In setting aside the 42- to 50-mc. band, the Commission has given the most effective encouragement to the use of frequency modulation for commercial broadcasting. Now the public will have full opportunity to render its opinion of the advantages attributed to frequency modulation. Thus we say of Major Armstrong: "He wins again!"

G. E. Engineers Find F-M Coverage 33 Times That of A-M Area

Unusual figures on the relative coverage areas of f-m and standard amplitude modulated broadcast stations under interference conditions have been announced, following extensive field tests by General Electric radio engineers.

The experiments indicate the startling fact that the area of interference-free reception with f-m is 33 times greater than with a-m broadcasting!

The engineers employed two a-m and two f-m transmitters, operating on the same frequency, placed upon level ground 15 miles apart. First the two a-m transmitters, with one kilowatt of power apiece, operated simultaneously. The area served without inter-station interference surrounding either transmitter was limited to a radius of $1\frac{1}{2}$ miles.

Next, the two f-m transmitters, using the same power, were operated and the area of the zone of interference between them proved so slight that the engineers calculated the area served satisfactorily by f-m was 33 times greater than was the case with the a-m set-up.

The measurements were made by I. R. Weir, G-E engineer and f-m expert.

SERVICE MANUAL

The Serviceman's Complete and Authoritative Source of Information on Frequency Modulation Receivers

PILOT RADIO—Model 12 Series

F-M, A-M RECEIVER

IDENTIFICATION TABLE

Model FM-12 .... Table Model
Model CFM-12 .... Console
Model LFM-12
Lowboy Phonograph Combination

SPECIFICATIONS

Voltage Rating: 110-125 volts, 50-60 cycles

Type of Circuit: Frequency modulation, superheterodyne

Tuning Range:
F-M tuning, 42 to 50 mc. — 7.14 to 6 m.
A-M tuning, 540 to 1750 kc. — 555 to 171 m.

Number and types of tubes: 12 plus tuning beacon

RF	— 6AC7/1852
Converter	— 6K8
IF	— 6AC7/1852
IF	— 6AC7/1852
Limiter	— 6SJ7
F-M Det.	— 6H6
Balance Rect.	— 6H6
A-M Det. and QAVC	— 6SQ7
AF Amp. and Phase Inv.	— 6C8G
AF Output	— 6L6G
AF Output	— 6L6G
Rectifier	— 5U4G
Tuning Beacon	— 5U5/6G6

A-M IF Frequency: 455 kc.
F-M IF Frequency: 2100 kc.

Antenna: Pilot F-M, A-M di-pole, No. 110-7

FEATURES

This Pilot Radio receiver provides static-free full-fidelity reception by the Armstrong Wide-Band Frequency Modulation System, with switch-controlled changeover to the standard broadcast band. The following special features are incorporated in the design of this receiver:

1. Interstation silencer (QAVC) for f-m tuning
2. Balance detector for accurate cathode ray beacon tuning indicator on f-m reception.
3. Push-pull audio output with inverse feed-back for superior tone quality
4. Inverse feed-back tone control, providing sharper cut-off than conventional types.

INSTALLATION

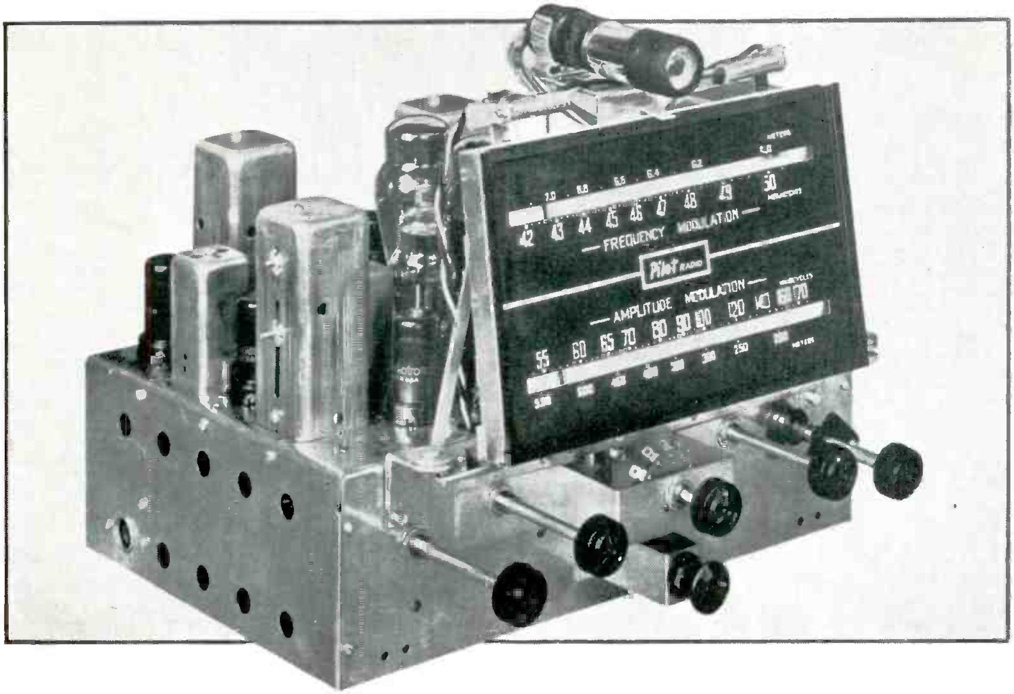
Packing Screws: Before putting the receiver into operation, remove the four red packing screws under the cabinet. The chassis will then float freely on four rubber cushions, eliminating vibration.

Antenna: For noise-free reception it is essential to use a good di-pole antenna, properly installed with down-leads arranged to avoid noise pickup. The Pilot FM-AM Antenna, No. 110-7, is recommended. This antenna is shipped in kit form and comprises a di-pole with supporting mast, transmission line, and special couplers at both ends of the transmission line which provide automatically for operation on either the FM or the broadcast band. Detailed instructions are furnished with the antenna.

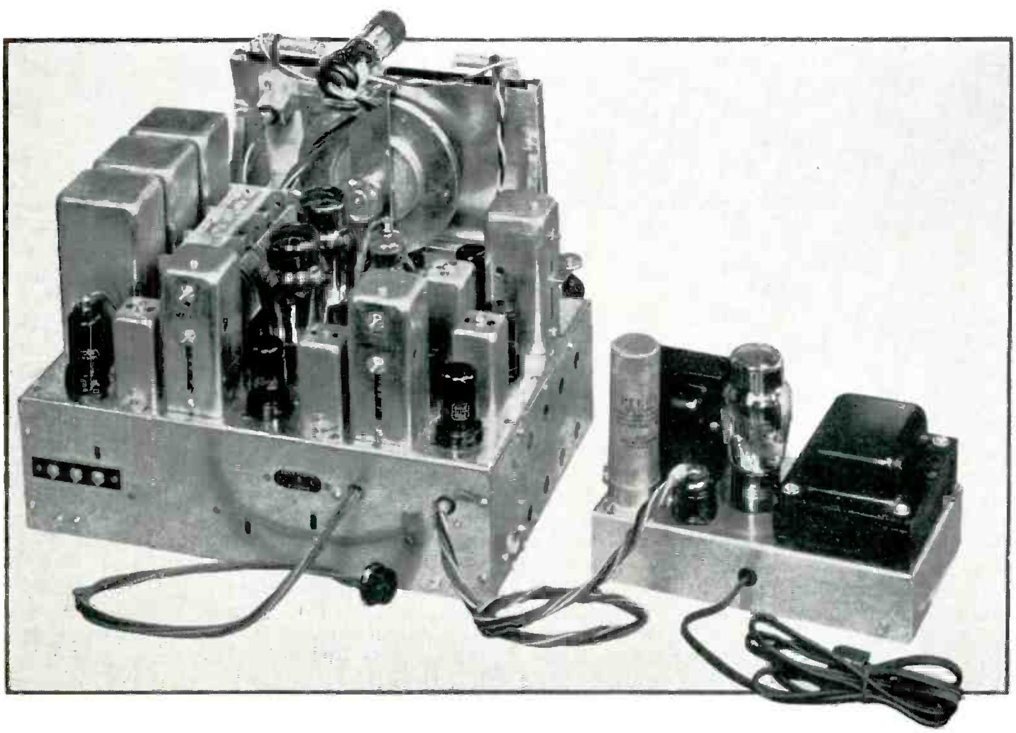
In choosing a location for the antenna it is desirable to place the di-pole as high as possible and as far as possible from sources of noise interference such as automobile traffic, power lines, etc. The transmission line should be brought down as far as practicable from building walls and obstructions.

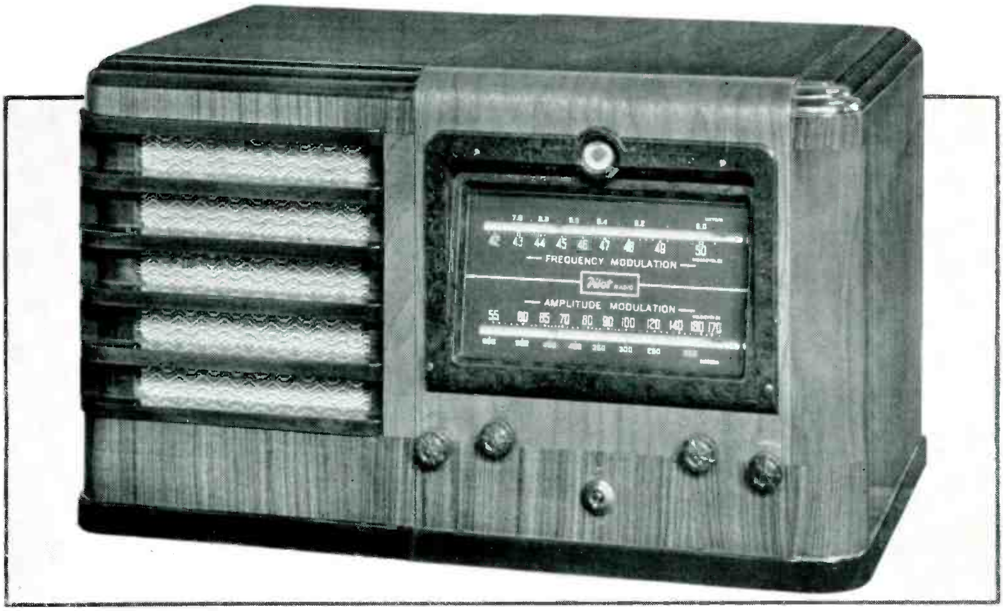
Under present-day conditions (prior to January 1, 1941), some localities are served by two f-m stations whose frequencies are on adjacent channels (200 kilocycles separation). When this is the case interference from the stronger station may be experienced in reception from the weaker. Such interference may be reduced by loosening the mast clamps and rotating the di-pole until the most favorable position is found.

After January 1, 1941, the new frequencies assigned to f-m stations by the Federal Communications Commission will be in effect, and stations serving the same area will be separated by at least 400 kilocycles. Under



ABOVE: THE MODEL 12 PILOT F-M, A-M CHASSIS OPERATES FROM A SEPARATE POWER SUPPLY. THIS DESIGN SIMPLIFIES SERVICE WORK GREATLY. BELOW: REAR VIEW OF THE TUNER AND POWER SUPPLY, USED IN THE TABLE, CONSOLE, AND PHONOGRAPH COMBINATION CABINETS





THE TABLE MODEL, WITH 10-IN. SPEAKER IS ADAPTED TO MANY SPECIAL-PURPOSE INSTALLATIONS

these conditions interference between stations will not occur.

Power Supply: Before plugging in, make sure that all tubes are properly inserted in the positions shown in the tube diagram on the back of the chassis. The power cable from the main chassis must be plugged into the socket on the power pack marked "Plug" on the diagram.

