FM

AUGUST 1941

ANOTHER FM STATION INCREASES POWER

THE COMPLETE AND AUTHORITATIVE SOURCE OF INFORMATION ON FREQUENCY MODULATION ★ ★ *Edited by M. B. SLEEPER*

HOW TO SELL AN FM RADIO

"Before you buy your new set you'll want to hear FM."

Tell your customer what you yourself know — that the trend is rocketing to FM — that long before his new radio is discarded Frequency Modulation will be *the* broadcasting.

"Have you ever been troubled by static?"

Remind your customer of AM radio's big disadvantages—static, interference. DO THIS BEFORE YOU TURN ON THE FM SET!

"I want you to hear them side by side!"

Play an AM set to dramatize your story. Hook in an electric razor or vacuum cleaner to demonstrate interference. Then turn AM set off. *Now switch on your Stromberg-Carlson FM radio**, pre-tuned by button to an FM station giving "good signal."

"Note this easy push button tuning for FM as well as standard!"

Inform him this is the radio he's seen advertised in *Life*, *Time*, and *The New Yorker*. Explain how every feature —limiter circuit, push button tuning, tuning eye, automatic drift compensator — is built to give maximum reception of both FM and AM. Stress that this set employs FM as invented by Major Edwin H. Armstrong!

"Only a Stromberg-Carlson gives you all of FM's benefits!"

Your customer will want to know that his FM Stromberg-Carlson has the widest range of natural tone in radio — will bring him music lost by *ordinary* FM sets. Mention that for two years Stromberg-Carlson FM-AM sets have been used in more homes than all other FM makes combined! *"There is nothing finer than a Stromberg-Carlson!"*

STROMBERG-CARLSON

ROCHESTER, NEW YORK

A FINER RADIO FOR STANDARD PROGRAMS

THE ONLY RADIO FOR FM AT ITS BEST...

**Licensed under Armstrong FM Patents*

FM MAGAZINE:

"An Idea Clinic for Radio Engineers and Executives"

4. "Your *FM* Magazine doesn't follow the conventional trade-paper groove at all," a broadcast station engineer remarked to me recently. "It's more of an idea clinic for engineers and executives. You know, I judge from reading the Magazine that you've been active in the radio business for a long time."

Well, it is a long time. It's so long that it goes back to the time when most all the vacuum tubes made in this country were produced at Dr. deForest's laboratory in New York, down by the Harlem River.

Part of my job there was to test the daily output of tubular Audions. About five hundred yards away, in the basement of an apartment house, was an oscillator, run from a storage battery and a lot of flashlight cells soldered together. In the morning, I turned on this oscillator, and put the battery on charge at night.

I tested each tube by connecting it to an ultra-audion receiver, tuned to the oscillator. If I thought that the signal, heard from headphones, sounded all right, it was a good tube. If I didn't, it wasn't! Sometimes, going home at night, I forgot to put the battery on charge, and it ran down before morning. Next day, the production from the largest source of vacuum tubes in all the U. S. A. couldn't be tested!

Yes, that goes back a long way. I'll wager that Dr. deForest knows just how many years ago that was!

M. B. Sleeper, *Editor and Publisher*

Only ZENITH has this

MICROSTATIC FREQUENCY MODULATION *plus* RADIORGAN TONE COLOR CONTROL

FOUR STYLINGS AVAILABLE

Zenith FM Receivers are available in Chairside, Console, Spinet and Radio-phonograph combination stylings —all in fine hand-rubbed finish—all designed for FM-AM reception.

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Phone—write or wire your Zenith distributor today for complete information on all the Zenith Microstatic Frequency Modulation Receivers.

Modern radio listening demands receivers designed for FM-AM reception. New FM stations are going on the air all over the country—many more are planned. Public interest and, more important, public buying are growing with amazing rapidity . . . And Zenith is ready now with a wide selection of FM-AM receivers incorporating fourteen points of definite superiority. You need these Zenith FM-AM models on your sales floor—otherwise you are not selling modern radio.

Model illustrated is 12-H-678 permitting four band reception. Also plays and automatically changes phonograph records. Available in mahogany or walnut finish.

ZENITH

AMERICA'S OLDEST MANUFACTURER OF FINE RADIOS FOR THE HOME

STEP by step, FM broadcasting advances toward its goal of making static-free, high-fidelity reception available to listeners throughout the Nation, and toward self-supporting operation on a commercial basis.

Compared to the establishment of AM broadcasting, FM has not only made more rapid progress, but it has started out as a completed, perfected system.

Whereas the performance standards of AM stations, for many years, were only as high as the individual owners chose to make them, the FCC established standards of FM performance, before the first commercial FM license was issued, far higher than those which AM stations are required to meet now!

It is interesting for those of us who remember WOR's first AM equipment to compare it with the 10-kw. Western Electric FM transmitter now being set up at 444 Madison Avenue for WOR's W71NY station.

The driver unit for the full-power, commercial FM station was already in place when this month's cover photograph was taken. By the time this issue is off the press, the power amplifier may be on the air for its initial trials. This, by the way, is the first 10-kw. installation to be delivered by Western Electric.

W71NY will keep its original 1-kw. transmitter as a spare, for emergency use.

No decision about changing the present vertical radiator will be made until field strength measurements have been taken with the 10-kw. transmitter.

FM

THE RADIO ENGINEERING NEWS JOURNAL OF BROADCASTING, COMMUNICATIONS & TELEVISION

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M. B. SLEEPER, *Editor and Publisher*

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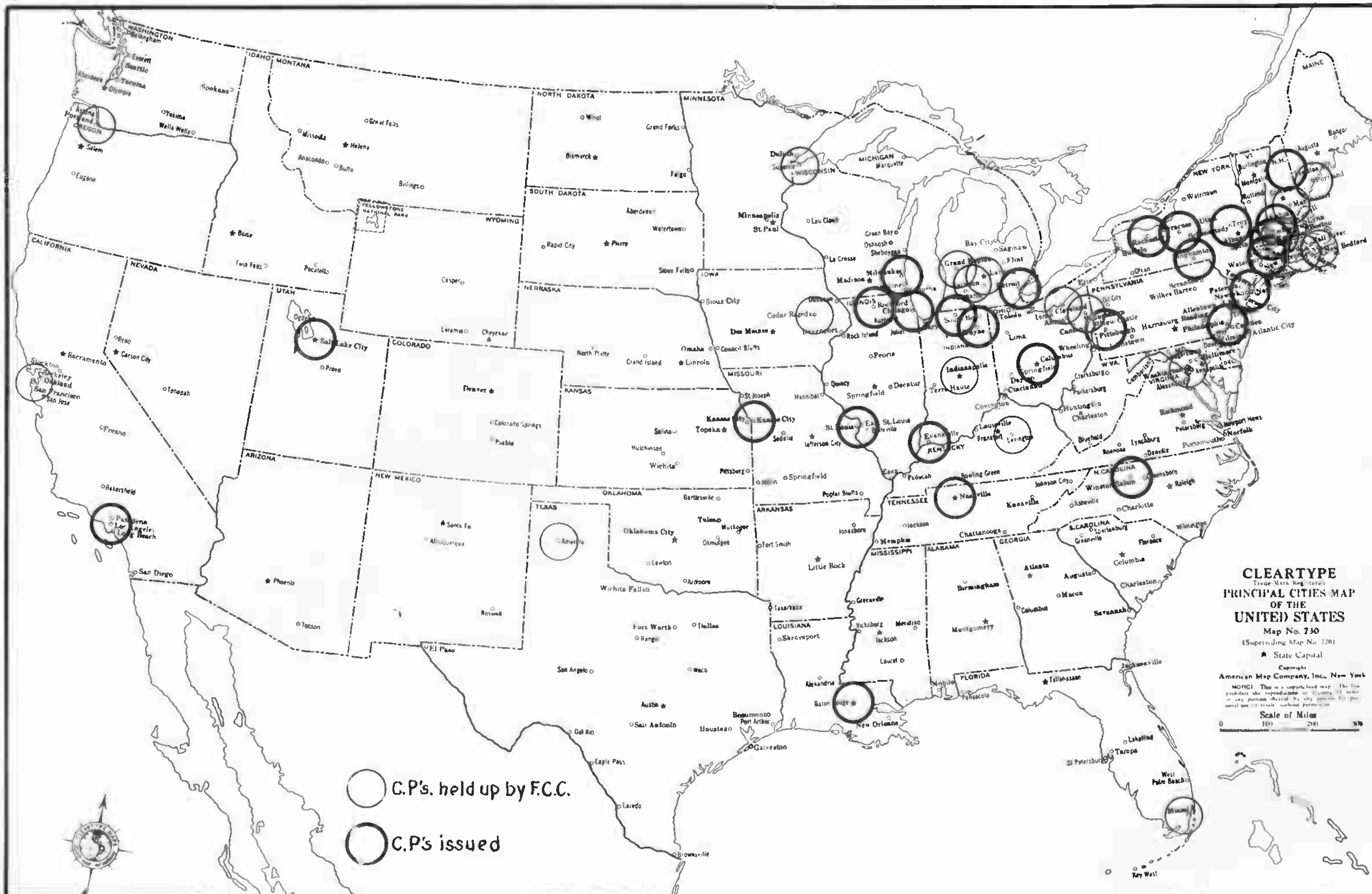
SEE THE ANNOUNCEMENT OF HALF-PRICE MILITARY SUBSCRIPTIONS, PAGE 44

MAP SHOWING THE DISTRIBUTION OF FM TRANSMITTERS IN THE UNITED STATES



FM MOVES FORWARD STEADILY

Chairman Fly Permits His Sense of Self-Importance to Take Precedence over Public Interest, Convenience, and Necessity

BY M. B. SLEEPER

TO the outsider looking in, it certainly appears as if Chairman Fly is having a grand time. This must be so, for nothing but an inflated sense of self-importance and self-interest could so blind him to the harm he is doing to the broadcast industry and, in consequence, to radio listeners.

The pat on the back given to Schenectady's W47A, and his remark that "the possibilities of FM for conveying good music to the public are unsurpassed by any other media" becomes a pedantic gesture when it is merely an aside to his feature act of giving the industry a kick in the pants every time a station official turns his back to give attention to his business of serving the public.

His obligation as a public servant, paid by public funds, has been forgotten in his egotistical desire to play the dual roles of trial lawyer and chief G man. Instead of carrying out the useful intent of the law, Chairman Fly is using the law to prove that he has the right to make the broadcasting industry conform to his private and personal ideas.

That, of course, is the great danger when a lawyer is given the use of the great public funds in the exercising of wide authority.

If Commissioner Fly were concerned with public interest, convenience, and necessity, he would have no time for his Cops and Robbers game which, however entertaining it is to him, is a serious matter to the broadcasters whom he has forced to spend sums now mounting into the millions for self-defense.

Such conduct in public office is so small, and cheap, and petty from a man whose position should command the highest regard and respect, and so wasteful when it should be useful and constructive.

FM Score to Date ★ The fact that FM broadcasting continues to make steady progress in spite of the FCC rather than because of it serves to emphasize its important usefulness in the service of public interest, convenience, and necessity.

This is what has happened since February:

February 1st	*July 17*
32 C.P.'s issued	52 C.P.'s issued
54 Applications pending	57 Applications pending
86 Total	109 Total

In other words, the efficiency and effectiveness of the FCC is indicated by the fact that they have not been able to handle as much as one FM application per week.

Chairman Fly not long ago compared conditions in the broadcasting industry to a dead fish in the moonlight, which shines and stinks. That is picturesque, though decidedly undignified language for a man speaking in his official capacity as Chairman of the Federal Communications Commission.

One wonders how our Chairman would characterize the administration of the FCC if he were an applicant for an FM Construction Permit.

The fact that C.P.'s issued and applications filed total 109 is really surprising. However, if the Commission would offer evidence that it would not cause new applicants prohibitive expense from delays and needless attorneys' costs, this number would double quickly, with a corresponding improvement in radio service to the listening public.

Newspaper Investigation ★ The latest windmill that our Chairman has erected for the purpose of exhibiting his prowess at jousting is the investigation of radio-newspaper affiliation. That no constructive results can come from it is evident from the absurdity of the ten "issues" on which testimony is to be taken for the purpose of guiding the Commission in formulating future policies and regulations.

The ordinary horse sense of the average American business man would supply the answers which Chairman Fly's legal training has not enabled him to perceive.

The last of the list of ten issues is: "What considerations influence newspaper interests to acquire broadcast stations?" This is a reasonable question to ask, but why is it necessary to upset the entire broadcasting industry by giving it the threatening aspect of an investigation?