Plug the line cord from the power pack into a 110–125 volt AC line, 50–60 cycles. *CAUTION: Do not under any circumstances plug into a line of higher voltage or lower frequency, or into a DC line.*

CONTROLS

The function of each control knob is indicated by lettering on the panel. From left to right the controls are as follows:

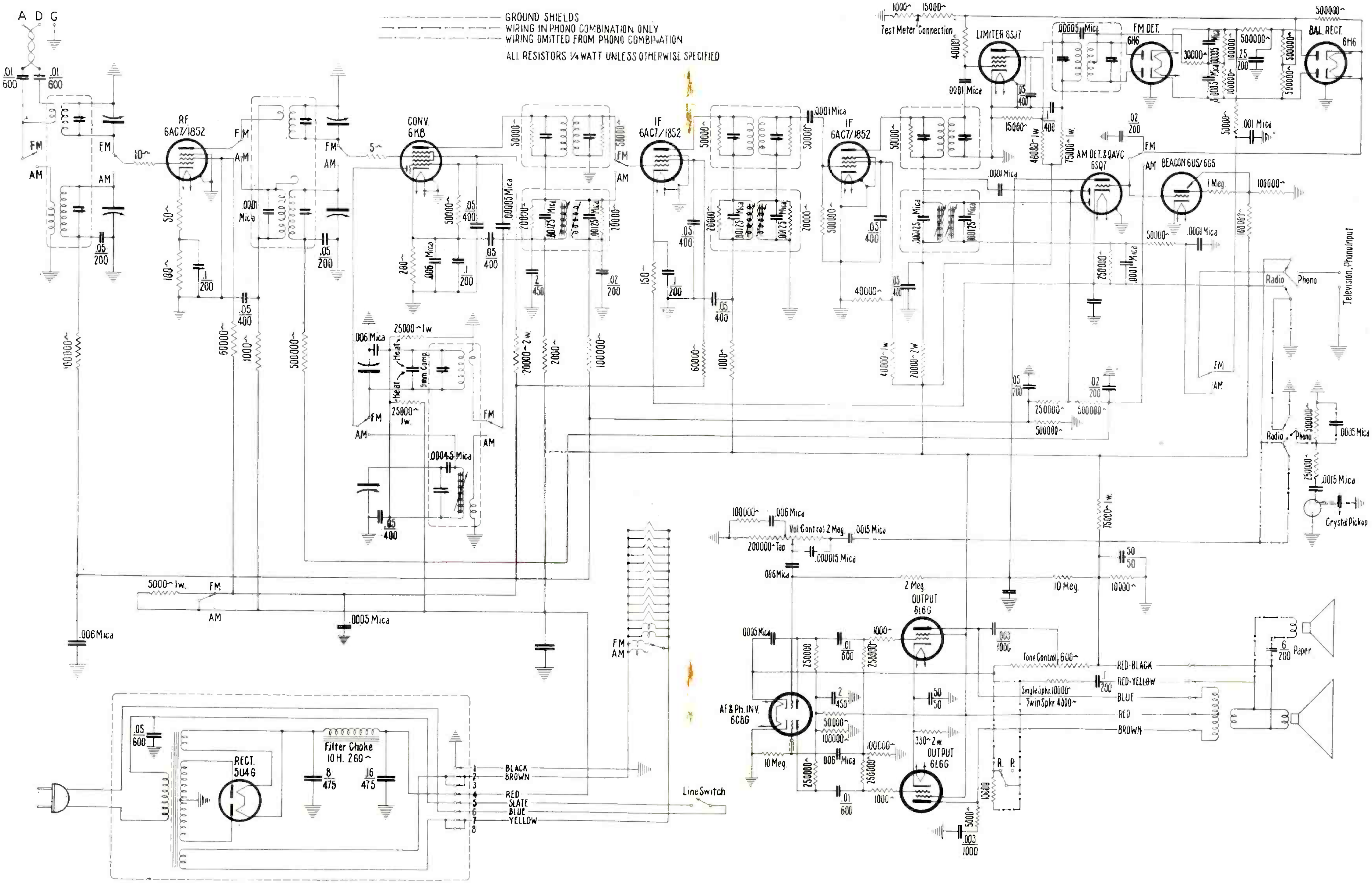
(1) Volume Control: Volume increases as this knob is turned to the right. This control may be left at a convenient setting when the receiver is turned off, so that it will require no readjustment when it is turned on again.

(2) Tone Control: When turned to the right this control increases the treble or high-pitched notes, producing "brilliant" quality. When turned to the left it reduces the treble and thereby emphasizes the bass register, producing "mellow" quality. This control may be adjusted in accordance with individual taste, but in general the best fidelity of reproduction is obtained with maximum brilliancy. This is particularly important on f-m, and it should be noted that a small rotation on the knob away from the extreme right produces a marked reduction in highs on a good f-m broadcast.

Attention is directed to certain differences in tone range among present-day f-m broadcasts. In general the best fidelity may be expected from an f-m broadcast utilizing live studio program material. When the f-m transmitter takes its program material from a distant studio over a wire-line network, or from ordinary phonograph records, there is usually a perceptible loss in reproduction of the extreme highs, such as the overtones of high violin notes, the "S" sounds in speech.

As the commercial use of f-m transmitters expands, in accordance with the plans of the Federal Communications Commission, special broadcasting methods and equipment, now in restricted use, will be more widely introduced. This progress will lead to fuller utilization of the potentialities of f-m, affording at all times the degree of realism and the quality of enjoyment obtainable with these special broadcasting methods and equipment.

(3) Line Switch: Throw up for "on," down for "off." This switch is made entirely separate from volume and tone controls in order that the adjustments of the latter may be left undisturbed when the receiver is turned off.



SCHEMATIC DIAGRAM OF PILOT MODEL 12 SERIES F-M, A-M RECEIVERS. NOTE THE CODED WIRING IN THE PHONO COMBINATION. PHONO AND CONSOLE HAVE BASS AND TWEETER SPEAKERS

(2) SPECIAL FEATURES OF FM-12 RECEIVER

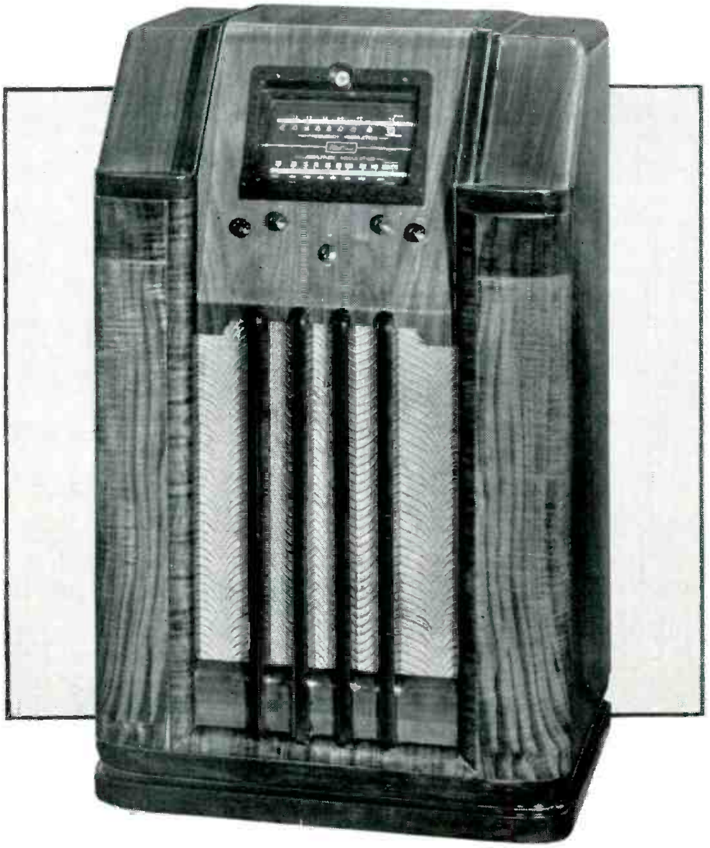
The FM-12 chassis embodies virtually two complete receivers, utilizing the same audio system and the same RF, converter, and IF tubes for both. The IF transformers for both systems are connected in series and work with the common IF tubes, but separate second detectors are used. A band switch selects the proper antenna, RF, and oscillator tuning components, and transfers the input terminal of the audio system from one second detector to the other. Reference to the schematic diagram will show additional details of the switching arrangements.

Audio System: The audio system comprises a 6C8G twin triode, used as first audio amplifier and self-regulating phase inverter, followed by a pair of 6L6G tubes operating in push-pull, Class AB1.

Inverse Feedback: Inverse feedback is employed to improve tone quality. For this purpose a resistor network is connected across the loudspeaker voice-coil and a suitable proportion of the voice-coil voltage is fed back into the cathode of the first audio triode. This cathode feedback voltage reduces the grid-cathode voltage which is effective in producing output. The action is equivalent to a *large* reduction of amplifier gain at those frequencies at which the gain is *high*, and a *small* reduction where the gain is *low*. The gain is also reduced more on the peaks of harmonics generated in the output stage. The result is the establishment of virtually uniform gain over a wide frequency range and the reduction of harmonics.

Inverse Feedback Tone Control: Continuous tone control is provided by a novel circuit arrangement. A network consisting of a condenser and a variable resistor is connected between the plate of one of the output tubes and ground. The variable resistor forms part of the inverse feedback network described above, so that the voltage across the variable portion is fed back to the cathode of the first audio triode. This reduces the input for all frequencies above a certain value, without affecting lower frequencies. The cutoff frequency is controlled by adjustment of the variable resistor. A moderately sharp cutoff of the high audio frequencies is produced, and the action is much more satisfactory than the gradual cutoff provided by conventional tone controls.

Balance Detector: In tuning an f-m receiver it is most essential to adjust the IF precisely to the "balance frequency" of the discriminator,



PILOT F-M, A-M CONSOLE MODEL CFM-12. SEPARABLE PLUG CONNECTORS BETWEEN TUNER, POWER SUPPLY, AND SPEAKERS FACILITATE REMOVAL OF THESE UNITS WHEN SERVICE WORK IS REQUIRED

(4) Band Switch: Turn to the *left* for f-m (Frequency Modulation), *right* for a-m (Amplitude Modulation).

(5) Tuning: This control combines fast and slow tuning in a special Pilot drive mechanism, permitting quick transfer from one part of the dial to another, yet providing for fine tuning with great facility.

TUNING BEACON

Accurate tuning is extremely important on both FM and AM; careless adjustment will introduce noise and distortion. The cathode ray tuning beacon in the top center of the dial scale provides visual means to facilitate tuning. As the tuning point is approached the V-shaped shadow of the beacon becomes smaller. On very strong signals the two sides of the V-shaped sector may overlap. For correct tuning adjust to the smallest shadow or the largest overlap.

PHONO-TELEVISION SOUND

Audio Input Jacks: All three models have pin-jack terminals at the rear of the receiver chassis for connection to an external phonograph pickup, a microphone, or the audio channel of a television receiver.

Phono-Radio Switch: Each model has a phono-radio switch at the rear of the receiver chassis, directly beneath the pin-jack terminals, for switching in an audio input fed to these terminals.

The phonograph combination, Model LFM-12, has an additional phono-radio switch on the front panel directly above the line switch, for switching in the built-in phonograph. When using audio input feed to the pin-jacks the *front* switch must be left in the RADIO position. When using the radio receiver *both* switches must be in the RADIO position.

SERVICE INFORMATION

The following sections include:

(1) a brief outline of the principles of frequency modulation, so far as they will assist in servicing this receiver;

(2) a description of the special features of this receiver;

(3) alignment procedure;

(4) trimmer diagram;

(5) tube and voltage chart;

(6) schematic wiring diagram.

(1) FREQUENCY-MODULATION

The Armstrong Wide-Band Frequency-Modulation system has a twofold purpose: (a) to eliminate interference from static, electrical induction, and tube noise; (b) to increase the fidelity of reproduction. To achieve these aims a new kind of signal is used, which is totally different in character from the disturbances, so that the receiver can discriminate between the two.

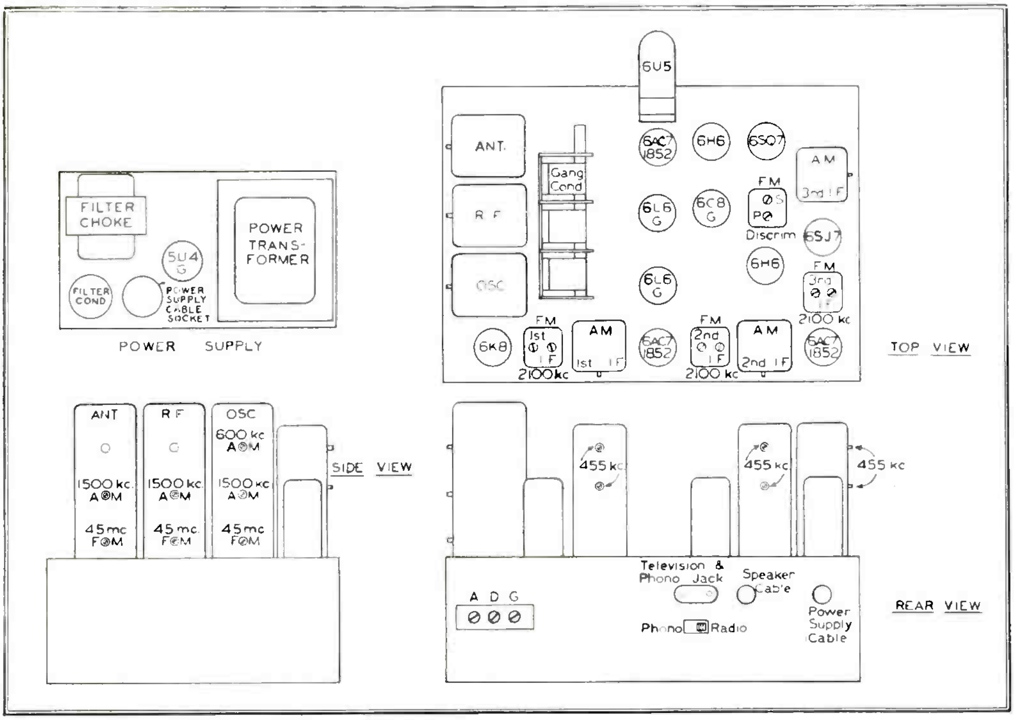
Under this new system the program material is impressed upon the carrier wave by changing the *frequency* of the carrier in accordance with the sound impulses instead of changing its *strength* or *amplitude*. The departure from carrier frequency, known as the "deviation," depends upon the sound intensity, and the number of times the deviation is applied and removed depends upon the pitch of the sound. The maximum deviation permitted by the Federal Communications Commission is 75 kilocycles, and this deviation corresponds to 100 per cent modulation at the transmitter.

To illustrate: suppose that the carrier frequency is 43,000 kilocycles, and that a 1,000-cycle note of maximum loudness occurs in the musical program; then the frequency of the transmitted wave will vary from 42,925 to 43,075 kilocycles and back again, and will repeat this process 1,000 times per second. Now suppose that the 1,000-cycle note becomes weaker, say 33 per cent modulation; then the transmitted wave will vary from 42,975 to 43,025 kilocycles and back again, and will repeat this process 1,000 times per second.

At the receiver, the frequency-modulated wave is converted, by the standard superheterodyne process, to a lower intermediate frequency with the same frequency modulation. (In the FM-12 receiver the intermediate frequency is 2,100 kilocycles, and a swing from 2,025 to 2,175 kilocycles would represent 100 per cent modulation.) After amplification, this IF signal is then applied to a "limiter" tube, in a circuit which is arranged to deliver *constant output regardless of changes in the amplitude of the input.* Since the static and other disturbances are primarily amplitude changes, the smoothing out of amplitude changes by the "limiter" removes the disturbing effects, but leaves the frequency modulation unaltered.

The output of the limiter is applied to a "frequency discriminator" (or second detector) which converts the frequency deviations into audio-frequency currents. These in turn are amplified and delivered to a loudspeaker.

This system makes possible the reproduction of audio frequencies up to 15,000 cycles per second. Such high-fidelity reproduction has been impracticable hitherto, for two reasons: first, a receiver designed to provide adequate selectivity between 10-kilocycle a-m broadcast channels generally cuts the sidebands representing modulation beyond about 5,000 cycles; and secondly, the noise interference lies mainly in the higher audio-frequency register.



LAYOUT OF THE RECEIVER CHASSIS AND POWER SUPPLY, SHOWING TUBE LOCATIONS AND ARRANGEMENT OF PARTS

in order to secure freedom from noise and distortion. It is not sufficient to provide means for tuning to resonance peak, because the resonance is too broad and the peak may be considerably off the balance frequency.

The FM-12 receiver provides means for tuning easily and precisely to the balance frequency. At this frequency there is no DC potential difference between the two cathodes of the discriminator tube, and a slight mistuning in either direction gives rise to a potential difference whose polarity corresponds to the direction of mistuning. In the FM-12 receiver this effect is utilized by a separate 6H6 tube, called the "balance detector," whose cathode becomes *positive* when there is a potential difference *in either direction* between the discriminator cathodes. This *positive* potential is used to neutralize a *negative* potential developed by the signal at the limiter tube, and prevents the negative potential from closing the tuning beacon. At exact tuning, the positive potential disappears, leaving the negative potential to close the beacon. The result is a sharp tuning indication, governed by discriminator balance and not by mere resonance.

Inter-Station Silencer: When signal input is detuned or otherwise removed from an f-m receiver, the limiter ceases to function so that the entire amplifying system up to the second detector operates at full gain. Under these conditions, unless steps are taken to prevent it, the tube noise becomes objectionably loud. In the FM-12 this inter-station noise is completely suppressed by a 6SQ7 squelch tube whose plate current flows in a biasing resistor in circuit with the grid of the first audio triode. The grid of the squelch tube is in turn controlled by the same balance detector system which operates the tuning beacon, so that the squelch tube is biased to cutoff when a signal is correctly tuned in. Under these conditions the 6SQ7 plate current ceases to flow in the grid circuit of the first audio triode, permitting the latter to function normally.

The value of the interstation silencer is readily and forcefully demonstrated by removing the 6SQ7 tube when the receiver is off tune on f-m reception.

While the squelch feature is intended primarily for f-m, it also functions on a-m when a very small aerial is used.

(3) ALIGNMENT PROCEDURE

A-M Alignment: The A-M alignment of this receiver is conventional in every respect. Most skilled radio servicemen have the equipment and experience needed to perform this alignment successfully. A detailed description of the a-m alignment will not, therefore, be given here, but the following information is included:

The locations of all trimmers are shown in the trimmer chart.

The a-m intermediate frequency is 455 kilocycles.

The voice coil terminals are accessible on the speaker frame for output meter connection. The voice coil impedance is approximately 6 ohms at 400 cycles.

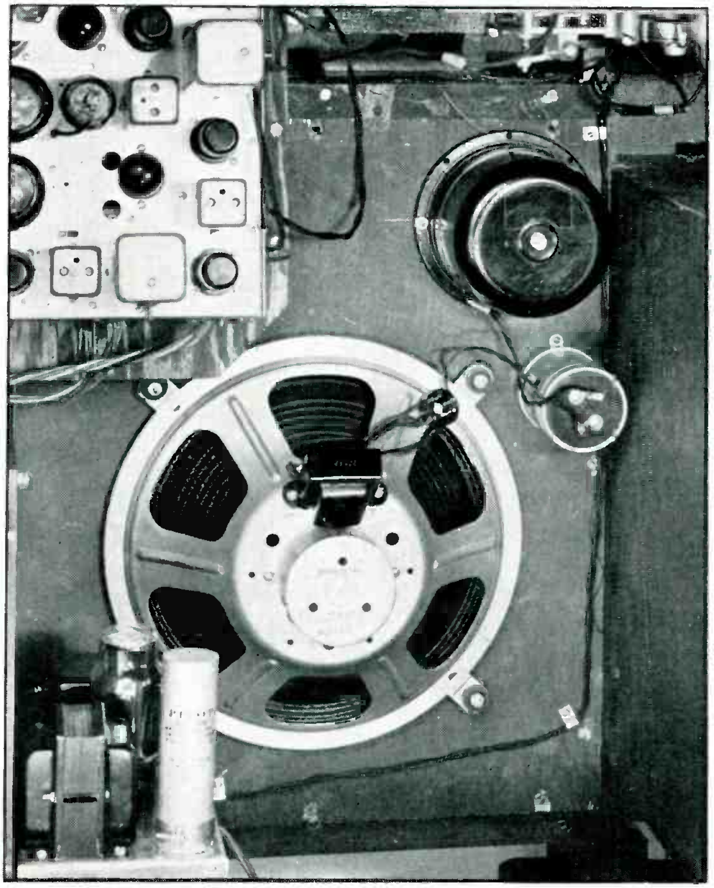
Should it be desired temporarily to remove the squelch feature so as to permit a-m alignment on weak inputs, this may be done by grounding the plate supply of the 6SQ7 tube (junction between 75,000-ohm and 10,000-ohm resistors on terminal strip on front apron). Since the diodes of this tube are used for a-m second detector and AVC, the tube cannot be removed as it can on f-m.

Should it be desired temporarily to remove the inverse feedback, this may be done either by shorting the 600-ohm tone control or by opening the resistor-condenser network connected in series with it across the voice coil. The former method will also remove tone control, while the latter will not.

The resistor in the inverse-feedback network above referred to is 10,000 ohms in the table model (with single speaker) and 4,000 ohms in the console and phono combination (for dual speakers). In the phono combination a 10,000-ohm resistor is switched in series with the 4,000-ohm resistor when the front phono-radio switch is thrown to phono position.

Removal of inverse feedback will increase the audio sensitivity about 2.0 times in the 10,000-ohm case, or about 2.5 times in the 4,000-ohm case.

F-M Alignment: The correct alignment of an f-m receiver, while not difficult, is an exact procedure requiring suitable equipment, an understanding of the fundamental principles



REAR VIEW OF THE PILOT F-M, A-M PHONOGRAPH COMBINATION. TUNER IS AT UPPER LEFT, WITH POWER SUPPLY BELOW. THIS VIEW SHOWS BASS SPEAKER AND TWEETER, ENTIRELY ENCLOSED, AT UPPER RIGHT. DIRECTLY ABOVE TWEETER IS RECORD-CHANGER involved, and some experience. *Alignment operations should not be attempted under any circumstances without these three essentials, and with them only if clearly necessary.*

Equipment for F-M Alignment: The following are the minimum requirements:

(a) Signal generator having the following frequency and output ranges: For IF alignment: Accurate calibration between 2,000 and 2,200 kilocycles; output adjustable at least between 100 and 10,000 microvolts. For RF alignment: Accurate calibration between 40 and 50 megacycles; output adjustable at least between 5 and 1,000 microvolts.

These requirements may be met either by one or by two separate signal generators. Amplitude modulation at 400–1,000 cycles is desirable to facilitate finding, but is not indispensable.

The signal generator output should be brought out through a short concentric transmission line. A .1 mfd. blocking condenser should be at all times inserted at one end of the central or high-potential conductor.

(b) Dummy antenna resistor, approximately 70 ohms, for connection between high-potential output conductor of signal generator and A terminal of receiver.

(c) D. C. milliammeter, 0–0.5 or 0–1.0 milliamperes, for measuring limiter grid current. A shunting resistor capable of increasing the range to about 0–2,000 microamperes is desirable but not essential. This meter should be connected to a pair of leads about two feet long, terminating in spring clips.

(d) D. C. microammeter having zero center with range of 100 microamperes to both right and left of center. As a substitute a single-sided meter with reversing switch may be used, but this will be much less convenient. This meter should be connected to a pair of leads about two feet long, each lead connected to a 250,000-ohm resistor, the free ends of the resistors terminating in spring clips.

(e) Resistor, 500,000 ohms, with clips for insertion between converter grid lead and grid cap.

F-M Meter Connections:

(a) Connect the limiter grid milliammeter across the 1,000-ohm resistor which is connected in series with 40,000-ohm and 16,000-ohm resistors from the grid of the 6SJ7 limiter to chassis. The positive terminal of the meter should be connected to the grounded end of the 1,000-ohm resistor, and the negative terminal to the other end.

(b) Connect the zero-center meter (through its two 250,000-ohm resistors) across the two 100,000-ohm resistors which are connected between the cathodes of the 6H6 discriminator tube. These resistors are readily identified because they are mounted end-to-end on a lug strip between the discriminator tube and the discriminator transformer.

F-M Intermediate-Frequency Alignment:

(a) Remove the converter grid cap and insert 500,000-ohm resistor between grid cap and grid lead. Connect signal generator between grid cap and chassis. Adjust signal generator to exactly 2,100 kilocycles, with IF input (signal generator output) at about 1,000 micro-volts.

(5) TUBE AND VOLTAGE CHART

All voltages taken with 117-volt 60-cycle line. Band switch on FM no signal
Voltmeter resistance =300,000 ohms for readings above 30 volts; 30,000 ohms for lower readings

Tube	*Location*	*Function*	*Voltage Between Chassis and Socket Terminal*							
			1	2	3	4	5	6	7	8
1852/6AC7	Receiver Chassis	R-f amplifier	0	0	0	0	1.9	138	6(a-c)	292
1852/6AC7	" "	1st i-f amplifier	0	0	0	0	1.9	138	6(a-c)	292
1852/6AC7	" "	2nd i-f amplifier	0	0	0	0	0	106	6(a-c)	140
6K8	" "	Oscillator-converter	0	0	282	129	1.3	81	6(a-c)	3.4
6SQ7	" "	AM-second detector / AM-AVC / Interstation silencer	0	0	0	0	0	0 *	0	6(a-c)
6H6	" "	FM-discriminator	0	0	C	0	0	0	6(a-c)	0
6H6	" "	FM-balance rectifier	0	6(a-c)	0	0	0	0	0	0
6C8G	" "	1st audio amplifier / Phase inverter	0	6(a-c)	33	0	0	93	0	35
6L6G	" "	Output	0	0	292	304	0	0	6(a-c)	22
6L6G	" "	Output	0	0	292	304	0	0	6(a-c)	22
6U5	Dial Bracket	Tuning Beacon	6(a-c)	3 †	0	112	0	0	—	—
5U4G	Pwr. Supp. Chassis	Rectifier	0	346	0	305(a-c)	0	305(a-c)	0	346

Rectifier heater voltage between terminals 2 and 8 =5 volts a-c.
*35 volts at 6SQ7 plate supply. †11 volt reading with 300.000-ohm voltmeter.

(b) Now tune each of the six 2,100 kc. IF trimmers (see trimmer diagram) for maximum response in limiter grid meter. Check sensitivity by adjusting IF input until milliammeter reads 0.20 milliamperes. This should take between 150 and 250 microvolts.

(c) Next increase signal generator output to about 10,000 microvolts and adjust secondary trimmer of discriminator transformer carefully until zero-center meter reads zero.

(d) Next detune signal generator by exactly 100 kilocycles upward and note reading of zero-center meter. Detune by 100 kilocycles downward and note reading. Adjust primary trimmer of discriminator transformer and repeat this test until readings on both sides of zero are equal (approximately 48 microamperes).

F-M Radio-Frequency Alignment:

(a) Restore normal grid lead connection to grid cap of converter tube. Connect low-potential output terminal of signal generator to terminal D of receiver. Connect high-potential terminal to terminal A through a 70-ohm dummy antenna resistor.

(b) Adjust signal generator to about 1,000 microvolts output at exactly 45 megacycles. Tune receiver dial to exactly 45 megacycles. Tune f-m oscillator trimmer until limiter grid meter responds, then adjust this trimmer very carefully to give zero reading on zero-center meter. Switch signal generator off and on and watch limiter grid meter to make sure that observed signal is coming from signal generator.

Adjust signal generator to vicinity of 40.8 megacycles, and find image frequency, which produces a somewhat weaker response in limiter grid meter. If image cannot be found near 40.8 megacycles, but appears instead near 49.2 megacycles on signal generator, then oscillator trimmer capacity is too low. In this case reset to 45 megacycles and increase oscillator trimmer capacity by turning screw counter-clockwise until a second response is found. Now adjust accurately to zero-center reading and repeat test for image response at 40.8 megacycles.

(c) Reduce signal generator output to about 50 microvolts. Tune f-m RF and antenna trimmers to maximum response on limiter grid meter.

This completes the alignment of the receiver.

REVOLUTION FOR PROFIT

(CONTINUED FROM PAGE 9)

if over-production of the previous season's models were offered at reduced prices.

Since this is permissive regulation, no company would be under compulsion to submit sets for test, or to meet the approved standards. The only pressure would come from purchasers who registered preference for models bearing the official approval. Such disciplinary action as might be necessary on the part of the testing laboratory would merely be withholding the seals, under terms on which they were issued, in case of their misuse.