If Chairman Fly had ever had the experience of meeting mounting costs with a decreasing income, he'd know the answer. Or he could get it quickly from studying yearly curves of advertising appropriations for radio time and newspaper lineage. In this way, he could conserve public funds appropriated for the FCC, and save the broadcasters and applicants

thousands of dollars in time and legal expense.

But, no. Chairman Fly must create a situation where he can double as judge and prosecuting attorney—just to find out that newspapers want to own broadcast stations so that they can recover some of the advertising revenue which, increasingly, is being diverted from newspapers to radio.

Running through the ten issues is the implication that there may be subversive interest among newspapers who plan to extend their influence by radio broadcasting. Issue 3, for example, refers to the restriction or distortion of news, and issue 4 is concerned with freedom of access to the radio forum.

Does this mean that Chairman Fly thinks that such conditions may be so prevalent as to warrant a general investigation of newspaper-radio affiliation? Most anything he could want to know about the history of station executives can be found in the voluminous forms filed by each applicant. However, it might save time to hold a hearing rather than hunt for any specific data in those forms. They have become so complicated that no one can wade through them after the lawyers have made them out.

A shorter course is available to Chairman Fly. The FBI probably has, in neat and tidy files, more information than will ever be brought out by an FCC investigation. But if Chairman Fly did it the easy way, he couldn't have the fun of sending out sleuths to flash badges and demand access to files of broadcast stations, as he has been doing, or of issuing subpoenas, as he has prepared to do.

The list of issues would not be complete without three concerned with monopolization and concentration of control. In individual instances, there might be some reason why the ownership of a radio station by a newspaper would raise the question of the concentration of control over broadcast facilities, but that is a purely local matter. There is no typical situation that warrants a general investigation and the resulting delays.

The second and third issues deal with prejudice to the free and fair presentation of public issues and information, and the restrictions and distortion of news.

If Chairman Fly only has time to acquaint himself with the presentation of news and information which might be distorted or limited or affected adversely—in other words, if he would stop to listen from time to time—he would know that the newscasting in which listeners take the greatest interest is done by sponsored commentators over networks. The individual stations do not control these news programs, so that their ownership is immaterial. Therefore, any investigation of this sort should be directed toward the commentators and their sponsors.

Another large source of broadcast information is the various Government agencies, some of whom are working overtime to create influence favorable to the present administration. A third source is the War, Navy, and Treasury Departments, and the U.S.O. Does the FCC need to take testimony concerning the broadcasting of news from these sources?

Newspapers supply the local news items, regardless of the ownership of the individual stations, so that listeners may know that the cash register of Smith's Bakery was rifled, or that the Jones garage was burned down, or that Mr. Brown fell and broke his leg.

But what, in all this, calls for an investigation of radio station ownership by newspapers or any specific group? Why not department stores? Why not religious groups? Why not individuals who have no means of earning a livelihood?

Interference, Not Investigation ★ Chairman Fly's current investigation boils down to a case of egotism gone rampant in public office, for it will serve no more useful purpose than his other windmill jousting. It is unwarranted interference with broadcasters and with their service to public interest, convenience, and necessity. It has aroused distrust and ill-feeling at a time when the safety of the Nation requires the closest coöperation between broadcasters and all Government departments.

It does not appear that the FCC has the authority to discriminate against any one group of broadcast station operators or applicants for licenses. Why should it, when a station operated by or affiliated with a newspaper does not devote any more time to news programs than a station affiliated with or owned by any other kind of business?

Disunity in FCC ★ The Commissioners themselves are not in agreement on these proceedings. Commissioners Craven, Case and Wakefield, in what amounted to a test vote, were opposed to holding the hearings as scheduled for July 23rd, while only Commissioners Walker and Payne supported Chairman Fly.

Where it will all wind up, and what further disservice will be done by our Chairman to the radio listeners we do not know at this time, but we do know that no good and much harm invariably comes when any man in public office permits his egotism and self-importance to control his official actions.

FM ENGINEERING CONSIDERATIONS

Part II — Design of Transmitting Station Equipment

BY E. S. WINLUND*

IN selecting a frequency-modulated transmitter and associate equipment, there appear to be at least six very important general considerations. These are: reliability, accessibility, operating convenience, fidelity, stability, and adaptability.

TRANSMITTER DESIGN FACTORS

1. Reliability ★ Reliability is most intimately associated with ruggedness and design simplicity. The fewer tubes used in the transmitter, in general, the less opportunity there will be for failure of the tubes and their associated circuits. It can be said roughly that the number of components in any piece of radio equipment, such as resistors, transformers, condensers, is about proportional to the number of tubes in the circuit. From that point of view, a frequency-controlling circuit using four tubes should have about one-fifth the chance of something going wrong than one having twenty tubes. When, in other respects, the two circuits do an equally good job, there can be but one logical selection. The operation of components at conservative ratings is a very important factor in increasing their life and consequently, reliability. The use of specially selected tubes of conservative ratings is an excellent insurance of long life.

2. Accessibility ★ Because the transmitter has not yet been built by any manufacturer which has not at some time suffered some type of failure, and because time off the air at any commercial transmitter ultimately costs a great deal, it is vitally necessary that complete accessibility be provided to all components in a transmitter. This is especially true of the components known to have a definite life, such as tubes or metal-plate rectifier units. Provision is especially needed for rapid change of large power tubes. When enclosed construction is provided to obtain especially good stability, this requirement can be met adequately, as in RCA frequency-modulation transmitters, by providing sliding tracks for heat chambers, and likewise for the panels or groups of components within them. Such construction allows a part to be replaced within the shortest possible time. Also, it permits an extra heat chamber, complete with control circuits and tubes, to be maintained at operat-

*Engineer, Transmitter Sales Department, RCA Mfg. Co., Inc., Camden, N. J.

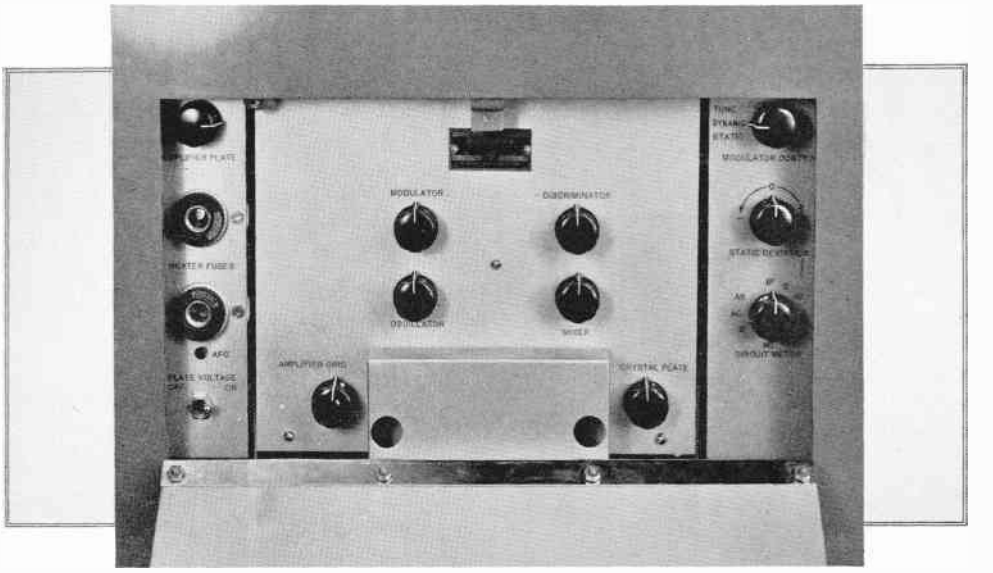


FIG. 10. ACCESSIBILITY IS AN IMPORTANT FACTOR OF TRANSMITTER DESIGN. THIS FM EXCITER UNIT, FOR EXAMPLE, CAN BE REPLACED IN A MATTER OF SECONDS

ing temperature and available for very quick replacement of the normally used heat chamber in case of any small failure within the latter. Repair of the components can then be effected at leisure. An example of this construction is shown in the design of the FM transmitter exciter unit, Fig. 10.

3. Operating Conveniences ★ In order to have full command of the circuits at all times, a complete set of plainly marked and accessible controls is essential. In case of failure of the control circuit, provision should be made for easy manual control of the transmitter frequency. In the case of reactance-modulated transmitters, the use of special high-stability modulated oscillators is a distinct advantage. When heat-chamber construction is used for the modulated oscillator, the stability can be made extremely good, even without the automatic frequency control in operation. This means that it is very easy to hold the transmitter on frequency, and the necessity for constant readjustment, if the AFC circuit is not in operation, is reduced to a minimum. Complete metering of all circuits within the exciter and subsequent amplifier stages is essential for initial tuning, continuous indication of operation, and for routine maintenance checking of tubes. Design of the equipment for immunity to line voltage fluctuations and lightning discharges by means of automatic voltage-regulating and automatic transmission-line protective equipment, minimizes the load upon the engineer in charge and dependence upon his personal equation. Operating convenience can be further enhanced, in the case of very large transmitters, by the installation of a complete control desk such as is shown in Fig. 11, with all essential indicating instruments and switches on the panel; likewise by provision for instantaneous cutback to lower power in case of failure of the high-power amplifier, with the high-power circuits made thoroughly "dead" to facilitate rapid repair.

4. Fidelity ★ Building fidelity into frequency modulation transmitters has turned out to be a relatively simple task in nearly all types currently manufactured. The modulation is effected at low-level, obviating saturation of transformers, since the design of low-level transformers and linear tubes for low-level circuit application is comparatively simple. Reactance modulators provide a direct frequency modulation means which is virtually independent of the audio-frequency requirements. With suitable design, the distortion of reactance modulators at 20 cycles is no higher than at 200. In the RCA frequency-modulation exciter equipment, no audio tubes are used, the zero-level audio signal being applied directly to the grids of the modulators, providing a distortion substantially less than the FCC's initial permissible maximum. It is especially important for the transmitter fidelity to be substantially *better* than the requirements, since some allowance must be made for speech input and associated equipment to meet the overall requirements.

FIG. 11. THIS FM STATION CONTROL DESK PUTS ALL OPERATING INSTRUMENTS AND SWITCHES WITHIN ARM'S LENGTH OF THE ENGINEER IN CHARGE OF THE TRANSMITTER

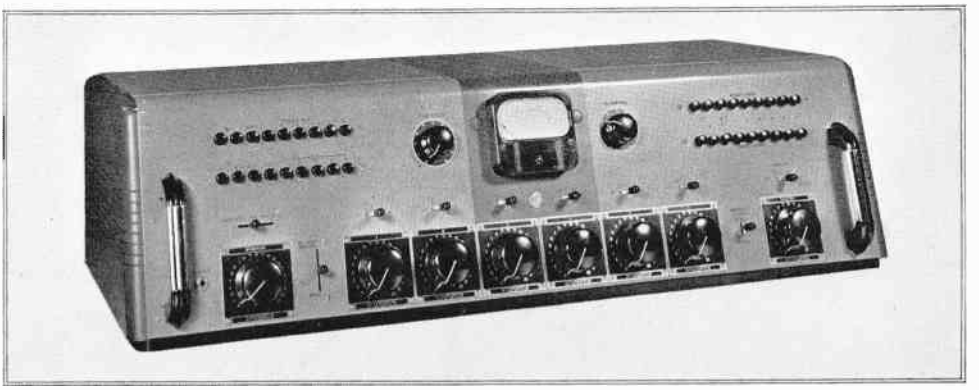


FIG. 12. THE RCA TYPE 76-B2 CONSOLETTE MEETS ALL THE FIDELITY REQUIREMENTS OF FM STUDIOS. THIS IS A VERSATILE DESIGN, CONTROLLING ALL STUDIO FACILITIES

High-frequency distortion is a problem common to all currently manufactured equipment, and can be taken care of by proper design of the radio-frequency-amplifier tank circuits. That is, they must have a sufficiently low kva/kw ratio to be broad enough to pass the maximum swing and sideband frequencies without introducing too much non-linear phase shift. Since the phase shift of the tank circuits is cumulative for a multiple-stage radio-frequency line-up, it is an advantage to have as little frequency multiplication as possible. Hand in hand with this go the relative complexity and increasing phase noise level of circuits employing large multiplication in the radio-frequency line-up. It must be emphasized that linearity curves are but a rough indication of distortion. Static methods of making measurements do not show up phase distortion and other secondary effects. A very good demodulator must be used following the antenna.