This, of course, is only the suggestion of one individual. There may be other, better ways to apprise the public of f-m performance standards. Certainly, some such plan will perform a highly useful service to the industry and to the purchasers of the new receivers.

All the Elements of Success ★ The commercial perfection of frequency modulation has created an entirely new situation for the radio industry. It provides all the elements necessary to success beyond any records of the past. At the same time, the stage has been set for a reshuffling of broadcasting which, by the f-m system, furnishes facilities for giving the American public home entertainment of still greater excellence than has been possible with the amplitude modulation system.

Surely, the people of this country are responsive to technical improvements. Right here in the U. S. A. we have the greatest market in the world and the greatest purchasing power to encourage the commercial development of anything representing scientific progress. If the radio manufacturers will make capital of past mistakes, frequency modulation will restore it to its place among the leading industries.

School Broadcasting Goes F-M

The Cleveland City Board of Education has been granted authority by the FCC to change that school system's non-commercial education radio service from amplitude modulation to frequency modulation.

The specific grant involves the education board's station WBOE shifting from 41.5 mc., 500 watts power night and day, A3 emission, to 42.5 mc., and increasing day and night power to 1000 watts for f-m transmission.

Extensive use has been made of the facilities of WBOE in serving 156 receivers in the Cleveland school system. The Board of Education states that the objective to be attained with f-m is higher fidelity and reduction of interference with classroom instruction and public education.

In August the Commission authorized the San Francisco Board of Education to use f-m for similar service in that area. Other cities now using radio for educational purposes are expected to shift to f-m equipment.

LICENSEES List of the Manufacturers Licensed for the Various Applications of Armstrong F-M Patents, as of Sept. 25

INTRODUCING a new, patented radio gadget or circuit improvement is a matter attended by very little formality, but the nature of the f-m invention makes it a three-sided problem of many ramifications. These include all the conventional complications, with some special ones all its own. It is no small tribute to Major Armstrong's capacity for being right and for getting his ideas across to others that the commercial application of f-m has proceeded so smoothly and rapidly, without a single snag to cause delays.

The three phases of this new development are: (1) commercial perfection of f-m transmitters and receivers, and the associated equipment; (2) approval by the FCC, and allocation of frequencies for f-m broadcasting; (3) establishing a patent situation, and working out acceptable license contracts.

With the first phase cleared up, as it has been, f-m might have bogged down on either or both of the other two. Actually, the second was settled in a most satisfactory way when the FCC assigned the 42- to 50-mc. band to f-m broadcasting. The third phase has proceeded smoothly, too. Manufacturers have recognized the validity of the Armstrong patents without any contest, and they have found the f-m license contracts to be reasonable, workable instruments. Major Armstrong, of course, has had much practical experience in such matters himself, and he is ably represented in legal matters by the firm of Cravath, deGersdorff, Swaine & Wood. The negotiations for f-m licenses have been handled by Alfred McCormack, of that office.

Already, twenty license contracts have been signed in the six fields of application of frequency modulation. These are with the following manufacturers of radio equipment:

1. Manufacture of Broadcast transmitters:

Radio Engineering Laboratories, Inc.
General Electric Company
Western Electric Company

2. Broadcast receivers:

General Electric Company
Stromberg-Carlson Telephone Manufacturing Company
Zenith Radio Corporation
E. H. Scott Radio Laboratories, Inc.
Pilot Radio Corporation
Stewart-Warner Corporation
Ansley Radio Corporation

3. Amateur and experimental receivers:

National Company, Inc.
Hallicrafters, Inc.
The Hammarlund Manufacturing Company, Inc.

4. Special receivers for broadcasting companies:

Radio Engineering Laboratories, Inc.
Western Electric Company

5. Mobile communication and miscellaneous apparatus:

Radio Engineering Laboratories, Inc.
General Electric Company
F. M. Link

6. Aviation apparatus:

Radio Engineering Laboratories, Inc.
General Electric Company

At this time of writing, eight additional broadcast receiver manufacturers have applied for licenses, and these are in process of negotiation. Included in this number are largest producers of home radio sets. At least fifteen requests are also being considered for licenses in the other fields of application.

It has been learned on good authority that RCA has applied for a license under the Armstrong patents in all fields. Contrary to previous reports, no license has been granted yet to Farnsworth Radio and Television Corporation.

The above is in accordance with information available on September 25th. However, it may be incomplete at the time of publication, because applicants for licenses are anxious to complete arrangements to get f-m sets in production in time for the post-Christmas sales activities.

The licenses referred to above do not include those issued to owners of individual f-m broadcast stations. These are covered by a short form of contract. While the royalty paid by apparatus manufacturers is based on selling prices, the royalty paid by the broadcasters is a fee determined by the operating power of the transmitter.

Supplementary lists of manufacturers to whom f-m licenses are issued will be published in forthcoming numbers of FM MAGAZINE.

E. J. McDONALD, JR.

HIS RECORD OF RIGHT GUESSES MAKES COMMANDER McDONALD'S OPINION ON NEW RADIO DEVELOPMENTS WORTHY OF SERIOUS CONSIDERATION. HERE ARE HIS VIEWS ABOUT FREQUENCY MODULATION, ITS SIGNIFICANCE, AND FIELD OF USEFULNESS:

THE MANUFACTURERS SAY:

A Statement by Commander E. J. McDonald, Jr., President of Zenith Radio Corporation

MANY retail dealers are asking questions about the new type of radio transmission and reception, frequency modulation, known for short as FM. They ask, for example, "Will FM obsolete and displace the present type of broadcasting?" "What will be the effect on the unit of sale?"

I shall try to answer these questions, and in addition give you some facts about frequency modulation as I have found them to exist.

Frequency modulation faces none of the economic hurdles of television. Increased program costs and increased program production problems are not a consideration as with television. Television, because of the economic obstacles, is still a long way off so far as general use in the home is concerned. That is my opinion. Not so with FM. It's here. Programs now used for standard or amplitude modulation radio broadcasts may be used on FM without change.

Combination Types Will Prevail

Frequency modulation transmission has two great advantages; comparative freedom from static, and high fidelity reproduction. Consequently, its greatest appeal will be to music lovers.

In my opinion radios of the combination type providing for both FM and the present AM type reception will constitute 99 per cent of the FM receiver business. That is, 99 per cent of all FM receivers manufactured will also contain AM or standard type reception facilities.

FM Will Not Replace Other Types

Meanwhile FM should be a boon to the transcription business, since FM stations may send from records FM transmissions capable of reproducing as much fidelity as the best transcriptions contain without the fidelity loss that would occur in a hookup over existing chain telephone lines.

I do not believe FM broadcasting and the type of receiver it demands will in the near future or even ultimately displace all other types. There are several reasons for this. Audio systems and loudspeakers capable of reproducing 15,000 cycle high fidelity from a direct studio FM broadcast are necessarily more costly than systems and speakers that will reproduce only 6,000 cycles. Where there is a special demand on the part of music lovers for high fidelity, such extra cost will no doubt gladly be borne by the purchasers of FM receivers for the sake of the quality that can be obtained from them.

Present Bands Could Be Revised

If the changeover of smaller stations to FM should relieve the congestion of stations in the present amplitude modulation band, I am confident that the present band itself can be revised to give 20,000 or 30,000 cycle separation between stations upon this band, and that then a measure of high fidelity will be possible on the standard broadcast band not permitted today because of congestion.

As frequency modulation improves, amplitude modulation will also improve, and with its long distance ability will still have an important place in American broadcasting.

FM Means Plus Business

The new market to be opened up is not a replacement market but a plus market. Just as the first drive of manufacturers was to get one radio in every home, and a more recent drive has been to place additional receivers in every home, frequency modulation will be basically a drive on the family living room where every home, regardless of what other receivers it has, should have a high fidelity instrument for special musical broadcasts. We are planning a program in line with this thinking.

FM Will Raise Industry Sales Unit

The general effect of FM on radio dealers, as this system of transmission and reception develops, will be to raise the unit of sale, and no dealer, I feel, will regret that circumstance.

Zenith has already introduced FM receivers in the 1941 radio line. They are definitely developed as quality items.

Zenith's own FM transmitter, Station W9XZR, the only one now operating in the Chicago area, has been on the air since February 1st. It is located at the top of the Chicago Towers Club, one of the city's highest buildings, and is hooked up by a mile of special high fidelity cable to the Columbia Broadcasting System via its Chicago outlet, Station WBBM. This station gives us ample facilities for first-hand experimentation.

FM Transmitters Cost Less

FM transmitters are relatively inexpensive to erect. They cost less than our present amplitude modulation transmitters. This fact may help in speeding their erection.

Eventually, as more FM stations are erected, the public will become aware of a special characteristic of FM stations which does not exist in connection with the present type of

(CONCLUDED ON PAGE 43)

FCC Rules Governing High Frequency Broadcast Stations, Comprising Subpart B from Part 3 of the Federal Communication Commission's Rules

EDITOR'S NOTE: *It is important to all concerned to understand the rules and regulations governing f-m transmitters, for it is within the limitations of such control that f-m broadcasting will expand. Of particular interest to manufacturers and the trade are the definitions of f-m terms, and Sec. 3.225, as this explains the assignment of frequencies in areas of various population densities, in order to avoid inter-station interference. The complete text of the Rules, promulgated by the FCC on June 22, 1940, appear below. Further additions or revisions will be published, when they are released, in subsequent issues of* FM MAGAZINE. *The Standards of Good Engineering Practice referred to frequently in this text were to have been published in this issue of* FM MAGAZINE, *by the authority of the FCC. However, the Standards for high frequency broadcast stations are being revised, owing to the need of clarification and simplication. It is expected that the revised Standards will be issued in time for publication in* FM MAGAZINE *for December.*

THE existing rules governing standard broadcast stations, and the new rules governing high frequency broadcast stations are to be combined in Part 3 of the Commission's rules, which will be entitled "Rules Governing Standard and High Frequency Broadcast Stations." Subpart A of the rules, applicable only to standard broadcast stations comprises existing rules 3.1 to 3.86 inclusive. Subpart C, containing general rules applicable both to standard and high frequency broadcast stations, will comprise existing rules 3.87 to 3.104 inclusive. Subpart B, comprising the new rules governing high frequency broadcast stations is as follows:

SUB-PART B. RULES GOVERNING HIGH FREQUENCY BROADCAST STATIONS

DEFINITIONS [1]

Sec. 3.201. High Frequency Broadcast Station ★ The term "high frequency broadcast station" means a station licensed primarily for the transmission of radiotelephone emissions intended to be received by the general public and operated on a channel in the High Frequency broadcast [2,3] band.

Sec. 3.202. High Frequency Broadcast Band ★ The term "high frequency broadcast band" means the band of frequencies extending from 43,000 to 50,000 kilocycles, both inclusive.

Sec. 3.203. Frequency Modulation ★ The term "frequency modulation" means a system of modulation of a radio signal in which the frequency of the carrier wave is varied in accordance with the signal to be transmitted while the amplitude of the carrier remains constant.

Sec. 3.204. Center Frequency ★ The term "center frequency" means the frequency of the carrier wave with no modulation. (With modulation the instantaneous operating frequency swings above and below the center frequency. The operating frequency with no modulation shall be the center frequency within the frequency tolerance.)

Sec. 3.205. High Frequency Broadcast Channel ★ The term "high frequency broadcast channel" means a band of frequencies 200 kilocycles wide and is designated by its center frequency. Channels for high frequency broadcast stations begin at 43,100 kilocycles and continue in successive steps of 200 kilocyc'es to and including the frequency 49,900 kilocycles.

Sec. 3.206. Service Area ★ The term "service area" of a high frequency broadcast station means the area in which the signal is not subject to objectionable interference or objectionable fading. (High frequency broadcast stations are considered to have only one service area; for determination of such area see Standards of Good Engineering Practice for High Frequency Broadcast Stations.)

Sec. 3.207. Antenna Field Gain ★ The term "antenna field gain" of a high frequency broadcast antenna means the ratio of the effective free space field intensity produced at one mile in the horizontal plane expressed in millivolts per meter for 1 kilowatt antenna input power to 137.6.

Sec. 3.208. Free Space Field Intensity ★ The term "free space field intensity" means the field intensity that would exist at a point in the absence of waves reflected from the earth or other reflecting objects.

Sec. 3.209. Frequency Swing ★ The term "frequency swing" is used only with respect to frequency modulation and means the instantaneous departure of the carrier frequency from the center frequency resulting from modulation.

[1] Other definitions which may pertain to high frequency broadcast stations are included in Sections 2.1 to 2.35 and Sections 3.1 to 3.16, and the Communications Act of 1934, as amended.

[2] See Section 3.226 concerning multiplexing, aural and facsimile programs.

[3] High frequency broadcast stations must use frequency modulation exclusively in accordance with Section 3.225 (d).

Sec. 3.210. Multiplex Transmission ★ The term "multiplex transmission" means the simultaneous transmission of two or more signals by means of a common carrier wave. (Multiplex transmission as applied to high frequency broadcast stations means the transmission of facsimile or other aural signals in addition to the regular broadcast signals.)

Sec. 3.211. Percentage Modulation ★ The term "percentage modulation" with respect to frequency modulation means the ratio of the actual frequency swing to the frequency swing required for 100 per cent modulation expressed in percentage. (For high frequency broadcast stations, a frequency swing of 75 kilocycles is standard for 100 per cent modulation.)

Sec. 3.212. Experimental Period ★ The term "experimental period" means that period of time between 12 midnight and sunrise. This period may be used for experimental purposes in testing and maintaining apparatus by the licensee of any high frequency broadcast station, on its assigned frequency and with its authorized power, provided no interference is caused to other stations maintaining a regular operating schedule within such period.