5. Stability ★ Stability has probably caused the greatest concern to designers of frequency modulation equipment. Any design ultimately involves a balance between stability, fidelity and simplicity. The advent of inexpensive quartz crystals has apparently obscured the stability possibilities of ordinary tuned circuits, and probably led many early FM designers away from simple, straightforward modulated oscillators. An LC circuit can be made to have superior stability to that of many crystals. By the use of ceramic forms, compensating capacitors, and heat-chamber construction, such as RCA has used for many years on master-oscillators built to rigid Government specifications, good stability in frequency-modulation transmitter oscillator design is no particular problem. By incorporating, in addition to the stable oscillator, the Crosby AFC circuit, in which the already small drift of this oscillator is reduced a great deal further, a very stable exciter equipment is obtained. A stability curve taken on a typical exciter unit, displayed at the I.R.E. convention in New York in January, 1941, shows a total variation of frequency of 750 cycles (±375 compared to the ±2,000 requirement) for a temperature range of 5° C to 45° C, a line voltage range of ±10 per cent, and a humidity range of 30 to 95 per cent. Actually, humidity effects are the most difficult to overcome and are, consequently, the important part of any stability consideration. When the heat-chamber construction is used in conjunction with a simple automatic frequency control, all of these components, including the crystal, can be housed within the same heat-chamber.

This exciter equipment was described in *FM* Magazine[1] and the detailed mathematical analysis of the incorporated Crosby circuit was given before the Institute of Radio Engineers.

Amplitude modulation of an FM transmitter output is always present to some extent in high-power equipment, because of (1) 120-cycle, etc., ripple on the plate supply and (2) AM incident to FM as the frequency is swung over the round-topped impedance characteristic or "selectivity curve" of the plate tank and antenna load. With antennas having high directivity or gain, a flat impedance characteristic becomes increasingly difficult to obtain and, of course, this tendency toward variation of load with the instantaneous transmitter frequency during the swing reflects back through the P.A. tank. Amplitude modulation from either of these causes can be minimized quite effectively by the use of feedback around the P.A. stage. The would-be amplitude-modulated output RF voltage is rectified, amplified, and fed in proper phase to

[1] RCA Enters the FM Field, *FM* Magazine, March, 1941.

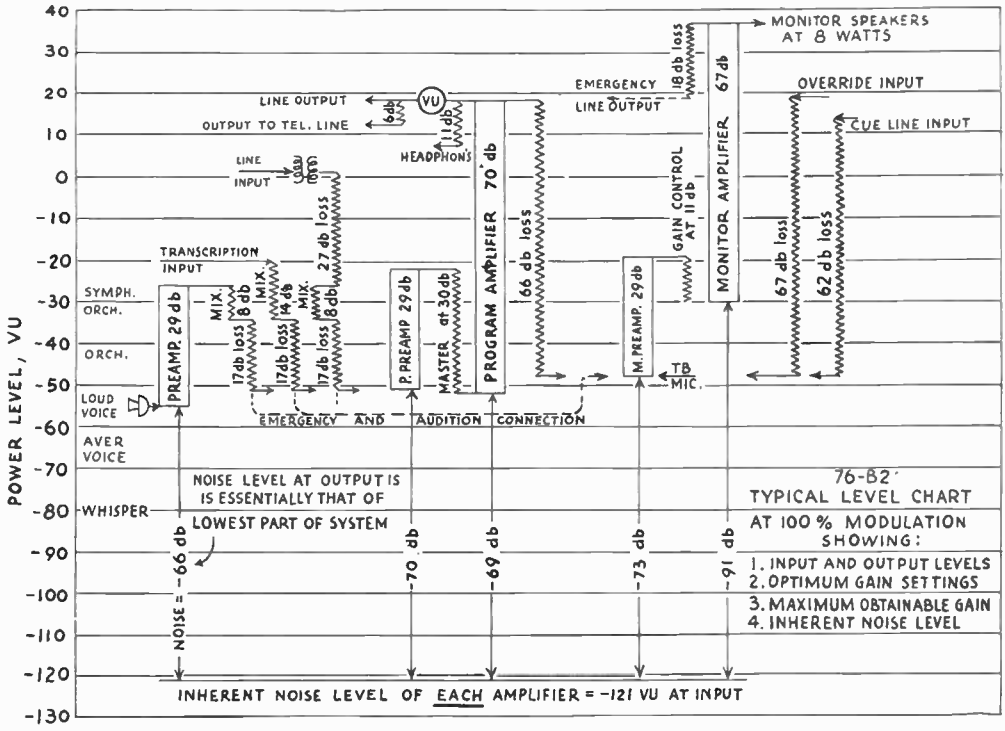


FIG. 8. LEVEL CHART, SHOWING TYPICAL MIXER- AND MASTER-CONTROL SETTINGS

an amplitude modulator in the plate circuit of the P.A. DC supply, so that "impedance modulation" is automatically counterbalanced by counter-modulation of exactly the correct waveshape. The incorporation of such a feedback amplifier also reduces the amount of equipment and cost of high-voltage filtering by brute-force methods.

Within the service area of high-frequency stations, it seems likely that about 1 or 2 per cent amplitude modulation will not affect the FM service. High-fidelity, well-designed receivers should prevent the introduction of AM distortion even when the receiver is slightly detuned. Receivers of lower fidelity, such as table models, may have a distortion appreciably greater than that which could possibly be caused by amplitude modulation.

6. Adaptability ★ When broadcasters, manufacturers and the Commission have in back of them several years' experience with the new technical and economic problems sure to present themselves when a large number of FM stations actually get on the air, it is certain that some changes, at least in particular instances, will be required of the stations. Realizing this, the purchaser of a transmitter today must know that his equipment is built for convenient change of power, and adaptability to new standards. For example, an increase to higher center frequencies or a change of the ±75-kc. modulation swing to some higher figure to incorporate facsimile, binaural systems, etc., may eventually be required.

The purchaser also wants some assurance that if he needs to increase power later, he can easily obtain an amplifier built to fit the equipment first installed. Only by using reputable equipment fabricated by a manufacturer with a considerable background of experience can he minimize lost time, including both occasional failure and changeover time to higher power at the FM frequencies.

SPEECH INPUT EQUIPMENT

1. Studio Console ★ Typical of speech-input equipment recommended for use with FM installations is the RCA type 76-B2 consolette, Fig. 12. This equipment is designed to provide a complete and flexible input system in one conveniently arranged cabinet. All the necessary functions of switching, mixing, and amplifying the outputs of two studios, an announce-booth microphone, two transcription turntables and six remote lines are provided. Four low-level microphones and two high-level inputs can be individually or simultaneously mixed and amplified to about +20 VU on the outgoing pro-

FIG. 13. RCA RATES THE 44-BX AS HAVING SUITABLE RESPONSE CHARACTERISTICS FOR USE IN FM BROADCAST STUDIOS

gram line, and visually monitored with the full-sized VU meter. A separate amplifier and power supply included within the equipment provides monitoring of the line or of individual inputs, and talkback facilities for simultaneous auditioning and broadcasting from any combination of studios, turntables, or remote lines. A selector switch allows use of the VU meter for measuring cathode currents. A source of external relay power is provided as well as emergency use of the monitor amplifier for programs, or the monitor power supply in place of the regular supply for the pre-amplifiers. The harmonic distortion is less than ½ per cent r.m.s. for a +16 VU normal line output, and frequency response is within 2 db. between 30 and 15,000 cycles. Noise level with proper adjustment is at least 63 db. below 100 per cent modulation.

Since the inherent input noise level due to hum and rush noise in any amplifier is in the vicinity of −121 VU, the signal to noise ratio in the program channel cannot be any better than the ratio of high-fidelity microphone output level to −121 VU. This situation is shown by the "level chart" of Fig. 8, together with typical mixer- and master-control settings. A varying sound level into the microphone is the equivalent of sliding all components affected (amplifiers, mixers, output level, etc.) up and down on the VU scale, without changing their positions relative to one another. The "noise-level" line at −121 VU, however, remains fixed so that the distance in db. between this line and the lowest part of the system is the probable signal-to-noise ratio at the output. When the inter-amplifier attenuator is set so that the input-signal level of each of two pre-amplifiers connected in cascade is about the same, it is important to remember that these consequently equal noise intensities may result in anything from near-cancellation of noise to a 6 db. stronger noise at the output, depending upon the phase relationship. In other words, it is not possible to predict hum and noise level accurately when two sources are introduced with approximately the same intensity.

For ordinary orchestras, symphony orchestras, or strong voice pickup, this does not present any particular noise problem, but for very soft passages or a whispering voice, the microphone output level of a high fidelity microphone is generally not very far above −121 VU. At the present state of the art, this means a 60-db. or a better signal-to-noise ratio can be obtained only on certain types of program material, fortunately on some types showing up high fidelity to good advantage. Mixer and master gain settings in any speech input system thus have a very pronounced effect on the noise level of the program. They must be manipulated in such a way that in no part of the system does the signal level dip below that at the input of the microphone amplifier.

2. Microphones ★ Nowadays, microphones with very good frequency response characteristics are readily obtainable. The RCA type 44-BX Velocity Microphone, Fig. 13, has a response with respect to 1,000 cycles of −5 db. at 30 cycles, −2 db. at 10 kc, and −7 db. at 15 kc.

Noise level, however, due to thermal agitation in the ribbon, enters at approximately the same level as in a microphone pre-amplifier. Even if the inherent noise of a microphone is made better than −121 VU by increasing its sensitivity, there is no way to substantially reduce the pre-amplifier noise to take advantage of it. Furthermore, the noise level of the quietest studio delivers a voltage at the micro-

FIG. 14. THE RCA TYPE 64-B LOUDSPEAKER IS RECOMMENDED FOR FULL FM QUALITY

phone terminals considerably higher than −121 VU.

Although it may be shown that the distortion introduced by a good microphone is relatively low, it is an extremely difficult entity to measure. It can be measured at a single tone through a half-wave "organ pipe" so that harmonics of the initial sound are greatly attenuated and the presence of any harmonics in the microphone output indicates distortion. This method is subject to the rather serious drawbacks: (1) a complete frequency response curve involves quite an investment in organ pipes, and (2) a pre-amplifier of finite distortion must be used to bring the microphone output level up to one which can be analyzed. Tests made on the RCA 44-BX Velocity (ribbon) microphone together with amplifiers to zero VU show the harmonic distortion to be less than 0.2 per cent at the frequencies in the audio band.

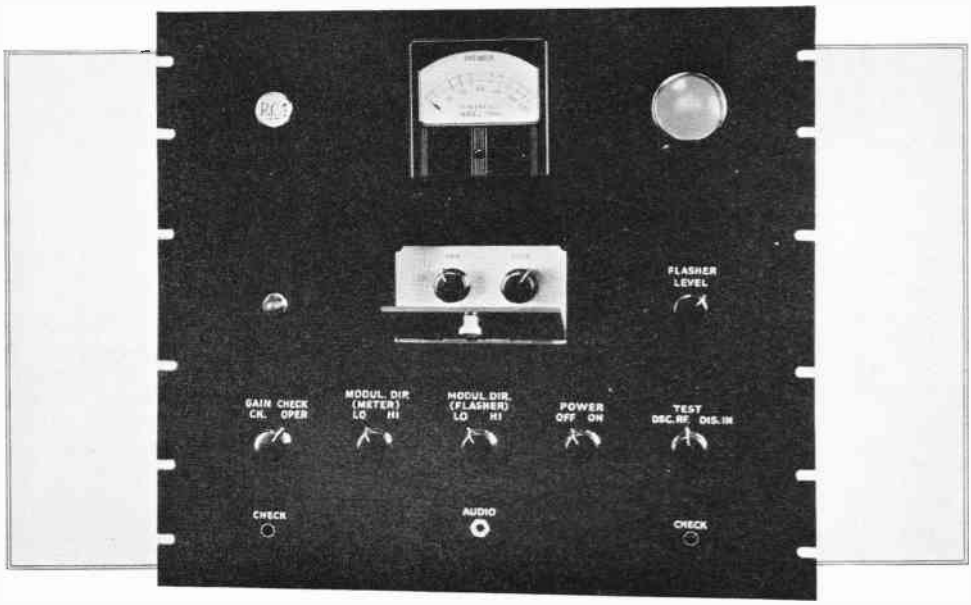


FIG. 15. RACK MOUNTED RCA MODULATION MONITOR, TYPE 322-A, EMPLOYS A COUNTER TYPE DEMODULATOR WHICH HAS NO TUNED CIRCUITS AT DEMODULATION FREQUENCY

3. Speakers ★ It is well known at the present time that loudspeakers associated with the radio receivers in the average home introduce a great deal of distortion, probably of the order of 10 to 20 per cent or more at low frequencies. Some concerted effort has been made to build speakers of low distortion, but this has been hampered no little by the lack of public appreciation of low distortion and the high cost of low-distortion construction. The RCA Type 64-B speaker, Fig. 14, is typical of the best speakers currently available. It has a measured distortion of about 2 per cent at 70 cycles at a normal room volume of 1 watt. Recent interest in frequency modulation will no doubt lead a few manufacturers to market the more expensive low-distortion speakers eventually. The new RCA accordion-edge speaker, in which high sound-output levels are obtained by using several separate small speakers, connected in parallel, represents a convenient way to obtain low distortion at low frequencies.