Sec. 3.213. Main Studio ★ The term "main studio" means, as to any station, the studio from which the majority of its local programs originate, and/or from which a majority of its station announcements are made of programs originating at remote points.

ALLOCATION OF FACILITIES [1]

Sec. 3.221. Basis of Licensing High Frequency Broadcast Stations ★ High frequency broadcast stations shall be licensed to serve a specified area in square miles. The contour bounding the service area and the radii of the contour shall be determined in accordance with the Standards of Good Engineering Practice for High Frequency Broadcast Stations.

Sec. 3.222. Area Served ★ (a) High frequency broadcast stations shall be licensed to serve areas having characteristics falling within the provisions of subparagraphs (a), (b), or (c) of Sec. 3.225 hereof. The Commission, in considering applications for high frequency broadcast stations, will establish service areas.

(b) Where a service area has been established in which one or more existing high frequency broadcast stations are in operation, the contours of any new station proposed to serve such area shall compare with those of the existing station or stations as nearly as possible.

Sec. 3.223. Time of Operation ★ All high frequency broadcast stations shall be licensed for unlimited time operation.

Sec. 3.224. Showing Required ★ Authorization for a new high frequency broadcast station or increase in facilities of an existing station [2] will be issued only after a satisfactory showing has been made in regard to the following matters:

(a) That the area and population which the applicant proposes to serve has the characteristics of an area described in subparagraphs (a), (b), or (c) of Sec. 3.225 hereof. The application shall be accompanied by a full analysis of the basis upon which the area as set forth in the application was determined. No application for construction permit for a new station or change of service area will be accepted unless a definite site, full details of the proposed antenna, and a suitable map showing the expected service area are furnished with the application. (See Standards of Good Engineering Practice for High Frequency Broadcast Stations.)

(b) Where a service area has been established in which one or more existing high frequency broadcast stations are in operation, that the contours of any new station proposed to serve such area will compare with those of the existing station or stations as nearly as possible, or that the service area already established should be modified.

(c) That objectionable interference will not be caused to existing stations or that if interference will be caused the need for the proposed service outweighs the need for the service which will be lost by reason of such interference.

(d) That the proposed station will not suffer interference to such an extent that its service would be reduced to an unsatisfactory degree. (For determining objectionable interference, see Standards of Good Engineering Practice for High Frequency Broadcast Stations.)

(e) That the technical equipment proposed, the location of the transmitter, and other technical phases of operation comply with the regulations governing the same, and the requirements of good engineering practice. (See technical regulations herein and Standards of Good Engineering Practice for High Frequency Broadcast Stations.)

(f) That there is a need for the proposed program service in the area to be served.

(g) That the applicant is financially quali-

[1] The rules relating to allocation of facilities are intended primarily for the information of applicants. Nothing contained in said rules shall be regarded as any recognition of any legal right on behalf of any person to a grant or denial of any application.

[2] Special authorizations which do not involve experimental authorization may be granted pursuant to Sec. 1.365.

fied to construct and operate the proposed station; and, if the proposed station is to serve substantially the same area as an existing station, that applicant will be able to compete effectively with the existing station or stations.

(h) That the program service will include a portion of programs particularly adapted to a service utilizing the full fidelity capability of the system, as set forth in the Standards of Good Engineering Practice for High Frequency Broadcast Stations.

(i) That the proposed assignment will tend to effect a fair, efficient, and equitable distribution of radio service among the several states and communities.

(j) That the applicant is legally qualified, is of good character, and possesses other qualifications sufficient to provide a satisfactory public service.

(k) That the facilities sought are subject to assignment as requested under existing international agreements and the Rules and Regulations of the Commission.

(l) That the public interest, convenience and necessity will be served through the operation under the proposed assignment

Sec. 3.225. Channel Assignments ★ The channels set forth below with the indicated center frequencies are available for high frequency broadcast stations:

(a) (1) Applicants for licenses to serve cities or towns having a total population of less than 25,000 (approximate) (exclusive of adjacent rural areas) shall apply for one of the following channel assignments:

48900	49500
49100	49700
49300	49900

(2) The application shall specify a service area which shall not exceed 500 square miles, except where a definite need for a greater area is shown and no objectionable interference will result.

(b) (1) Applicants for licenses to serve populations of 25,000 (approximate) or more within areas comprising less than 3,000 square miles shall apply for one of the following channel assignments:

44500	45900	47500
44700	46100	47700
44900	46300	47900
45100	46500	48100
45300	46700	48300
45500	46900	48500
45700	47100	48700
	47300	

(2) The applications shall specify a service area which shall comprise (i) either a metropolitan district, (ii) a city, (iii) an area which may comprise one or more towns or communities or subdivisions of cities or metropolitan districts having such common cultural, economic, geographical, or other characteristics as to justify service to the area as a unit.

(c) (1) Applicants for licenses to serve areas in excess of 3,000 square miles shall apply for one of the following channel assignments:

43100	43900
43300	44100
43500	44300
43700	

(2) The application shall specify a service area comprising two or more large cities or metropolitan districts and a large adjacent rural area; or, in exceptional cases, one city or metropolitan district and a large adjacent rural area.

(d) High frequency broadcast stations shall use frequency modulation exclusively.

(e) Stations serving all or a substantial part of the same area will not be assigned adjacent channels.

(f) One channel only will be assigned to a station.

Sec. 3.226. Facsimile Broadcasting and Multiplex Transmission ★ The Commission may grant authority to a high frequency broadcast station for the multiplex transmission of facsimile and aural broadcast programs provided the facsimile transmission is incidental to the aural broadcast and does not either reduce the quality of or the frequency swing required for the transmission of the aural program. The frequency swing for the modulation of the aural program should be maintained at 75 kc. and the facsimile signal added thereto. No transmission outside the authorized band of 200 kc. shall result from such multiplex operation nor shall interference be caused to other stations operating on adjacent channels. The transmission of multiplex signals may also be authorized on an experimental basis in accordance with Section 3.32, sub-part A.

Sec. 3.227. Proof of Performance Required ★ Within one year of the date of first regular operation of a high frequency broadcast station, continuous field intensity records along several radials shall be submitted to the Commission which will establish the actual field contours, and from which operating constants required to deliver service to the area specified in the license are determined. The Commission may grant extensions of time upon showing of reasonable need therefor.

Sec. 3.228. Multiple Ownership ★ (a) No person (including all persons under common control)[1] shall, directly or indirectly, own,

[1] The word "control" as used herein is not limited to majority stock ownership but includes actual working control in whatever manner exercised.

operate, or control more than one high frequency broadcast station that would serve substantially the same service area as another high frequency broadcast station owned, operated, or controlled by such person.

(b) No person (including all persons under common control) shall, directly or indirectly, own, operate, or control more than one high frequency broadcast station, except upon a showing (1) that such ownership, operation, or control would foster competition among high frequency broadcast stations or provide a high frequency broadcasting service distinct and separate from existing services, and (2) that such ownership, operation, or control would not result in the concentration of control of high frequency broadcasting facilities in a manner inconsistent with public interest, convenience, or necessity; provided, however, that the Commission will consider the ownership, operation, or control of more than six high frequency broadcast stations to constitute the concentration of control of high frequency broadcasting facilities in a manner inconsistent with public interest, convenience, or necessity.

Sec. 3.229. Normal License Period ★ All high frequency broadcast station licenses will be issued so as to expire at the hour of 3 A.M., Eastern Standard Time, and will be issued for a normal license period of one year, expiring as follows:

(a) For stations operating on the frequencies 48900, 49100, 49300, 49500, 49700, and 49900, April 1.

(b) For stations operating on the frequencies 44500, 44700, 44900, 45100, 45300, 45500, 45700, 45900, 46100, 46300, and 46500, May 1.

(c) For stations operating on the frequencies 46700, 46900, 47100, 47300, 47500, 47700, 47900, 48100, 48300, 48500, and 48700, June 1.

(d) For stations operating on the frequencies 43100, 43300, 43500, 43700, 43900, 44100, and 44300, July 1.

EQUIPMENT

Sec. 3.241. Maximum Power Rating ★ The Commission will not authorize the installation of a transmitter having a maximum rated power more than twice the operating power of the station.

Sec. 3.242. Maximum Rated Carrier Power; How Determined ★ (a) The maximum rated carrier power of a standard transmitter shall be determined by the manufacturer's rating of the equipment.

(b) The maximum rated carrier power of a composite transmitter shall be determined by the sum of the applicable commercial ratings of the vacuum tubes employed in the last radio stage.

Sec. 3.243. Frequency Monitor ★ The licensee of each high frequency broadcast station shall have in operation at the transmitter a frequency monitor independent of the frequency control of the transmitter. It shall have a stability of 20 parts per million. For detailed requirements thereof see Standards of Good Engineering Practice for High Frequency Broadcast Stations.

Sec. 3.244. Modulation Monitor ★ The licensee of each high frequency broadcast station shall have in operation at the transmitter an approved modulation monitor. For detailed requirements thereof see Standards of Good Engineering Practice for High Frequency Broadcast Stations.

Sec. 3.245. Required Transmitter Performance ★ (a) The external performance of high frequency broadcast transmitters shall be within the minimum requirements prescribed by the Commission contained in the Standards of Good Engineering Practice for High Frequency Broadcast Stations.

(b) The transmitter center frequency shall be controlled directly by automatic means which do not depend on inductances and capacities for inherent stability.

(c) The transmitter shall be wired and shielded in accordance with good engineering practice and shall be provided with safety features in accordance with the specifications of article 810 of the current National Electrical Code as approved by the American Standards Association.

Sec. 3.246. Indicating Instruments ★ The direct plate circuit current and voltage shall be measured by instruments having an acceptable accuracy. (See Standards of Good Engineering Practice for High Frequency Broadcast Stations.)

Sec. 3.247. Auxiliary and Duplicate Transmitters ★ See Sections 3.63 and 3.64 for provisions governing the use of auxiliary and duplicate transmitters at high frequency broadcast stations.

Sec. 3.248. Changes in Equipment and Antenna System ★ Licensees of high frequency broadcast stations shall observe the following provisions with regard to changes in equipment and antenna system:

(a) No changes in equipment shall be made:

1. That would result in the emission of signals outside of the authorized channel.

2. That would result in the external performance of the transmitter being in disagreement with that prescribed in the Standards of

Good Engineering Practice for High Frequency Broadcast Stations.

(b) Specific authority, upon filing formal application[1] therefor, is required for a change in service area or for any of the following changes:

1. Changes involving an increase in the maximum power rating of the transmitter.

2. A replacement of the transmitter as a whole.

3. Change in the location of the transmitter antenna.

4. Change in antenna system, including transmission line, which would result in a measurable change in service or which would affect the determination of the operating power by the direct method. If any change is made in the antenna system or any change made which may affect the antenna system, the method of determining operating power shall be changed immediately to the indirect method.

5. Change in location of main studio to outside of the borders of the city, state, district, territory, or possession.

6. Change in the power delivered to the antenna.

(c) Specific authority, upon filing informal request therefor, is not required for the following change in equipment and antenna:

1. Change in the indicating instruments installed to measure the antenna current or transmission line, direct plate circuit voltage and the direct current of the last radio stage, except by instruments of the same type, maximum scale reading and accuracy.

2. Minor changes in the antenna system and/or transmission line which would not result in an increase of service area.

3. Changes in the location of the main studio except as provided for in subsection (b) 5.

(d) Other changes, except as above provided for in this section or in Standards of Good Engineering Practice for High Frequency Broadcast Stations prescribed by the Commission may be made at any time without the authority of the Commission, provided that the Commission shall be promptly notified thereof, and such changes shall be shown in the next application for renewal of license.

Sec. 3.251. Operating Power; How Determined ★ The operating power, and the requirements for maintenance thereof, of each high frequency broadcast station shall be determined by the Standards of Good Engineering Practice for High Frequency Broadcast Stations.

[1] See Standards of Good Engineering Practice for High Frequency Broadcast Stations for specific application form required.

Sec. 3.252. Modulation ★ (a) The percentage of modulation of all stations shall be maintained as high as possible consistent with good quality of transmission and good broadcast practice and in no case less than 85 per cent on peaks of frequent recurrence during any selection which normally is transmitted at the highest level of the program under consideration.

Sec. 3.253. Frequency Tolerance ★ The operating frequency without modulation of each broadcast station shall be maintained within 2,000 cycles of the assigned center frequency.

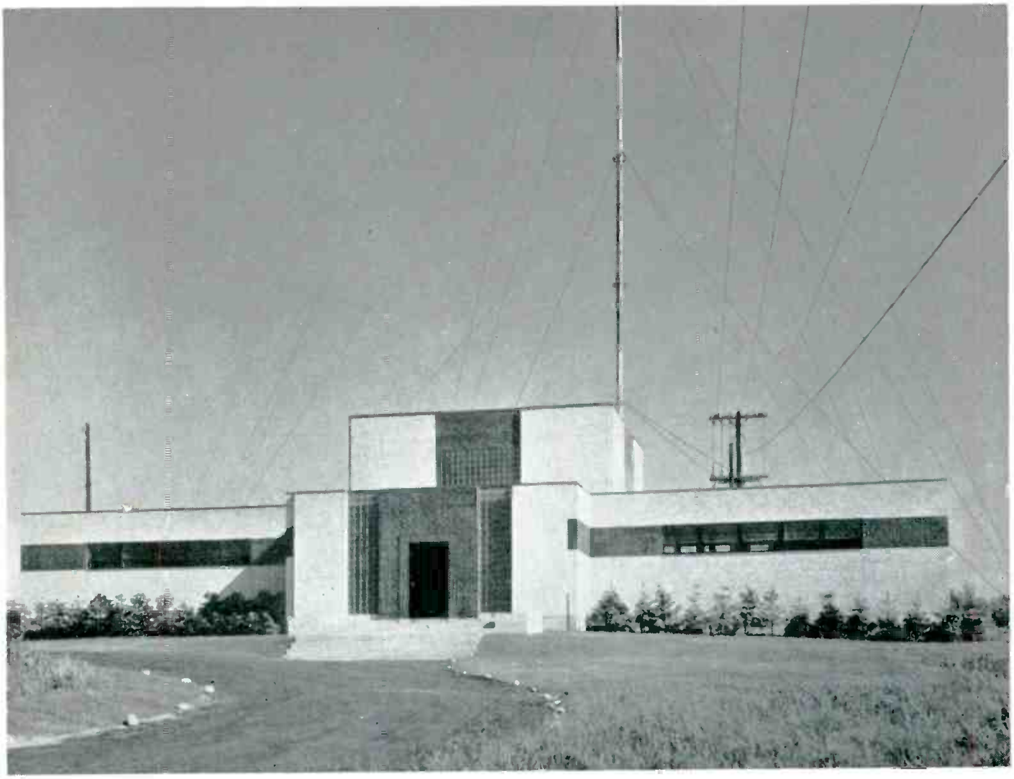
OPERATION

Sec. 3.261. Minimum Operating Schedule; Service ★ (a) Except Sundays, the licensee of each high frequency broadcast station shall maintain a regular daily operating schedule which shall consist of at least three hours of operation during the period 6 A.M. to 6 P.M., local standard time, and three hours of operation during the period 6 P.M. to midnight, local standard time. In an emergency, however, when due to causes beyond the control of the licensee, it becomes impossible to continue operating, the station may cease operation for a period not to exceed ten days, provided that the Commission and the Inspector in Charge of the radio district in which the station is located[2] shall be notified in writing immediately after the emergency develops.

(b) Such stations shall devote a minimum of one hour each day during the period 6 A.M. to 6 P.M., and one hour each day during the period 6 P.M. to midnight, to programs not duplicated simultaneously as primary service in the same area by any standard broadcast station or by any high frequency broadcast station. During said one hour periods, a service utilizing the full fidelity capability of the system, as set forth in the Standards of Good Engineering Practice for High Frequency Broadcast Stations, shall be rendered. However, the Commission may, upon request accompanied by a showing of reasons therefor, grant exemption from the foregoing requirements, in whole or in part, for periods not in excess of three months.

(c) In addition to the foregoing minimum requirements, the Commission will consider, in determining whether public interest, convenience, and necessity has been or will be served by the operation of the station, the extent to which the station has made or will make use of the facility to develop a distinct and separate service from that otherwise available in the service area.

[2] See Appendix No. 3, Part 1.



ON THE WOODED HEIGHTS OF MT. ASNEBUMSKIT, MASS., STANDS THIS PIONEER F-M STATION

GATEWAY TO FINER ENTERTAINMENT

Description of Yankee Network's W1XOJ at Paxton—by Paul A. deMars

WHEN, in October of 1938, a road was built through woods and pastures to the summit of Mt. Asnebumskit in the town of Paxton, Mass., there was inaugurated a most important step in broadcasting's newest development.

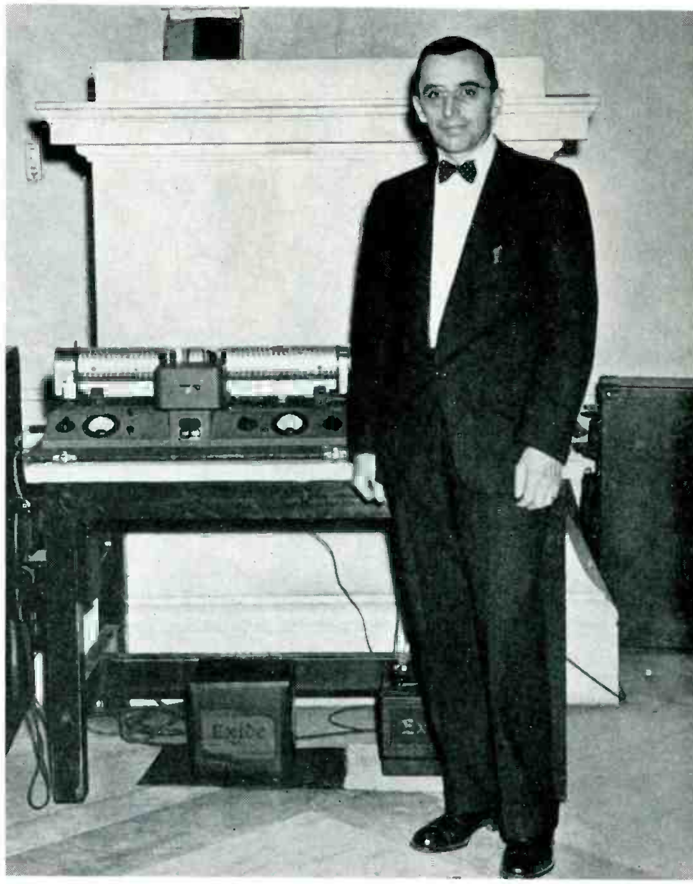
Under the direction of Yankee Network engineers, there were erected the buildings and antennas that now comprise John Shepard 3rd's pioneer broadcasting station, W1XOJ, using Major Edwin H. Armstrong's system of frequency modulation.

A daily schedule of 16 hours of broadcasting was begun on July 24, 1939, with a power of 2 kw. This was the first station to broadcast frequency modulated programs on a regular schedule. During February of 1940 the installation of equipment with a capacity of 50 kw. was completed and put in operation.

Since then frequency modulation broadcasting has been maintained on the same daily schedule from W1XOJ, with the power of about 30 kw. The efficiency of this station has not been fully realized because the transmitting antenna erected in 1939 atop a 400-foot guyed pole was destroyed during the unprecedented ice storm and gales of January 15, 1940. Meanwhile, a temporary antenna has been used, to provide uninterrupted service.

The former antenna is now being replaced by a structure of new design and is, at this writing, practically ready to go into operation. When the new antenna goes on the air John Shepard 3rd's W1XOJ in Paxton will be the world's most powerful and efficient f-m broadcasting station.

W1XOJ, on Mt. Asnebumskit, is adjacent to Worcester, and is situated 43 air-line miles from The Yankee Network studios in Boston. The programs are transmitted to Mt. Asnebumskit by means of an f-m radio link. This departure from the usual practice of using wire lines facilities for the transmission of programs from studio to station is done for the simple reason that f-m does a better job at less ex-



PAUL A. DE MARS, YANKEE NETWORK V.P. IN CHARGE OF ENGINEERING, HAS HAD A LEADING PART IN COMMERCIALIZATION OF F-M, AND HE CONTRIBUTED MUCH PRACTICAL TESTIMONY AT THE FCC HEARING. IN THE BACKGROUND OF THIS PICTURE IS FACSIMILE EQUIPMENT USED AT PAXTON

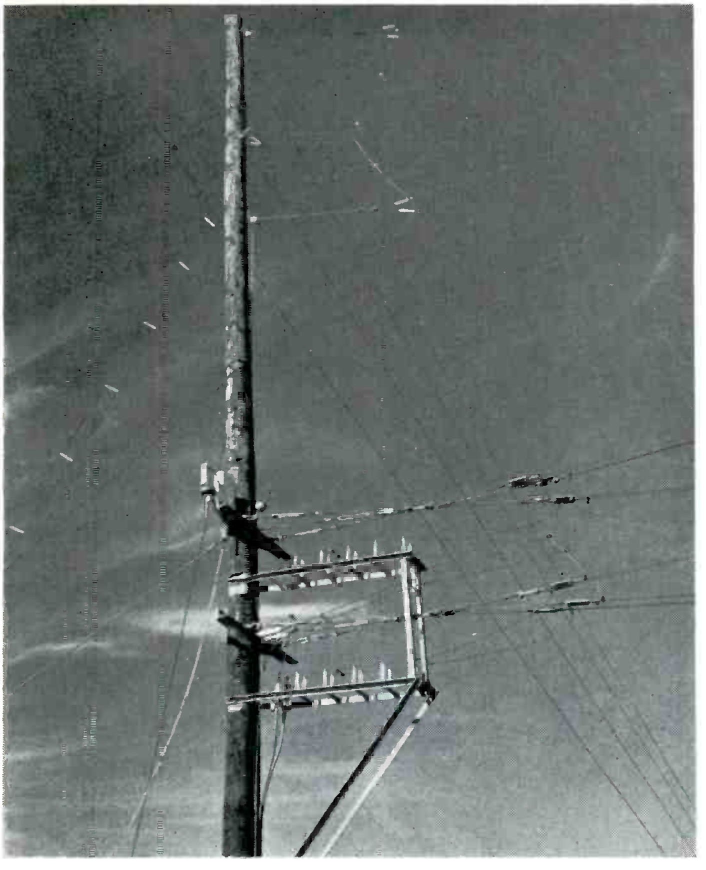
pense. Particularly, there is no loss in audio quality, as would be the case if ordinary wire connections were used.

To acquaint the readers of this publication with this new development of The Yankee Network the following facts are presented with respect to the technical and general considerations.

Relay Transmitter ★ The relay broadcast transmitter that carries the programs to W1XOJ is located atop the studio building in Boston. It has a capacity of 500 watts output and operates with an authorized output of 250 watts on a frequency of 133,030 kc. with call letters WEOD. Manufactured by Radio Engineering Laboratories, it employs the Armstrong system of frequency modulation. Associated with the transmitter are audio components which transmit the range of frequencies from 30 to 15,000 cycles per second flat to within less than 1 db, and with a noise level more than 70 db down from normal operating levels. The overall performance of the f-m link, including the receiver at W1XOJ, is flat to within 2 db from 30 to 15,000 cycles per second and with the noise level 65 db down from 100 per cent modulation. Minor improvements in the transmitter soon to be made will reduce the overall noise level to better than 70 db down from 100 per cent modulation.

The output of the transmitter is fed to a directive array by means of a balanced pair of standard 7/8-in. concentric lines. The array, illustrated on page 4, consists of 4 sets of horizontal elements spaced about 3/4 wavelength in the vertical plane. Each element of the array consists of a half wave di-pole with parasitic director and reflector. The currents in the elements are equal and in phase. The measured gain from this array is about 10 db, or a power gain of approximately 10 fold. The elements of the array are supported by an 80-ft. self-supported pole.

The relay signals are received at Paxton by means of an array of V antennas. To insure directivity and to provide ample voltage at the receiver input terminals, two V antennas



IF IT TAKES A 50-KW. TRANSMITTER AT PAXTON TO PUT A SERVICE SIGNAL INTO BOSTON, HOW CAN A 250-W. RELAY TRANSMITTER IN BOSTON GET PERFECT SIGNALS UP TO PAXTON? THE ANSWER IS THAT PAXTON USES AN ARRAY OF V'S FOR HIGH-EFFICIENCY PICK-UP, AS DESCRIBED HERE. THIS PICTURE SHOWS THE TERMINAL MAST OF THE V-TYPE ARRAY

approximately 20 wavelengths long are employed, spaced about ½ wavelength in the vertical plane. Each V has associated with it another V which increases directivity, reinforces the received signal, and functions as a parasitic reflector. The receiving V's are connected so that their outputs are in phase and matched to a balanced pair of standard ⅞-in. concentric lines which transmit the signal to the receiver located near the modulator units of the transmitter. The receiving array is about 22 ft. above ground, which is the optimum height in consideration of the slope of the terrain where the array is situated.

Measurement of the gain of the receiving array is difficult but is better than 20 db and insures ample signal at the receiver for satisfactory operation under all conditions, with a large margin of safety. It may be stated without qualification that over a year's operation of this circuit has failed to disclose any appreciable impairment in quality of program or the introduction of noise even during the severest lightning storms encountered.

Up to the present time, one of the early laboratory model receivers has been employed at W1XOJ. This will soon be replaced by a pair of receivers designed especially for this service to insure reliability of service and provide slight improvement in quality.

Transmitter ★ The site of W1XOJ at Paxton, Mass., . . . was entirely undeveloped, and it was necessary to construct a mile of road and a transmission line of equal length to bring power to the station. Adequate water supply was secured after drilling to a depth of 575 ft. through solid rock.

The W1XOJ transmitter is a standard No. 521 type, manufactured by Radio Engineering Laboratories, licensed for the Armstrong system of frequency modulation. The transmitting equipment is divided into five units. The speech input and modulator units are located in a completely shielded room. The lower level output of the modulator units is at a frequency of one-third of the station operating frequency and is amplified and tripled in the four-stage intermediate amplifier equipment.

The intermediate amplifiers are installed as a unit and deliver 2 kw. of power, sufficient to drive the final 50-kw. amplifier. The 50-kw. output amplifier is located in a completely shielded, sound-proof room. The shielding reduces stray fields and the sound-proofing is desirable to minimize the noise from the air blast directed on the grid and filament seals of the large tubes. A pair of Westinghouse type AW-200 tubes, used in the final stage, are capable of power output in excess of 50 kw. The fourth unit of the equipment comprises the high voltage rectifiers and control equipment, and situated at some distance are the various auxiliary apparatus such as filament generators, water-cooling and air blast units.