The frequency response of speakers is also not all that could be desired. Investigators have been quite shocked to discover that most speakers currently available, even some of those "built to the requirements of FM," are down 10 to 20 db. at 30 cycles and 15 kc. Some of them apparently have no output at 15 kc.

4. Telephone Lines vs. Relay Links ★ Many telephone lines are currently in use for frequency modulation, one of the longest publicized to date being 27 miles long and incorporating three repeaters. The telephone companies are evidently prepared to provide lines of any length for the requirements of frequency modulation. The questions entering the minds of broadcasters regarding the use of telephone lines have been their cost, their relatively high noise level under some circumstances, and phase displacement of the audio frequencies on the line.

FIG. 17. TYPE 69-B DISTORTION METER CAN BE USED WITH 322-A MONITOR

Apparently more and more engineers are beginning to believe that phase displacement with respect to frequency in an audio signal has a detrimental effect on fidelity.

Very few manufacturers have had experience with transmitting and receiving equipment above 300 megacycles where the Commission has set aside a relay link (STL) channel. Probably the manufacturers best equipped are those having done work on ultra-high frequency, police, aviation, and government equipment. Television design experience is also invaluable in fabricating equipment of this kind. For long-distance relay application it is probable that radio links will be considerably more desirable, especially for unattended service. Also a radio link should certainly have very little difficulty with respect to the phase displacement effect upon fidelity. Stability can be a problem at these frequencies, but the relative freedom from noise and other interference at 300 megacycles is without question an all-important feature.

MEASURING EQUIPMENT

1. Distortion Measurement ★ Since an ordinary discriminator type of demodulator has an inherent distortion range between ½ and 3 per cent, depending upon the design and operating care, such circuits are not suitable for quantitative distortion measurements. It is not only a question of non-linearity of the discriminator characteristic, but also one of phase shift in the discriminator and the circuits preceding it. Ordinary receivers using a discriminator detector commonly have a great deal of phase shift and are, therefore, suitable only for aural monitoring. Static linearity curves, especially of the modulator itself, are useful only as a rough check upon distortion. They do not indicate phase distortion.

The RCA Type 322-A Modulation Monitor, Fig. 15, is provided with a countertype demodulator which incorporates no tuned circuits at the intermediate (demodulation) frequency. The counter circuit was originally used in

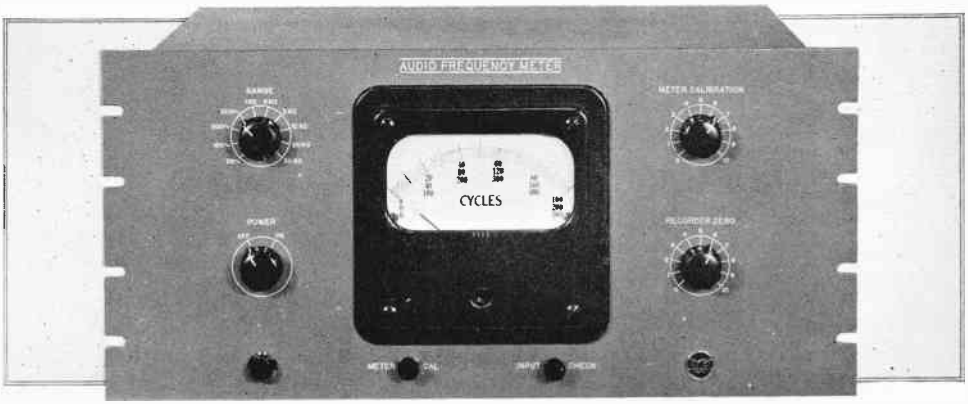


FIG. 16. RCA TYPE 306-A AUDIO FREQUENCY METER FOR USE AT FM STATIONS

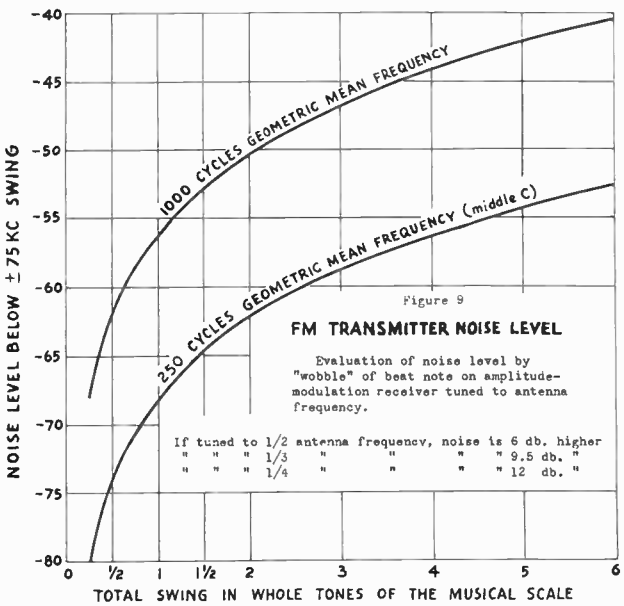
Europe about 10 or 15 years ago and has only begun to become popular in this country since broadcast stations required continuously-reading frequency monitors. The RCA Type 306-A Audio-Frequency Meter, Fig. 16, which uses high-vacuum instead of gaseous counter tubes, is an example of this type of circuit.

Since the 322-A uses no tuned circuits in its intermediate-frequency line-up, its phase shift is virtually eliminated. This means that if two modulating frequencies on the input of the transmitter add up to a certain total deviation at a given time, they add up in exactly the same way at the output of the modulation monitor. Monitors having phase shift cannot help allowing the two peaks to get out of alignment, thus indicating a lower deviation than that instantaneously occurring in the transmitter. Obviously, a flasher circuit cannot have true meaning when phase shift occurs. The type 322-A monitor used in conjunction with either the RCA Type 69-B Distortion Meter or a square-wave generator and oscilloscope provides a complete equipment capable of measuring distortions of the order of 0.2 per cent.

2. Response Measurement ★ Ordinary discriminators can be built to have very good frequency-response characteristics in spite of their relatively poor distortion characteristics. They can be used for response measurement in place of a more elaborate demodulator. The frequency modulation monitor unit supplied with all RCA frequency modulation transmitters incorporates such a discriminator circuit, having a distortion of about ½ per cent. and this monitor in conjunction with the 69-B distortion meter equipment, Fig. 17, provides all that is necessary. The Type 322-A Modulation Monitor mentioned above can, of course, be used in conjunction with the Type 69-B distortion meter for very accurate evaluation of frequency response in place of the discriminator-type frequency modulation monitor.

3. Noise Level Measurement ★ The accurate measurement of noise level also requires an extremely good demodulator in conjunction with a distortion-indicating instrument, such as the 322-A and 69-B combination. The presence of extraneous fields around an ordinary discriminator, as well as hum and hiss level in the discriminator tube itself, inevitably leads to the use of a counter-type demodulator for determinations of the order of 60 to 80 db. below program level. However, a hum level of −60 to −80 db. is quite easily noticed as a "wobble" on the unmodulated carrier, if received on an amplitude-modulation receiver equipped with a beat-frequency oscillator. Thus, if there is apparently no wobble of the beat note, as heard for example on the frequency monitor, the hum level of the system is probably far better than is necessary. Fig. 9 shows that a wobble (total swing) of one musical half-tone, rather accurately discernible by anyone who plays a musical instrument, is a positive indication of −62 db. noise level, when listening to a 1,000-cycle beat note.

FIG. 9. FM TRANSMITTER NOISE LEVEL



4. Frequency Monitors ★ Currently, three types of center-frequency indicating instruments have appeared on the market:

1. Those which indicate continuously, even during modulation, such as the RCA Type 326-A.

2. Those which indicate only at modulation rest periods, requiring merely waiting until the needle has come to rest during this period. This type normally employs hard-vacuum tubes in the counter circuit and readings can usually be obtained during rest periods of ordinary program material by waiting for a sufficiently long silence.

3. Those which indicate only during the modulation rest period, but which require pressing a de-ionization switch after the modulation has come to rest. This type generally uses gaseous counter tubes which ionize with modulation. Not only is it necessary to wait for a modulation rest period, but a button must be pressed and deliberate switching-off of the program is required while frequency checks are being made.

The first type is a true, continuous, frequency check on which readings can be ob-

tained at any time without waiting for a lapse in program material. With such a continuous indication, any deviation of the instrument needle is a warning to the operator. All of the models use reference crystals and differ little fundamentally from the type currently used in broadcast transmitters.

Installation and Operation ★ A quite different conception of good grounding is necessary, compared to that for standard broadcast frequencies.

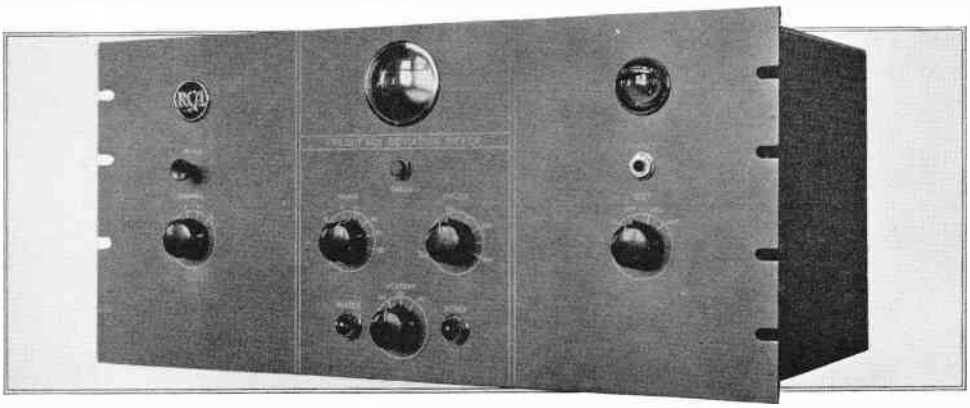


FIG. 18. THIS FREQUENCY DEVIATION METER INDICATES CONTINUOUSLY

Because of the inductance of ordinary wires, it is usually best to install wide copper straps the first time instead of being forced into it at a later date. Sixteen-gauge, 5-in. copper has been used with a considerable amount of success. With well-shielded transmitter design there has been surprisingly little trouble experienced from the proximity of associated speech-input equipment involving low-level microphones and input circuits as close as 10 feet from the power amplifier of a 1-kw. FM station. This may be partially due to the lack of amplitude modulation on the carrier, causing merely biasing of the pre-amplifier tubes. It also seems probable that grounding to actual earth is not as necessary as at standard broadcast frequencies, since in ultra-high frequency antenna design the antenna very rarely operates against ground; that is, little trouble should be experienced when all components of the frequency modulation system are grounded together, even though the system is not actually grounded to earth. Special care should be taken in the installation of low-level shielded lines and the avoidance of ground currents within the shielding. However, it is usually advisable to locate low-level equipment, especially pre-amplifiers and interconnecting shielded lines, as far away from the transmitter as possible and also away from low-frequency power lines.

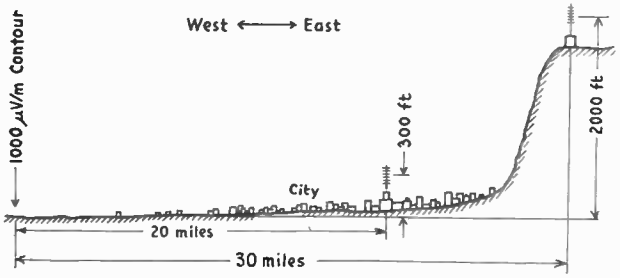
Unification ★ In purchasing the components of a frequency-modulation broadcast station, it is usually imperative to know that they will all "fit together" from the point of view of distortion, response and noise level. In general, this can be insured only by the use of components which have been previously used together with known overall fidelity, or by using the components all from the same manufacturer. Using the equipment of one manufacturer also insures uniform and attractive styling.

Receivers ★ At the present time several manufacturers have placed on the market and sold several types of frequency-modulation receivers, some of these having quite good fidelity. The comments made above on speakers, however, apply to the majority of frequency-modulation receivers on the market today. In looking at any overall frequency modulation system from microphone through the transmitter, antennas, receiver and speaker, the obvious weak link in the chain is the *speaker*. At the present time it appears that few, if any, of these receivers are suitable for quantitatively measuring distortion or other fidelity characteristics, but many of them are entirely suitable for aural monitoring purposes.

ADDENDUM

The following data is presented in further explanation of Fig. 4, of Part I, which is reprinted herewith:

Here is a hypothetical city whose center is located 20 miles from the required western one millivolt contour. Ten miles to the east of the city is a 2,000-ft. hill, rising rather sharply.



		CITY LOCATION			HILLTOP LOCATION		
Whirling Joe	*Gain*	*Power*	*Invest.*	*Yearly*	*Power*	*Invest.*	*Yearly*
Circular	1	10 kw.	$30,500	$35,700	1.5 kw.	$24,675	$18,380
Directional	1.85	5.4	30,500	29,900	.81	18,090	15,360
Turnstile							
Circular	4.15	2.4	22,100	20,750	.362	22,500	16,020
Directional	8	1.25	23,100	19,250	.190	17,900	14,750

Reference to the FCC chart 41722 in the Standards of Good Engineering Practice for High Frequency Stations shows that approximately 10 kw. are required in the city with the antenna at 300 ft. elevation (on a tall building) where only about 1.5 kw. will do the job on the hilltop.

Using antennas of the various gains shown in the table, the actual power into the antenna and the yearly operating costs of such stations are listed. The six-bay directional turnstile (unsymmetrical pattern, having negligible radiation east) is not yet commercially available but power gains of 8 should be possible.

The estimate of initial and operating costs for the various antenna combinations on page 27, Part 1, is based primarily upon Mr. Guy's curves, with specific deviations to fit the particular case involved. It is included to show the source of the yearly operating costs.

The figures which apply to the .81 kw. transmitter are given in the following table, showing power in kilowatts, capital investment, and yearly operating cost:

Power in Kilowatts:	
Antenna	.81
Transmitter	.90
Nominal Trans.	1.0
Hill Location	
Capital Investment:	
Transmitter	$9,200
Land, Building	5,000
Antenna	90
Installation	2,200
Miscellaneous	1,600
	$18,090
Yearly Operating Cost:	
Salaries	$12,000
Power	600
Tubes	420
Miscellaneous	480
Depreciation	1,860
	$15,360

Similar data on transmitters of other power ratings was given on page 27, Part 1, in the July issue of *FM* Magazine.

REMEMBER YOUR RADIO FRIENDS WHO ARE IN THE SERVICE

When a man is in the Service, radio publications are not only difficult to get. They are expensive if they have to be bought from Service pay! If you have a friend in the Army, Navy, or Marine Corps, you can have *FM* Magazine sent to him each month at the half-price Service subscription rate.

SEE THE ANNOUNCEMENT OF THIS SPECIAL RATE ON PAGE 44

WHAT THE FM BROADCASTERS HAVE TO SAY:

A Statement Concerning the Nation's Loftiest FM Transmitter, W41MM, Winston-Salem, by Gordon Grey, President

THE breaking of a trail, several weeks ago, along the rocky ridge, more than a mile high, between Stepps Gap and Clingmans Peak in North Carolina, marked the beginning of the construction of W41MM.

Located in the heart of North Carolina's mountains, the top of the station's antenna will reach to a height of 6,885 feet above sea level. This will be more than 200 feet higher than the summit of adjacent Mt. Mitchell, which is the highest point east of the Rocky Mountains.

With 50-kw. of power, maximum antenna gain and this great altitude, W41MM, on the basis of coverage area, will be possibly the largest frequency modulated broadcasting station in the world. The calculated area within the 50-microvolt contour is approximately 70,000 square miles. Since signals of considerably less intensity than 50 microvolts are useful in rural areas, in all probability, the total service area will exceed that figure.

No available site in the east is better suited for the location of an FM broadcasting station. To the east, and south, within a very short distance, the elevation falls off thousands of feet to a plateau sloping gradually to sea level. To the west are the Smoky Mountains with a convenient pass in direct line with Knoxville and Nashville, Tennessee. Northwards are the mountain regions of Virginia, West Virginia and Kentucky. The elevation of these mountains decreases rapidly as the distance from the transmitter increases, in such a manner that very few undesirable shadows are anticipated.

The transmitter will render service to parts of seven states. Within the 50-microvolt contour live over 5,000,000 people. There are more than 400,000 farms, hundreds of villages, towns, and cities, innumerable mills and manufacturing plants, more than thirty standard AM broadcasting stations, plenty of static, and comparatively poor broadcast service.

Among the larger cities in the 1-millivolt area are Knoxville and Bristol, Tenn., Asheville, Charlotte, and Gastonia, N. C., and Spartansburg and Greenville, S. C. In the secondary area are located Winston-Salem, Greensboro, High Point, and Salisbury, N. C., Columbia, S. C., Augusta and Athens, Ga., and Bluefield, West Va. If directive receiving antennas are used, it is expected that a good signal can be received in Durham and Raleigh, N. C., Nashville, Tenn., as well as in Chattanooga and Atlanta, Ga., and Roanoke, Va.

The erection of Station W41MM was undertaken because of my active interest in the many organizations and projects engaged in the promotion of economic and cultural developments in the South. I believe that an FM broadcasting station operated from Winston-Salem will be of great value in furthering these public services.

Because of its remote location in the Southern Appalachians, W41MM necessarily will be

(CONTINUED ON PAGE 36)

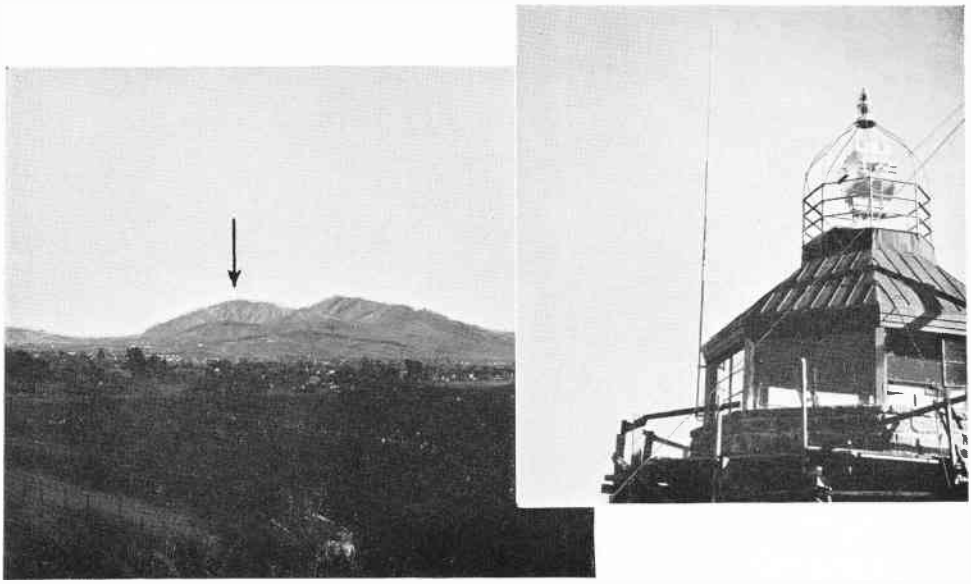


FIG. 1, LEFT. ARROW POINTS TO LOCATION OF FM RELAY STATION, 4,100 FT. HIGH, ON MT. DIABLO, CALIF. FIG. 2, RIGHT. ANTENNA ON MT. DIABLO FOR PICKING UP CAR SIGNALS

How California Police Use

MOUNTAIN-TOP FM RELAY

Contra Costa Sheriff's Office Obtains Surprising Results with FM Relay to Repeat Back Car Signals

BY DONALD G. BEACHLER *

ONE of the most unusual radio installations in the country is operated by the Sheriff's Office of Contra Costa County, not far from San Francisco, California. John A. Miller is the sheriff, and George K. Burton is the radio technician in charge.

The following description of the 2-way radio system used there may answer some of the questions which have been raised as to the practicability of radio talk-back from patrol cars operating in hilly or mountainous country, and particularly concerning FM transmission under such conditions.

The original equipment at the Contra Costa Sheriff's office was a conventional ½-kw. AM transmitter, operating on 1,658 kc. This transmitter was found adequate for getting out to the patrol cars within their area of operations, but the 15-watt AM talk-back transmitter in the cars, on 35.22 mc., did not deliver adequately dependable communication to headquarters.

Accordingly, a receiver was installed in the building on the summit of Mt. Diablo, 4,100 feet above sea level, and tests were made of reception from the cars. From this advantageous location, perfect reception was obtained from a surrounding area of 5,000 square miles.

However, there were no telephone lines to carry the voice signals from the top of Mt. Diablo down to the Sheriff's office.

Here, then, was the situation: The cars could hear the main station, but the talk-back was not satisfactory. The Mt. Diablo receiver could get the cars perfectly, but there was no way to carry the car signals picked up by Mt. Diablo to the main station.

Working with George Burton on this prob-

* Engineer, F. M. Link, 125 West 17th Street, New York City.

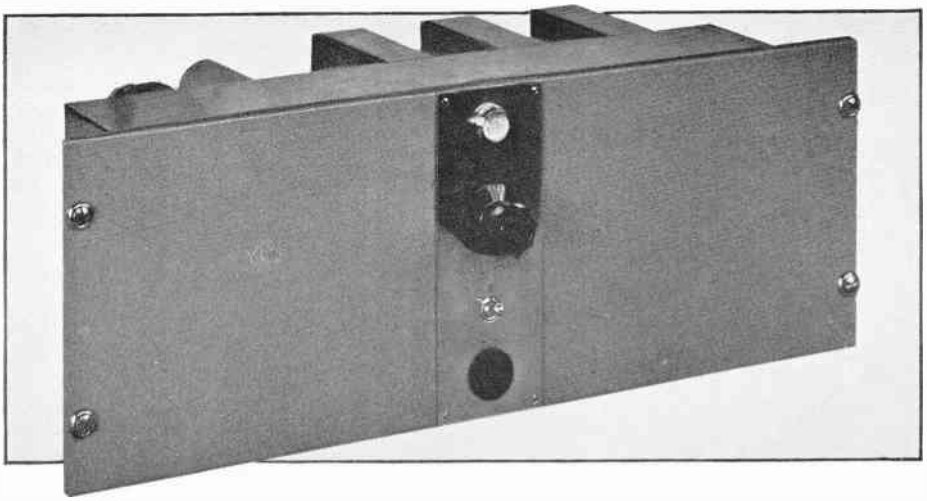


FIG. 3. FIXED STATION RECEIVER IS DESIGNED FOR RACK MOUNTING. THIS IS THE TYPE USED AT THE CONTRA COSTA SHERIFF'S OFFICE

lem. F. M. Link designed and built a special AM receiver to pick up the car signals, an FM relay transmitter to repeat them back to the headquarters station, and an FM set for receiving the relayed signals at the main station.

In this system, the FM relay transmitter actually takes the place of telephone wires, and eliminates the hazard of line failures or deliberate sabotage by those who might have reasons for wanting to render the system inoperative.

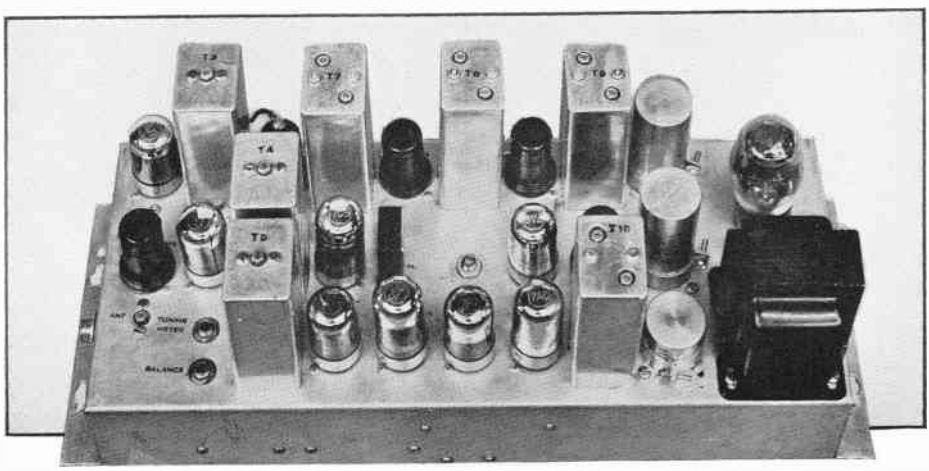
Under this arrangement, signals go from the main station to the cars by AM on 1,658 kc. The cars talk to the relay receiver on Mt. Diablo by AM on 35.22 mc. Then the relay transmitter takes the car signals back to the main station by FM on 116.16 mc.