When completed, the new antenna system will consist of ten so-called "turnstile" bays. The radiating elements of the turnstile are mounted on a 100-ft. mast supported on a fabricated steel structure 150 ft. high. Power is transmitted from the output stage to the base of the antenna structure by means of a balanced pair of concentric lines. These lines consist of 4-in. diameter outer conductors and 2-in. diameter inner conductors. At the base of the tower, the power is divided into 40 concentric lines which feed each individual element of the array. These lines consist of 7/8-in. diameter outer sheath and 3/8-in. diameter inner conductor. A coupling house at the base of the structure shelters the dividing network and phasing equipment.

It is estimated that the array will realize an actual gain in excess of 6 db with reference to a single half wave di-pole. Horizontally polarized emission is determined upon after weighing all factors that contribute to giving the listeners the best service.

The overall performance with respect to quality of W1XOJ's transmitter is practically identical with that of the relay transmitter WEOD. Tests of the complete circuit from studio to receiver show the audio frequency range flat to within 2db from 30 to 15,000 cycles, with the carrier noise level about 65 db below 100% modulation and distortion less than 2 per cent. As in the case of the relay link, the carrier noise level will be still further reduced.

CONTROL DESK AND 50-KW. R.E.L. AMPLIFIER—THE WORLD'S FIRST 50-KW. F-M STATION

Present plans contemplate continued operation with a daily schedule of 16 hours from 8 A.M. to midnight. Programs are selected from Yankee and Colonial Network, NBC Blue Network and Mutual Broadcasting System. About four hours a day are live talent programs, directly from the studio, providing full f-m fidelity.

We have received a number of interesting comments about the comparative quality of the same programs received by a-m and by f-m from Paxton. Radio dealers, for example, aware that it is not possible to utilize the full tone quality of our f-m transmitter on network programs, are surprised to find that these network programs sound better on f-m than a-m. There are two reasons for this. First of all, the f-m transmitter has a pre-emphasis amplifier to bring up as much of the highs as are present. This brings out the individual characteristics of musical instruments, and improves speech articulation. Second, with an adequate signal to operate the f-m receiver, the highs sound clean, clear, and crisp, since there is no background noise. Third, there is not the harmonic distortion in a properly-designed f-m receiver that occurs in most a-m sets.

Still, the contrast between network programs and studio announcements is great. We are transmitting just as much live-talent studio program material as possible, so as to give our listeners the full entertainment value of the f-m system.

Another step in John Shepard 3rd's organization of a New England F-M Network which, in turn, will form a vital link in proposed nation-wide organization will be the conversion, in the near future, of the present 500-watt ultra-frequency amplitude Weather Service Station atop Mt. Washington (W1XOY) to a full-fledged f-m transmitter. This station will serve 1,000,000 listeners in the Northern New England area, 750,000 of whom have never before been within the primary coverage area of any broadcasting station.

The peak of Mt. Washington, 6,300 ft. above sea level, is the loftiest on the Atlantic Seaboard. The station will use the 100-ft. antenna structure already in place. The proposed operating power of 5,000 watts, at this great height, will be approximately equivalent to that of a 50,000-watt station at 2,000 ft. elevation, or to that of a 200,000 watt station at 1,000 ft. above the surrounding terrain.

I would like to take this opportunity to pay tribute to those New England dealers who are giving us their whole-hearted coöperation in building up the f-m audience. It is a tremendous task, involving enormous expenditures, to put this system of broadcast service into operation. It has required a considerable staff of engineers, electricians, and expert mechanics to install, check, revise, and test again the various elements of the installation, from studio microphone to transmitting antenna.

Always bearing in mind that the ultimate success of the undertaking would be measured by its service to the listening public, the work of perfecting each detail has been done with thoroughness, rather than haste, as a prime consideration. This has been pioneering work, because there were no precedents of engineering experience established by others. While this has been going on, we have had to depend largely upon radio dealers and servicemen to interpret to the listeners the significance of our efforts.

Now, as the new antenna is being completed, we are making ready to give listeners within range of Paxton the finest home entertainment that is available anywhere in the world.

The Manufacturers Say:

(CONTINUED FROM PAGE 33)

transmitter. If two FM stations should happen to transmit on the same frequency into the same area, there will be no interference as sometimes happens with present type stations feeding into overlapping areas. A frequency modulation receiver will simply pick up the stronger station and reject the weaker one.

Yet at the present time there are in the country little more than a dozen broadcasting stations giving regular programs of frequency modulation. In spite of the great interest among broadcasters, it is not likely that FM stations will actually be operating before the end of the year in many localities other than those in which experimental programs are now being carried on. Under these circumstances it is impossible to forecast the number of receivers that will be sold. The actual popularity of these models will depend largely upon the sincerity with which all radio manufacturers who enter FM will devote their energies to making it a quality product that will justify the interest of the public.

Wanted: Tall Buildings for F-M Antennas

NBC's new f-m transmitter, W2XWG, makes its home atop the Empire State Building in New York. W2XOR, the f-m outlet of WOR, is some 650 feet above street level, while CBS is expected to establish an f-m station in the pinnacle of the Chrysler Building. Other groups seeking f-m licenses will stud the skies with these new antennas wherever tall buildings or accessible mountaintops are found.

FM HANDBOOK

Chapter 1: The Background and Concepts of Frequency Modulation

BY GLENN H. BROWNING

EDITOR'S NOTE: *This is the first of a series of articles by Glenn H. Browning, in which he will present both the elementary and advanced theory of frequency modulation transmission and reception. Thus, these articles will carry the servicemen and experimenters as far as they care to go into f-m theory, and they will meet the requirements of advanced students. Subsequently, this material will be published in book form, under the title: FM Handbook.*

As a clear physical concept is essential, the first chapter explains the basic principles in terms familiar to all.

THE latter part of 1939 ushered in a new era in the transmission of radio signals. This new method, known as frequency modulation, was invented and developed by radio's most enterprising pioneer, Major Edwin H. Armstrong. Once again he has given the radio art a new forward impetus, which bids fair to be revolutionary in its effect. Frequency modulation is outstanding, because of the following characteristics: The reception is essentially noise-free; the fidelity of reproduction can be made perfect; the dynamic range is such that the original program is literally brought into the listener's home; and at the same time interference between stations can be eliminated entirely.

Ever since the earliest days of radio, interference caused by atmospheric static and man-made noise has been the outstanding problem confronting the radio field. In many cases, it is this interference that limits the consistent transmission of intelligence. There are probably few radio engineers of an inventive nature, who have not at some time during their career attacked this problem. Major Armstrong started a concerted effort some ten years ago to solve this outstanding problem. After trying various methods of attack, he and his associates had practically decided there was no solution. However, the idea occurred that if the present system of radio transmission could not be made noise-free, the desired result might be obtained by changing the method of transmission and reception.

There are at least two methods of modulating a carrier so that intelligence could readily be transmitted: amplitude modulation and frequency modulation. In the former method, the carrier-frequency amplitude is varied while the carrier frequency remains fixed. In the latter method the carrier frequency is varied while its amplitude remains fixed. Frequency modulation had been known for years, but no one had seen in it any advantage over the existing method. In fact, varying the frequency of the transmitted carrier would take up a considerably greater band of frequencies in the ether than amplitude modulated signals.

It remained for the Major to recognize that frequency modulation had the potentialities of eliminating radio interference, and to invent a commercially practical method of accomplishing frequency modulation. As is the case with all radically new inventions, there were more skeptics than converts in the beginning.

However, the new system talked for itself so successfully, even through thunder storms and man-made interference, that everyone who heard and compared its merits with the older system had to admit that the radio noise problem was solved. Through Major Armstrong's persistence, this type of transmission has emerged from the laboratory stage in perfected form, and it is safe to say it will go down in history as a major invention.

Pioneering regular broadcast service with frequency modulation is the development of the Yankee Network in New England, where John Shepard, 3rd, president of the Yankee Network, built at Paxton, Mass., a 50,000-watt frequency modulation transmitter, operating on a frequency of 43 mc. This station, W1XOJ, was the first commercial station to be built outside of Major Armstrong's own transmitter, W2XMN at Alpine, N. J.

In order to have high fidelity program material available at the Paxton station, a high frequency modulated relay station was erected at the Boston studios, with a beam antenna system directed towards Paxton. All programs broadcast from Paxton are received over this relay station some 43 miles distant, without the use of telephone lines. The Yankee Network's pioneering of frequency modulation, under the able direction of Paul A. deMars, chief engineer, demonstrated conclusively to the world what could be accomplished by Major Armstrong's system, and laid the ground work for the general use of high frequency, frequency modulation broadcasting.

Difference Between F-M and A-M ★ To obtain a concept of the difference between amplitude and frequency modulation, let us refer to Figs. 1, 2, 3, and 4. In Fig. 1, one of the simplest vacuum tube oscillator circuits is shown with a carbon type microphone in series with the tuned circuit L_1 and C_1. If no sound is impressed on the microphone, an alternating current will be set up in the L_1-C_1 circuit and the amplitude of this alternating current will be constant. The frequency of the current will depend upon the values of the inductance of the coil L_1 and the capacitance of the condenser C_1.

$$f = \frac{1}{2\pi\sqrt{L_1C_1}}$$

As is well known, a carbon microphone has the property of changing its internal resistance

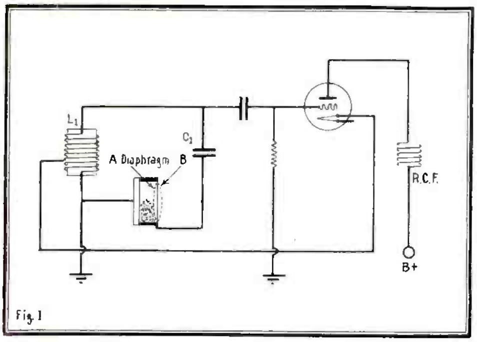


FIG. 1. ELEMENTARY A-M TRANSMITTER CIRCUIT

as sound strikes the diaphragm, for the carbon granules are compressed when the diaphragm moves toward the cavity and the resistance of the microphone is reduced. On the other hand, when the diaphragm moves out, the carbon granuals make poorer contact as the pressure is reduced, and the resistance of the microphone is increased. When this type of microphone is placed in series with a tuned circuit and its resistance changed by air waves striking the diaphragm, the high frequency alternating current is in turn increased or decreased as the circuit resistance is changed, thus producing the carrier amplitude variations shown in Fig. 2.

It should be noted that the sound striking the microphone in the case just described does not appreciably change the inductance or capacitance of the tuned circuit and thus the carrier or fundamental frequency of the circuit remains constant. It should also be noted that the amount the carrier amplitude is changed or modulated is directly dependent upon the resistance of the microphone. If this resistance is sufficiently high, the tuned circuit would not oscillate, and if the resistance is made very small, the oscillatory current is large. Thus the amplitude modulation of the carrier is controlled by the intensity of the air waves which strike the diaphragm.

A good physical picture of frequency modulation can be obtained from Fig. 3 where a similar oscillator circuit is shown with the inductance L_2 and the capacitance C_2. Instead of a carbon type microphone placed in series with the circuit, a condenser-type microphone is placed directly across the tuned circuit. It is assumed that this condenser type microphone does not change its resistance appreciably as the diaphragm moves. Therefore, as the resistance in the tuned circuit does not change appreciably, the amplitude of the alternating current set up in this circuit is substantially constant.

However, as the frequency of the current in the tuned circuit depends upon the capacitance and inductance, changing either varies the frequency. The condenser type microphone, as

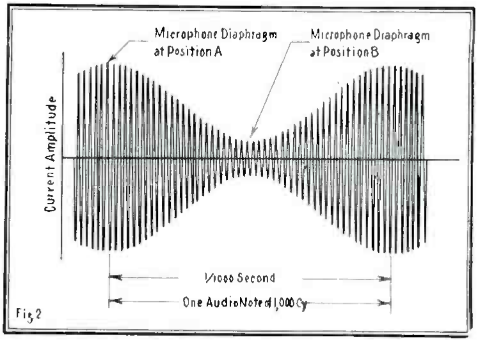


FIG. 2. CARRIER CURRENT AMPLITUDE VARIATIONS

its name implies, consists essentially of one rigid plate and a readily movable diaphragm insulated from each other. As air waves strike this diaphragm, the capacitance of the microphone changes and this in turn changes the total capacitance of the tuned circuit, resulting in a frequency change. It will be noted that the louder the sound, the more the deflection of the diaphragm and, consequently, the greater is the frequency variation.

The rate (audio frequency) with which the sound strikes the diaphragm will determine how rapidly the frequency changes. This is shown in Fig. 4. The circuits used to illustrate a-m (amplitude modulation) and f-m (frequency modulation) are not feasible in actual practice but give an accurate physical picture of the actions which occur.

Thus there are the following fundamental differences between amplitude and frequency modulation: In amplitude modulation, the louder the sound striking the microphone, the greater the change in amplitude of the carrier frequency. The rapidity (audio frequency) of the sound striking the diaphragm results in the carrier amplitude changing at a faster or slower rate.

In frequency modulation, the action is

different. The louder the sound striking the diaphragm, the greater the frequency deviation of the carrier. How rapidly the frequency deviates is dependent upon the rapidity of the sound waves striking the microphone. In frequency modulation, the amplitude of the carrier remains fixed at all times. These fundamental concepts of the two methods of modulation will be brought out more in detail as this study of f-m progresses.