The FM relay transmitter, of 15 watts output, operates from the 220-volt line which runs up the mountain. It is crystal-controlled, and employs a frequency deviation of ±37.5 kc.

Fig. 5 shows the transmitter, arranged for rack mounting. The filaments of the tubes are kept hot at all times, but the power is applied only when a relay is actuated by the reception of carrier signals from the cars.

Figs. 3 and 4 show the 116.15 mc. FM receiver which is installed at the main station. This, also, is crystal-controlled, to assure accurate tuning at all times. It has a superheterodyne circuit, with an IF frequency of 5. mc. The squelch is adjusted to work on 1. microvolt.

FIG. 4. CHASSIS OF THE RECEIVER SHOWN ABOVE. SET USES 15 TUBES, INCLUDING RECTIFIER FOR AC OPERATION. ALSO AVAILABLE FOR USE WITH DC SUPPLY



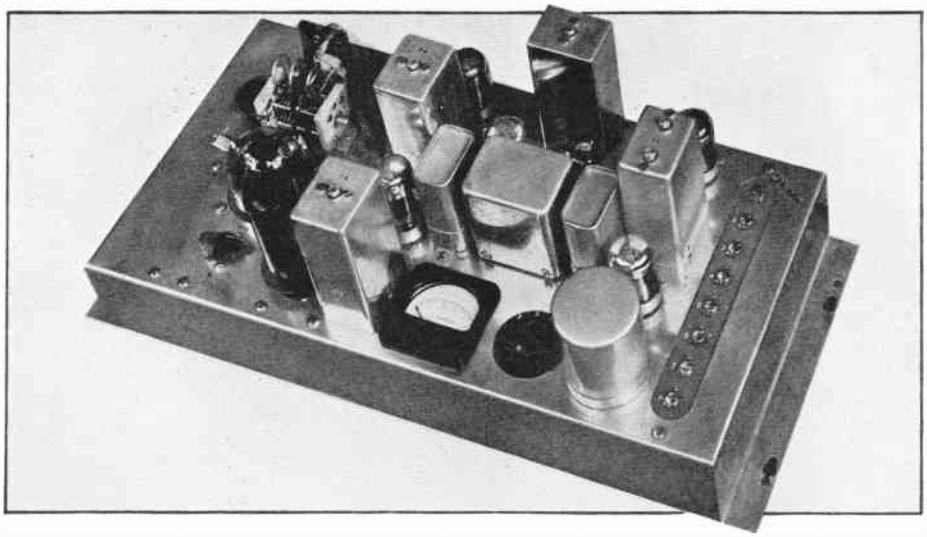


FIG. 5. THIS IS THE 116.15-MC. TRANSMITTER, OPERATING ON AC, USED TO REPEAT SIGNALS FROM POLICE CARS TO THE HEADQUARTERS STATION

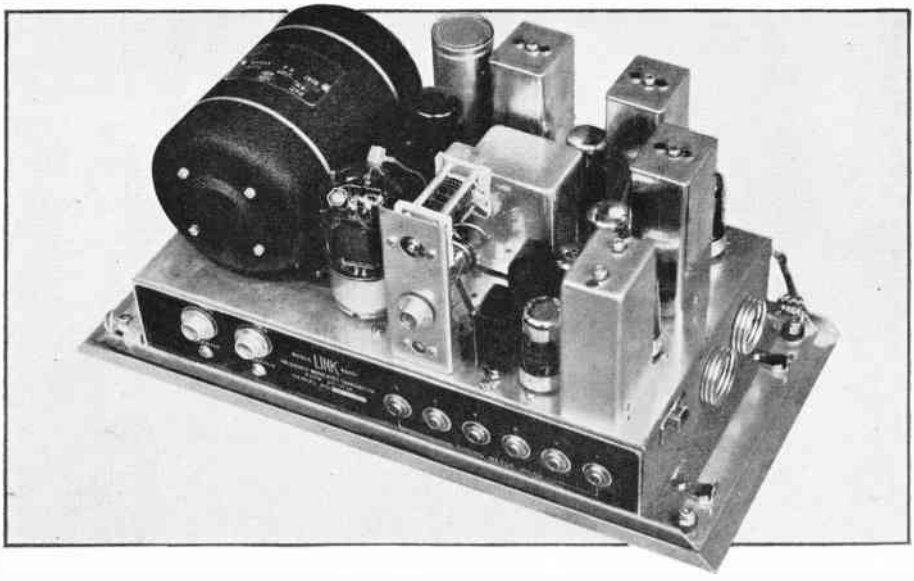
The performance of the FM relay transmitter offers several advantages over the use of AM. Most important, perhaps, is the fact that, although there is considerable variation in the strength of signals picked up from the cars, as well as the variations in signal strength commonly observed on ultra-frequency AM reception, this is very effectively smoothed out by the limiter action at the FM receiver.

Of course, a certain amount of noise is picked up along with the AM car signals. If this were augmented by AM re-transmission, the noise would be very bad, indeed, at the headquarters receiver. However, using FM for the relay transmitter, no noise is heard at headquarters other than from the AM reception fed into the FM relay.

Because of the height of the relay receiver on Mt. Diablo, remarkable distances are covered by this system. Two-way communication is possible at distances of over 100 miles,

(CONTINUED ON PAGE 33)

FIG. 6. THE SAME TRANSMITTER CAN BE USED FOR MOBILE SERVICE. BATTERY-OPERATED MOTOR-GENERATOR IS MOUNTED AT THE LEFT, AS SHOWN BELOW



22 U. S. TELEVISION STATIONS

Nine Cities Will Have Television Programs Soon

TELEVISION certainly has not suffered from the setback it received after its false start in 1939. Admittedly unprepared for public service at that time, engineers have made great progress in perfecting details of transmitters and receivers and the associated equipment required for staging shows of real entertainment value.

Now that definite television standards have been established and approved by the FCC, there are no less than 22 stations making their final preparations for going on the air with commercial programs. Each station so licensed must maintain a minimum schedule of 15 hours each week.

This will give the television audience in Chicago a total of 45 hours per week from three stations, 60 hours from four stations in Los Angeles, 75 hours from five New York stations, 45 hours from three stations in Philadelphia, and 30 hours from two stations in San Francisco and Washington, D. C.

FCC regulations specify that there shall be at least 2 hours of transmission between 2 P.M. and 11 P.M., including at least 1 hour of transmission between 7:30 P.M. and 10:30 P.M., on five week days.

Most of the television sets now being planned for production include standard and FM broadcast reception circuits. This will, therefore, justify the purchase of the new sets even in cities where only 15 hours of television programs will be available from one station. Undoubtedly, as the stations get into commercial operation, there will be enough sponsored time to keep the television transmitters on the air for much more than the minimum number of hours.

Following is a list of television stations which are now preparing to qualify for commercial licenses, according to information released by the Federal Communications Commission:

ALBANY—W2XB, General Electric Company.
CHICAGO—W9XBK, Balaban & Katz Corporation; W9XZV, Zenith Radio Corporation; W9XCB, Columbia Broadcasting System.
CINCINNATI—W8XCT, Crosley Corporation.
LOS ANGELES—W6XEA, Earl C. Anthony; W6XAO, Don Lee Broadcasting System; W6XHH, Hughes Productions, Inc.; W6XYZ, Television Productions, Inc.
MILWAUKEE—W9XMJ, The Milwaukee Journal.
NEW YORK—W2XWV, DuMont Laboratories; W2XBB, Bamberger Broadcasting Service; WNBT, National Broadcasting Company; W2XMT, Metropolitan Television, Inc.; W2XAB, Columbia Broadcasting System.
PHILADELPHIA—W3XAU, WCAU Broadcasting Company; W3XE, Philco Radio Corporation; W3XPP, National Broadcasting Company.
SAN FRANCISCO—W6XDL, Don Lee Broadcasting System; W6XHT, Hughes Productions, Inc.
WASHINGTON—W3XMB, National Broadcasting Company; W3XWT, DuMont Laboratories.

This list makes an imposing record of progress in the television field. So far, only NBC's New York station, WNBT, is licensed for full commercial operation. However, several of the others are practically ready to assume full commercial status.

It is expected that the coaxial cable already laid from New York City to Philadelphia will be used for exchanging programs, particularly of important public events. A similar cable is being laid from Washington, D. C., to Baltimore, where television transmission facilities will be provided later.

The FCC has extended its policy of limiting the number of FM stations which can be under one control to the television field. Under the new regulations, this is limited to three television stations. The stated policy is to guard against monopoly.

The present television standards will be maintained for six months following July 1, 1941. At the end of that period, the Commission will consider further changes, particularly with reference to new developments and to findings during this initial period.

In all probability, there will be no changes in the standards which will call for any extensive alterations in the receiving sets then in use.

On the other hand, the conviction has been expressed in some quarters that FM transmission should be employed for the video signals, as well as for the audio signals.

At this time of writing, the one bottleneck of television progress seems to be in the production of receivers. Just how serious that may be no one knows now. It is quite possible that priority restrictions may be eased, if not lifted, by the time public demand for television receivers begins to tax the ability of manufacturers to deliver them, for a considerable part of the 22 stations listed here will not be on the air until some time next year.

WHAT IS AN "FM" CIRCUIT?

Characteristics of FM Receivers Have Been Established by Common Use, and Trade Must Guard Against Misrepresentation in Advertising

JUST as various types of circuits can be used to receive AM signals, and with various resulting performance, so different circuits can be used to pick up signals from FM transmitters. For example, we used to use Crystal Detector sets for regular broadcast reception. These were replaced by the superior Regenerative sets. The Neutrodyne, with its three dials, came next.

Each type of receiver had certain identifying characteristics of performance which made it superior to its predecessor. Last in the series was the Superheterodyne,[1] which is employed almost universally today because it, in turn, possesses characteristics which are not equalled by the others.

Now, with Major Armstrong's invention of wide-swing FM transmission, he has invented and patented a special type of receiver using what he has called the "FM" circuit, possessing certain identifying characteristics of performance. Manufacturers licensed under his patents are now producing sets which provide the type of receiving characteristics identified by the "FM" circuit name.

However, it is not necessary to use Major Armstrong's FM type of circuit in order to receive signals from a station using his Frequency Modulation method of transmission. As explained by Glenn H. Browning,[2] it is possible to hear such signals on an AM short-wave receiver if the tuning is adjusted to just the right off-resonance point, provided the signals are quite strong, although reception so obtained would hardly be acceptable to the listening public.

Simplified circuits, not employing the patented features of Major Armstrong's FM circuit, are entirely practical, but, as Browning pointed out: ". . . such a receiver would be very insensitive. It would be difficult to tune . . . and noise would not be eliminated."

What Is an FM Set? ★ What, then, are the features of a receiver that identify it as having an Armstrong FM circuit? For the benefit of the trade and the listening public, Major Armstrong has set forth, in very simple terms, the performance characteristics of genuine FM receivers, produced by manufacturers licensed under his patents:

"The sale of sets which do not give full FM performance that measures up to what has been repeatedly demonstrated, and what the public has been led to understand FM will do, will not only have a bad effect on the industry generally but it will reflect on those pioneer manufacturers who have honestly tried to give the public its money's worth and to open up a new market for the dealers.

"The wide-swing Frequency Modulation system which I have invented and developed over a period of many years requires a transmitter that will do certain things, and a receiver, co-ordinated with the transmitter, that will also do certain things. A receiver which will do only some of these things, or which will do these things badly, is a fraud on the public if it is represented as giving real FM performance.

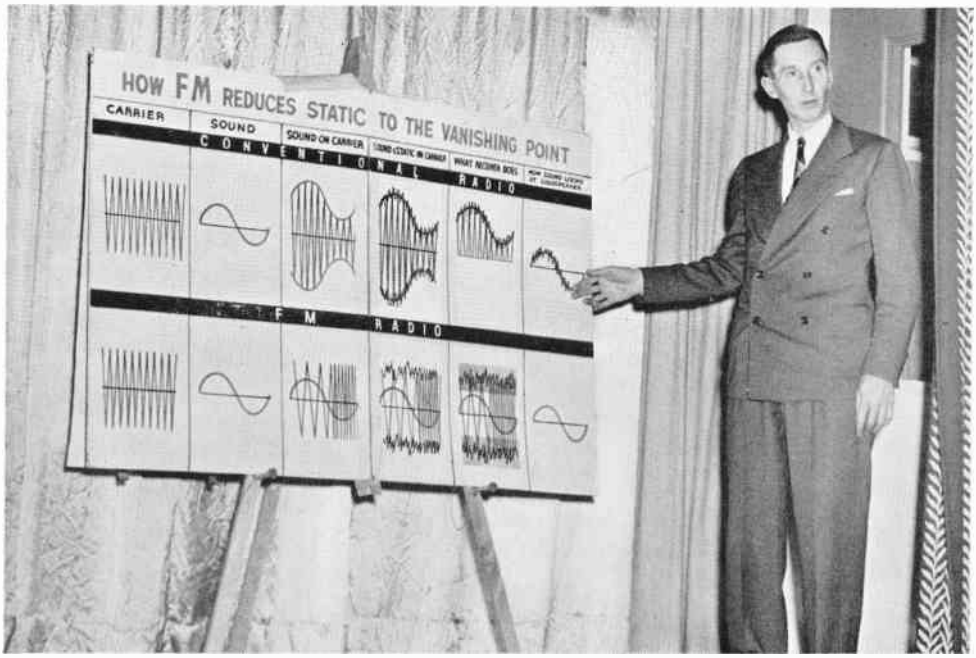
"Ordinary amplitude modulation is disturbed by both natural and man-made static —that is by lightning and by electric razors, violet-ray machines, automobile ignition, etc., because these disturbances are principally "amplitude modulated"[3] and have the same character as the wave radiated from the transmitter. Approximately 30 years of effort to overcome them have resulted in little improvement other than the use of high power at the transmitter.

"In Frequency Modulation there is a fundamentally new method of combating all sorts of static. It is to transmit a wave which is different in character from the static, and to use a receiver which responds only to this new type of wave and is deaf to "amplitude modulations" of the noise currents, and substantially deaf also to the small frequency swings occurring in the noise. The transmitted wave is made different in character from the noise by using a wide frequency-swing. The receiver is made specially responsive to the wide-swing signal, and substantially not responsive to the lesser swings of the noise and to amplitude variations, by proper coördination of design with the transmitter, and by use of devices which wipe out the effects of amplitude mod-

[1] The public at large probably does not realize it, but the Superheterodyne reciver was also Major Armstrong's invention, perfected when he was an officer in the A.E.F. during the last war. He built the first Superheterodyne sets for the U. S. Signal Corps in France, to provide super-sensitive reception of enemy radio communications.

[2] See FM Handbook, Chapter 3, in *FM* Magazine, January, 1941, page 42.

[3] These disturbances are also, but to a minor degree, frequency modulated.



MANUFACTURERS OF ARMSTRONG FM EQUIPMENT HAVE DONE MUCH TO MAKE KNOWN THE PERFORMANCE CHARACTERISTICS OF FM RECEIVERS. HERE IS HERB BELL, OF GENERAL ELECTRIC, EXPLAINING FM RECEPTION TO A GROUP OF DEALERS

ulation. To do this the design of the receiver must be coördinated with the transmitted wave, and the receiver must reject the amplitude disturbances created by static.

"The best method of rejecting the amplitude modulated disturbances which has been evolved to date is to use tubes known as "limiters" which prevent the amplitude disturbances from having any appreciable effect on the detector, and to use plenty of amplification of the high frequency currents before the limiter to insure its proper operation under all conditions. So important is the function of the limiter that the best sets today make use of double limiting so as to more effectively prevent the passage of amplitude modulated currents into the detector tubes. There is no satisfactory substitute for the process of limiting in FM broadcast receivers in use at the present time.

"There are two other results which are accomplished by taking out the effects of amplitude variations. One is the reduction of interference from other Frequency Modulation stations operating on the same channel. A correctly designed FM receiver will reject the weaker of two FM stations and reduce to the vanishing point that type of interstation interference which is so troublesome in certain sections of the broadcast band at night. Receivers which do not have the ability to reject the weaker of two signals will get into trouble later on as more FM stations go on the air. A second result is the elimination of distortion from the transmitted wave which may occur in the intervening space between the transmitter and receiver, or which may be produced by the amplifying circuits of the receiver itself.

"It is well known that real FM reception gives a quality of reproduction never before obtained in radio. This is principally because of three things. All FM transmitters are designed to send the full musical range, from 30 to 15,000 cycles. They transmit this range with much less distortion than any amplitude-modulation transmitter gives. The receiver, if properly designed, can eliminate the distortion introduced by the transmission path, by the effects of noise, and by the radio-frequency amplifying circuits in the receiver, and can therefore reproduce a broadcast signal exactly as supplied to the transmitter.

"It is essential that amplitude changes due to these various causes be effectively wiped out. Even where the first two effects are not present, distortion in the radio frequency circuits themselves will almost inevitably show up as the passage of time and aging change the tuning line-up of the amplifying circuits.

(CONTINUED ON PAGE 45)

FM SPOT NEWS

Notes and comments, personal and otherwise, that have to do with FM activities

J. J. Nance: Is the newly appointed Vice President and Director of Sales of Zenith Radio Corporation.

Portland, Me.: FM application has been filed by Portland Broadcasting System for use of 47.1 mc., to cover an area of 5,050 square miles. This company operates WGAN.

Transmitter Tubes: GE transmitter tubes are now being handled by the radio receiver sales organization.

Ben Miller: Former purchasing agent of Radio Wire Television, New York City, is now with Meissner Manufacturing Company. His place will be filled by Guy Maken.

Radio Census: 1940 figures on the number of homes equipped with radio receivers, by states and counties of the U.S.A., have been delayed again. Latest report is that this highly important data will not be available until early in 1942. So many of the junk sets sold in 1939 will have been discarded by next year that there may be considerable error in the census figures by the time they appear!

CBS: Has installed an FM link to carry studio programs to its short-wave transmitters, an air-line distance of 40 miles. New system to feed Latin-American network will start to function September 1st.

Zenith: Has extended their line of A-FM models greatly. Considerable emphasis has been put on higher price brackets. Most expensive is model 22-H-698, a 22-tube phono combination, listing at $600 in period cabinet of mahogany or walnut. FM, standard broadcast, and short-wave tuning are provided.

San Diego: School system has been granted a C.P. for a non-commercial, educational FM transmitter of 1 kw., on 42.3 mc. Station will serve 55 educational units, carrying wide range of lectures, plays, music, and special events geared to elementary and high school courses. Installation, costing slightly more than $6,000, will be at 348 West Market Street.

REL: Has appointed Norman B. Neely Enterprises as Pacific Coast representative for the sale of FM equipment. Offices are at 5334 Hollywood Boulevard, Hollywood, and at 420 Market Street, San Francisco.

Washington, D. C.: McNary and Chambers have withdrawn their application for an FM station.

FMBI: Three new members of FM Broadcasters, Inc., are: Don Lee Broadcasting System, building a 50 kw. station, W47LA, at Los Angeles; Capitol Broadcasting Company, with W47A now on the air at Schenectady; St. Louis Globe-Democrat Company, which has filed an application for an FM construction permit.

Chicago: FCC has granted WGN authority to proceed with their FM transmitter. Carl J. Meyer, chief engineer, expects to have 1 kw. on the air right away, with 50 kw. in operation by December. Antenna will be on the Tribune Building, with transmitter on the 29th floor.

GE: So successful has been the GE Translator in its original table cabinet styling that the same chassis is now offered in high-hat row-of-books disguise. Thus it is made acceptable to owners of expensive GE Musaphonic AM receivers and phonograph combinations. Price of camouflaged Translator is $69.95 list.

Free Shift: RCA and DuMont are checking lists of television set owners, preparatory to changing the video tuning to new frequencies, and replacing the AM circuits for sound reception to new FM circuits, in conformity with the FCC television standards.

Albany: WOKO has applied for a C.P. for a 50-watt FM relay transmitter to carry programs from their studios to their remote FM broadcast transmitter.

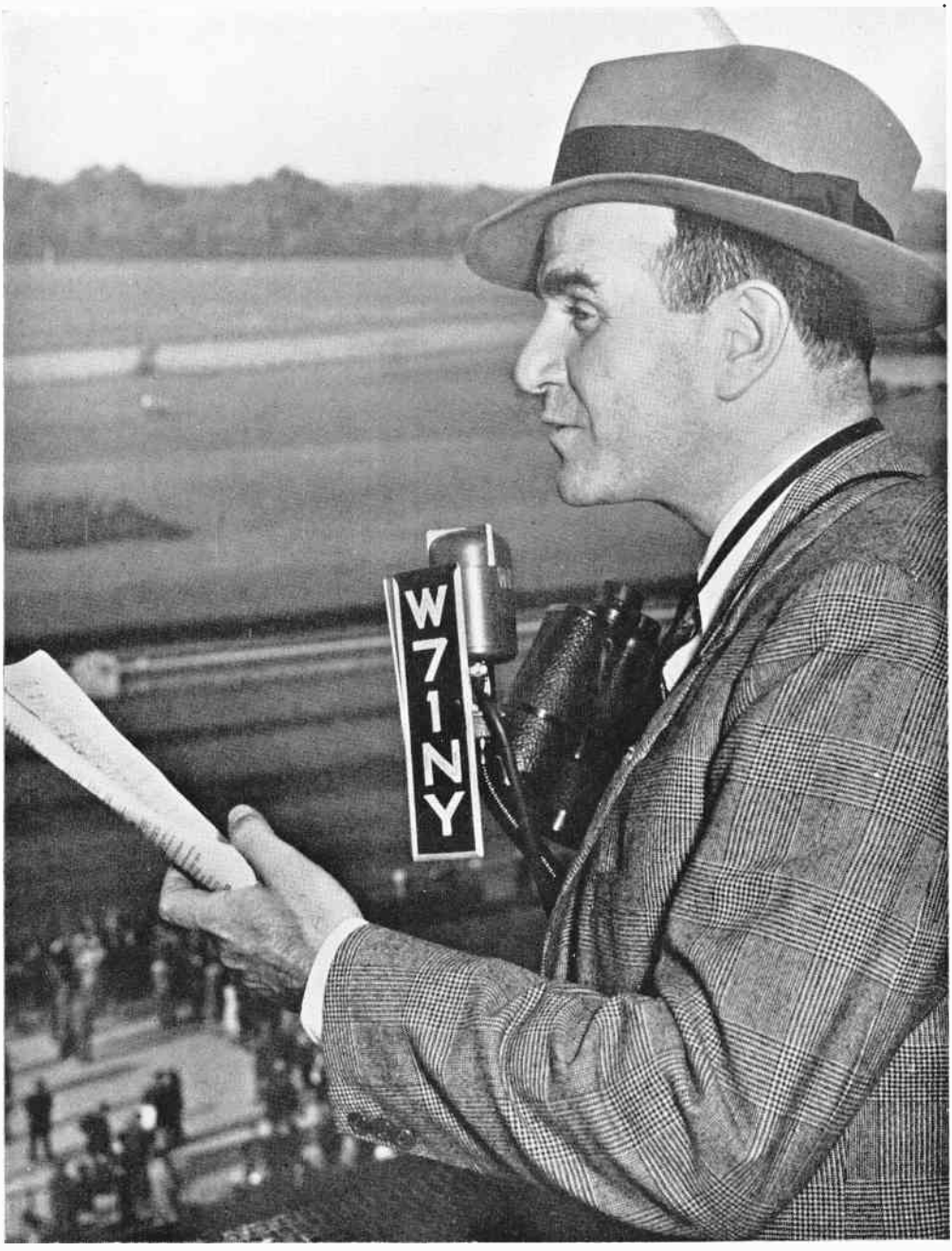
NBC: Has been granted authority to operate a 1-kw. video transmitter on FM, at Bound Brook, N. J. Purpose is to compare performance with AM video transmission.

Philadelphia: Strawbridge & Clothier, owners of WFIL, sold a 50 per cent interest in the station to Lit Brothers. Price, $126,000. WFIL may have the first FM station on the air in Philadelphia.

Stromberg: Reports all-time record of employment at their Rochester factory. Large factor is their increased production of A-FM receivers and combinations.