Why F-M Eliminates Static ★ To appreciate the fundamental soundness of reducing or

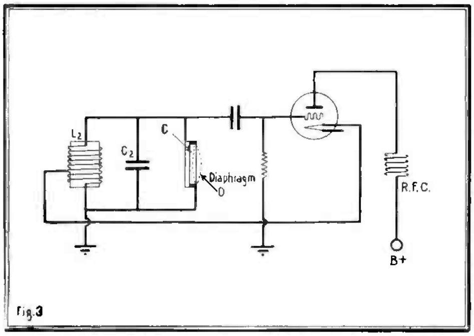


FIG. 3. ELEMENTARY F-M TRANSMITTER CIRCUIT

eliminating noise by means of f-m transmission, let us examine the fundamental concepts of radio interference. Static and man-made interference resulting from lightning or electrical disturbances of any type set up what might be termed a series of random pulses in the ether. These pulses are picked up by the receiving antenna and, due to the tuned circuit in the receiver, actually generate alternating currents, the frequency of which is the same as that to which the resonant circuits are tuned. These pulses are thus fed through the receiver, resulting in noise emanating from the speaker. If, at the same time, a strong signal is being received, the additional signal due to the pulse will not be as noticeable because this amplitude change may be limited by the tubes in the receiver itself. This explains the fact that static may not be heard if the radio signals are very strong. This is the principle on which limiter circuits for reducing noise operate.

A mechanical example of tuned circuit operation may help in clarifying the action just described. Assume a weight is attached to a spring. The weight may be likened to the inductance of the tuned circuit, the spring may be likened to the capacitance of the tuned circuit, while the motion of the weight may be likened to the alternating current flowing in the tuned circuit both as regards amplitude and frequency.

An incoming signal sets the tuned circuit oscillating much the same as a rhythmical tapping on the weighted spring system would do. If this rhythmic tapping is not at the correct frequency very little motion of the weight will result, but if the weight and spring are resonant to the frequency of tapping, a large amount of motion will be built up from a very small amount of energy expended. This latter condition corresponds to having the circuits tuned to the incoming frequency.

Noise and interference may be likened to a single blow on the weight, which naturally will set it in motion, the frequency of motion depending upon the mass of the weight and the elasticity of the spring. Thus interference is set

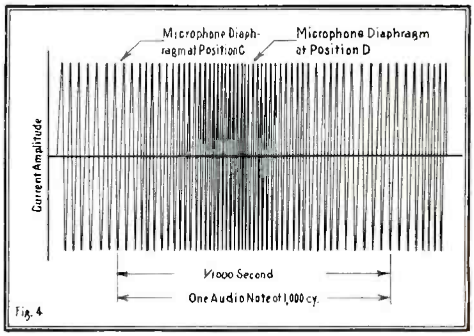


FIG. 4. FREQUENCY MODULATION OF CONSTANT AMPLITUDE

up in the tuned antenna system of a receiver and is passed along through the receiver to the loud speaker. In a-m, the voice frequencies cause changes in amplitude. If the amplitude is not allowed to change, no audio signal will result.

Such is not the case with f-m, for amplitude changes are not employed to transmit intelligible audio signals. Thus, in the foregoing illustration of a mechanical system, bumpers could be placed on either side of the weight allowing it only a definite amount of motion. When a signal is tuned in, the weight swings between these two bumpers striking each in turn and any interference which would cause more motion of the weight is entirely eliminated by means of the bumpers. However, in the case of frequency modulation, the rate of swing is variable, and this variable frequency is translated into audio frequencies at the radio receiver.

Thus an analysis of the fundamental differences between the two systems show that f-m allows the design of the receiver to incorporate an effective limiter circuit, whereby interference is prevented from causing amplitude changes.

Advantages Afforded by F-M ★ The increasingly wide-spread use of f-m for broadcast transmission is due to a number of special advantages which are inherent in this system. The most important of these are summed up as follows:

1. Static ★ Noise-free reception can be obtained where the signal strength is sufficient to operate the limiter circuit of the receiver. For a high-gain receiver, this condition prevails when the signal strength at the receiving antenna is 10 to 50 microvolts, depending upon the local noise. It should be understood, however, that if sufficient signal strength is not available to operate the limiter, absolute noise suppression may not be obtained.

The types of noise suppressed are not only atmospheric static, ignition noise, electrical appliance interference such as razors, motors, and oil burners, but also tube noise in the receiver itself. While on the subject of interference, it should be pointed out that diathermy apparatus develops a cw signal on a definite carrier frequency, and if this signal is on the same frequency and is more intense at the receiver than the f-m signals, the diathermy apparatus may cause trouble. The approximate frequencies at which this equipment operates are 13, 26, and 39 mc. It will be noted that the last frequency differs by only 3 mc. from the low end of the frequency modulation band, so that there is some possibility of interference. Plans to require the suppression of radiation from such equipment are being considered by the FCC.

2. Tone Quality ★ The quality of frequency modulation signals is superior to that of amplitude modulation. To check the theoretical considerations, listening tests have been conducted, using the same audio frequency range for high-fidelity a-m and f-m transmitters. The a-m and f-m receivers had as nearly identical audio systems as possible. Switching from one to the other, listeners observed a difference definitely in favor of the programs transmitted by frequency modulation. If there were not some inherent advantage in f-m, the quality of the two methods should have been very nearly identical.

One explanation for the results of these listening tests is that some harmonic distortion occurs in a-m transmission, especially at the higher frequencies. In the case of f-m transmission, the problem of harmonic distortion is not present, and as a consequence, higher fidelity is possible.

Under conditions of average home reception, f-m tone quality shows a marked improvement over a-m. One reason for this is that, since the noise produced by interference in a-m receivers is in the upper register, it is necessary to cut down the response to the higher audio frequencies in order to get rid of the noise. By so doing, the clear articulation of speech is destroyed, and the harmonics and overtones which give the different instruments their individual characteristics are lost. Thus, a-m reception, lacking highs, is incapable of the true reproduction of the original programs. That is why men's voices are muffled and indistinct, women's voices are unnaturally harsh, and music has a completely false bass emphasis, totally different from what is heard by studio audiences.

Of course, the use of land line networks for the distribution of programs and the limitations imposed by the 10,000-cycle separation between stations makes it impossible for a-m transmitters to make use of the audio range up to 15,000 cycles, anyway. In practice, good a-m receivers make very little use of frequencies above 3,500 cycles.

Since f-m transmitters, except on network programs, utilize the full audio range up to 15,000 cycles, and correctly designed f-m receivers, actuated by adequate signals, reproduce the full range without background interference, this system can deliver to the listener's home the exact sounds of the original speech and music.

3. Dynamic Range ★ Another reason f-m gives the illusion of hearing the original programs is that the full dynamic range can be employed. That is, the loud and soft passages are heard in their true variations of volume — something that is impossible with the a-m system.

When programs are transmitted by a-m, a monitor operator at the studio operates the controls of individual microphone amplifiers to bring up the output from soft passages, and to cut down the output during loud passages. Consequently, at the a-m receiver, low-volume parts of a program are much louder, and high-volume parts are much softer, than they are originally at the studio. Such alterations are required for, otherwise, the power output would be too low, on the one hand, to cover the normal transmitting range, and so high, on the other hand, that the transmitting tubes would be overloaded.

This effect is not present on f-m transmission, since the output is constant regardless of the signal level. The changes due to variations in volume in an f-m transmitter are only in the deviation of the frequency. With an available range in frequency deviation up to 75 kc. each side of the carrier frequency, the ratio of soft to loud passages heard at the loudspeaker is exactly the same as in the original studio program. This is an important contributing factor to the realism of f-m reception.

4. Inter-Station Interference ★ Exhaustive tests have been made concerning the claim that there is little interference between stations in the case of frequency modulation. When two stations are operating on identical frequencies and when the signal strength at the receiver has a ratio of more than two to one, the stronger signal will be received with very little interference from the weaker signal. This claim has been well substantiated by tests such as the following: Two frequency modulation transmitters of the same power were operated on identical frequencies. The receiver was positioned at different locations between the two transmitters. When the receiver was about midway between the two stations, sometimes one program would be received and sometimes both programs would be heard. However, as the receiver approached either transmitter, this interference disappeared, and the signal from the transmitter having the greater field strength was received with good quality. It should be pointed out that when there is interference between two frequency modulation stations, this interference takes the form of hearing the signal from both stations at the same time. There are no heterodyne whistles due to a very weak station in the case of frequency modulation.

This feature of f-m makes it possible for each community to be served with numerous transmitters, which will not interfere in any way with f-m transmitters located in other communities. This in turn allows better and more consistent coverage to be obtained and a much higher degree of program enjoyment.

5. Fading ★ There appears to be very little fading on frequency modulation transmissions. Of course, a material amount of fading is taken care of in the limiter circuit as the audio voltage remains constant through the wide variations in signal strength. However, during the recent magnetic storm particular attention was paid to strength, quality, etc., of f-m signals from W1XOJ, located some 40 miles distance from the receiver. No noticeable drop in signal strength could be observed nor was there any noticeable change in the fidelity of the received signals. Interference of all types was absent. The signal strength during day and night transmissions has also been carefully observed. These show that substantially the same signal is developed throughout the 24 hours which is very different from amplitude modulation stations where the transmission range varies materially. This is undoubtedly due to the frequency of f-m transmissions as well as the method.

Review Questions ★ Having read the above, can you answer the following questions:

1. In a-m, how does the sound intensity striking the microphone affect the amplitude of the carrier?
2. In a-m, does the audio frequency modulation vary the carrier frequency?
3. How does the sound intensity striking the microphone affect carrier in the case of f-m?
4. How does the audio frequency modulation affect the amplitude of the carrier in the case of f-m?
5. Assume the modulating audio frequencies have exactly the same amplitude. Does the total frequency swing of the f-m transmitter vary under audio modulation as the modulating audio
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New Mike Technique for F-M

Literally and figuratively, f-m broadcasting will permit of no stuffed shirts. So says E. E. (Ted) Hill, director of WTAG, Worcester, and of its pioneer f-m outlet, W1XTG, on the basis of experience already had with the microphone technique of f-m broadcasting.

Announcers and artists should not wear formal evening clothes when they face the supersensitive f-m mike, said Mr. Hill, because the crinkle of the soup-and-fish shirt front will be picked up. Nor can announcers be stuffed-shirt in delivery; f-m demands they be natural an
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six inches from the listener's ear. There will be no 'crawling' into the mike, and f-m is so sensitive that announcers must be doubly careful of diction and enunciation."

May We Suggest to the

F-M BROADCASTERS:

Since broadcasting became a business of selling time, radio stations and sponsors, competing for public attention, have spent increasing amounts to raise the quality of aural entertainment directed into studio microphones, and to deliver it intact to home radio antennas. This they are continuing to do.

During the last few years, however, heedless of these efforts, and mindful only of intra-industry matters, most radio set manufacturers have bent their efforts toward increasing the sale of receivers priced so low as to sacrifice the improved quality of entertainment which is being put on the air.

This is now true to such a degree that, to take a specific example, if the American Tobacco Company cut down the expense of the Lucky Strike orchestra by 40%, 75% of the listeners would hardly notice any difference in what they heard from their loudspeakers.

Yet everyone agrees that the stations and sponsors must continue their policy of seeking to raise still further the standards of program excellence.

Into this paradoxical situation, you have now injected a new development: frequency modulation broadcasting. This system is a challenge to your program and technical departments and to your sponsors to seek further advances in the creation of home entertainment. Now, through the medium of f-m, your listeners can hear your programs as accurately and completely, and without the interference of extraneous noises, as if they were sitting in your studios.

Yes, f-m can do that for them. But will the manufacturers sell f-m sets capable of such performance? Already, one of the largest producers has announced in a press release: "Our engineers are now busy shrinking the differential (in price) between sets that have f-m and those that do not." The inevitable result of such an engineering policy will be to shrink the differential in completeness and accuracy of reproduction between f-m reception and that of the average standard broadcast receiver sold today.

If continuous improvement of programs and transmitting facilities is sound policy, then every effort must be made to use f-m as a means of raising the standards of program reproduction in American homes. Everyone concerned will benefit if this is done.

Unquestionably, the set manufacturers should take the initiative in promoting the sale of receivers that will do justice to the possibilities of f-m. Actually, if left to their own devices, they will concentrate their efforts on shrinking the differential — of quality as well as price.

MAY WE SUGGEST to f-m broadcasters that you set aside some of your sustaining time on your a-m transmitters to tell the public what you and your sponsors are doing to make finer entertainment available — and how your listeners can go about shrinking the differential between what is heard by studio audiences, and what is emitted from the speakers of average, present-day receivers. You have made the public radio-conscious. Now it is time to make them tone-conscious!

The First of a Series of Discussions Concerning the Mutual Problems of the F-M Broadcasters, Set Manufacturers and Radio Dealers

RUMFORD PRESS
CONCORD, N. H.

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PILOT RADIO's leadership in being first with scientific improvements is not merely a matter of maintaining a long-standing reputation. It is an established policy to enable Pilot dealers to reach the Extra-Profit market — the people who demand high quality and fine performance.

As one of the first Armstrong frequency modulation licensees, Pilot has perfected and now offers to progressive dealers three magnificent new models which combine f-m and a-m reception: a table model at $139.50, a console at $179.50, and an automatic phonograph combination at $299.50.

Provided with every engineering advancement, the performance of these instruments is so far superior to conventional a-m radios as to amply justify their cost.

They are meeting with the most enthusiastic public reception for three reasons: (1) because, on a-m reception, the special Pilot Three Dimension circuits far out-perform standard broadcast receivers (2) because, on f-m reception, they provide all the advantages of Major Armstrong's revolutionary invention and (3) they assure the purchaser of reception of ALL programs on the air now, and in the future.

Progressive dealers who are planning for higher profits this season are invited to write for complete information on the Pilot Protective Franchise and the 1941 line of Pilot f-m, a-m and all-wave receivers. Address:

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