New York City: WNBT, operated by NBC, was the first commercial television station on the air under the July 1st FCC rules which require the use of FM for the audio channel. First sponsor was Bulova, showing a clock face that appears long enough for a second hand to run off one minute.

Emergency: Truly amazing is the rate at which both police and public utilities are installing 2-way or 3-way FM systems. Impetus has been given by defense emergency conditions, calling for the extra protection and faster action afforded by FM systems. Most extensive of these is the Link installation covering the entire state of Connecticut, where State Police Commissioner Hickey has demonstrated its effectiveness to visiting officials from practically every large city in the country.



NEWS PICTURE

More and more as FM broadcasting gets under way, special programs are being heard on FM waves. Here is Bryan Field, WOR-Mutual sportscaster, now covering the actual running of feature horse races from the leading Eastern tracks, over "71", WOR's FM outlet. Field is credited with being the first sports announcer heard on Frequency Modulation. W71NY is nearly ready to put its 10-kw. FM transmitter on the air, and to operate on permanent commercial status.

Washington, D. C.: Jansky & Bailey have been authorized to continue experimental FM broadcasting on 43.2 mc., with 1 kw. output. Transmitter is at 1219 Wisconsin Avenue, N. W. Call is W3XO.

First Tele Fights: Adam Hats will sponsor television broadcasts of boxing matches at Ebbets Field. Contract has been signed with NBC to carry the bouts on New York station WNBT.

Cincinnati: Crosley Corporation has been authorized to continue experimental FM broadcasting on 43.2 mc., with 1 kw. output. Call is W8XFM.

Solar: As a part of their plans to help customers meet priority limitations, Solar Manufacturing Company, Bayonne, N. J., has issued a most helpful folder entitled "Defense and You." Types of fixed condensers on which shortages may develop are listed, together with recommendations as to substitutes more readily obtainable which give equal performance. Copies can be obtained on request.

SPECIAL C.P. TO MUZAK FOR FM

Under experimental authorization from the FCC, Muzak Corporation of New York City will undertake to furnish by FM transmission the same type of service they have so successfully provided over wires.

The transmitter, operating on 117.65 mc. with 1 kw., will be located at 11 West 42nd Street.

G.E. FM TRANSLATOR IN NEW BOOK CABINET, AND MUSAPHONIC COMBINATION

In their application for a construction permit, Muzak stated:

"The purpose of the experiment is to determine whether the public or a sufficiently large portion of the public would prefer to obtain radio programs by direct payment for the service. The experiment will be conducted by offering a service to the general public in New York City and furnishing this service to those of the general public who pay for the service. There will be no advertising in connection with the service and the success or failure of the experiment will depend upon the willingness of the public to pay an amount which will warrant the furnishing of such a service as an established business."

A memorandum opinion issued by the FCC in connection with the Muzak grant states:

"A broadcast station is defined, both by treaty and statute, as one licensed for the transmission by radiotelephone emissions primarily intended to be received by the general public. The first such stations licensed in this country were sought and obtained by individuals or organizations engaged in manufacturing or similar enterprises who desired either to advertise their own product or to promote public good will in their own behalf. Licensees, in order to meet the increasing cost of providing broadcast programs, gradually entered into the practice of transmitting, for a fee, advertising matter for other persons. As the effectiveness of radio as an advertising medium developed broadcasting became a business in its own right. Thus arose the practice in this country of public support of broadcast service, not through any direct charge, but through the purchase of articles and services advertised by radio. This is not true in all countries of the world.

"The service which this applicant proposes will be available to the general public; any member of the public, without discrimination, may lease the equipment to receive the service. The distinguishing feature will be that those receiving the programs will pay directly rather than indirectly therefor. Operating of a station in this manner is within the definition of broadcasting.

". . . A charge to the subscriber for the program service is an integral and inseparable part of the experiment. The rule prohibiting a direct or indirect charge by the licensee of a developmental broadcast station for the transmission of programs was promulgated in the light of the existing practices of broadcast stations. Under the circumstances here presented, we are of the opinion that the rule should be construed in such a manner as to permit the proposed operation."

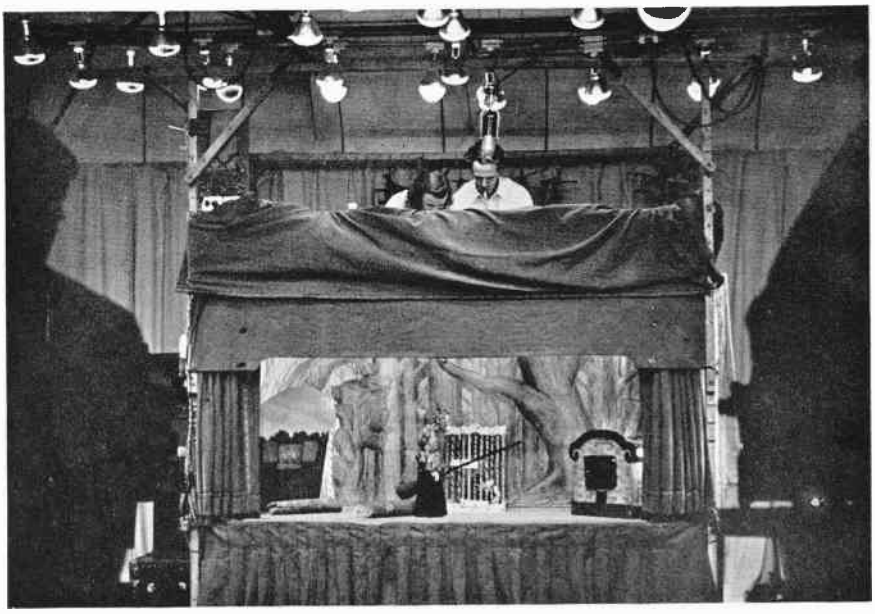


FIG. 12. MARIONETTE SHOWS BY TELEVISION ARE HIGHLY ENTERTAINING. THIS SCENE FROM "HANSEL AND GRETEL" IS STAGED AT PHILCO STUDIO

A Review of Philco

TELEVISION PROGRESS

Part 2—Research on Program Material, Video Effects, and Production Technique, and the Transmission of Motion Picture Film

BY E. N. ALEXANDER*

Broadcasts ★ In October 1939, Philco decided that a necessary adjunct to their program of technical research in television was the production of a regular schedule of television program broadcasts, and continuous broadcast program research. The objectives of this plan of program research were as follows:

1. To make immediate use of our existing television studio and motion picture facilities to determine the adaptability of this equipment to a commercial television broadcast service.
2. To alter, adapt, and build such new equipment as would be found necessary to carry on the above program.
3. Coincidently, to conduct a program of research to determine types of broadcast program material, video effects and production techniques most suitable and acceptable for this new medium.

Since this program was inaugurated, a total of 488 program hours have been televised—starting on the basis of two program hours per week, gradually increasing the total number of hours per week to five until, from March 15, 1940 to date, Philco has maintained ten hours of programs each week the transmitter was available.

This total of 488 hours was made up of these main classifications of program material:

Studio Programs
Motion Pictures
Remote Pickup

* Program Manager, Philco Radio & Television Corporation, Philadelphia, Pa.

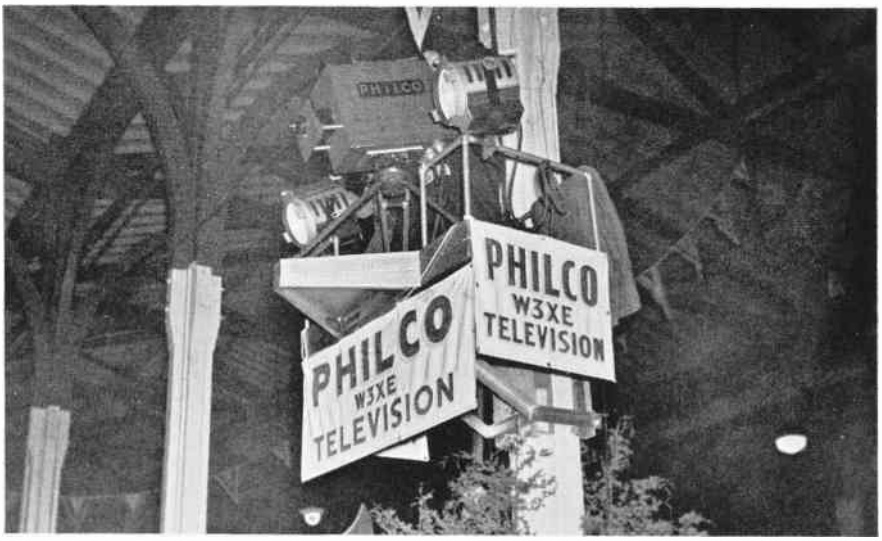


FIG. 13. TELEVISION CAMERA PICKS UP SPECIAL EVENTS AT SPORTSMEN'S SHOW

Studio Programs ★ Under this classification Philco has produced practically every known type of program adaptable to the television studio including:

VARIETY: running the gamut of night club, vaudeville, and musical comedy acts.

DRAMA: with such well-known stage successes as "Family Portrait," "Fresh Fields," and "Kind Lady," as well as a host of material including one-act plays, serials, and original scripts adapted to television.

WOMEN'S PROGRAMS: including Beauty Contests, Fashion Shows, Beauty Culture and Make Up, and Interior Decoration.

NEWS PROGRAMS: with world-famed war correspondent and Philco News Commentator, Frazier Hunt.

EDUCATIONAL PROGRAMS: such as scientific demonstrations, Hobby Shows, Arts and Crafts, and programs of historical interest.

PLUS: Musical Programs, Operas in Miniature, Political, Children's Programs and programs of religious interest.

MOTION PICTURES: include the televising to date of 1,578,150 feet of film, including both feature pictures and short subjects.

Remote Television Broadcasts ★ Our remote television broadcasting activities date back to the televising of the Republican National

FIG. 14. KAYE SEERY VOCALIZES A NUMBER WITH THE "STAR-DUSTERS" FROM THE PHILCO STUDIO. THIS IS THE HARDEST TEST OF AN ARTIST'S ABILITY TO PUT HIMSELF ACROSS TO HIS AUDIENCE

Convention, June 24 to June 28, 1940. At that time Philco engineers installed an ultra-high frequency relay transmitter, W3XP, atop Convention Hall, in Philadelphia.

This transmitter has proved to be the keystone of subsequent remote activities. Video signals, from several points of origination, have been piped to this relay transmitter, radiated to the main transmitter, and thence rebroadcast. The highlights of these programs follow:

Football Telecasts ★ During the Fall of 1940, we undertook the project of televising, for the first time in history, a complete schedule of major college football games. This effort took place at historic Franklin Field of the University of Pennsylvania, from October 5 to November 23, 1940. The schedule of home games was unusually heavy, due to the University of Pennsylvania Bicentennial Celebration, which was running currently. The schedule of the total of the seven home games is as follows:

October 5	Penn *vs.* Maryland
October 12	Penn *vs.* Yale
October 19	Penn *vs.* Princeton
November 2	Penn *vs.* Navy
November 9	Penn *vs.* Harvard
November 16	Penn *vs.* Army
November 23	Penn *vs.* Cornell

Concurrent with the technical discoveries and developments made possible by the experimental broadcast of these games, our program staff conducted extensive research to develop a commercially desirable program technique. This research naturally included the attack of such fundamental problems as camera placement, angles, and lens complements. In addition, we sought the solutions to the problems of developing an absorbing program continuity, the relief of the many slow and inactive visual portions of the game, circumvented in radio by "color" commentating, and the conception of a production technique to enable the welding of the many elements into a complete, unified, entertaining program.

To fulfill the above, many production devices were originated, including a pre-game visual analysis and comparison of teams, a camera-announcer "color" technique, a unique and all-inclusive television scoreboard and gridiron chart for recapitulation of the plays, as well as a complete, graphic, check chart to make all necessary information available to the television announcer at a glance.

In order to produce maximum enjoyment of these programs, 5 television cameras were used: 2 for the variety of shots originating at Franklin Field, and the balance at the Philco Live and Projection Studios for the origination of the various devices and effects discussed. The arrangement of this equipment is shown in the accompanying diagram.

FIG. 15. THE 240-MC. RADIATOR ATOP PHILADELPHIA'S CONVENTION HALL

Remote Arena Broadcasts ★ At the close of the 1940 football season, we installed in the Philadelphia Arena the necessary platforms, cameras and associated television equipment to televise from this source the variety of events it afforded. During the period December 21 to

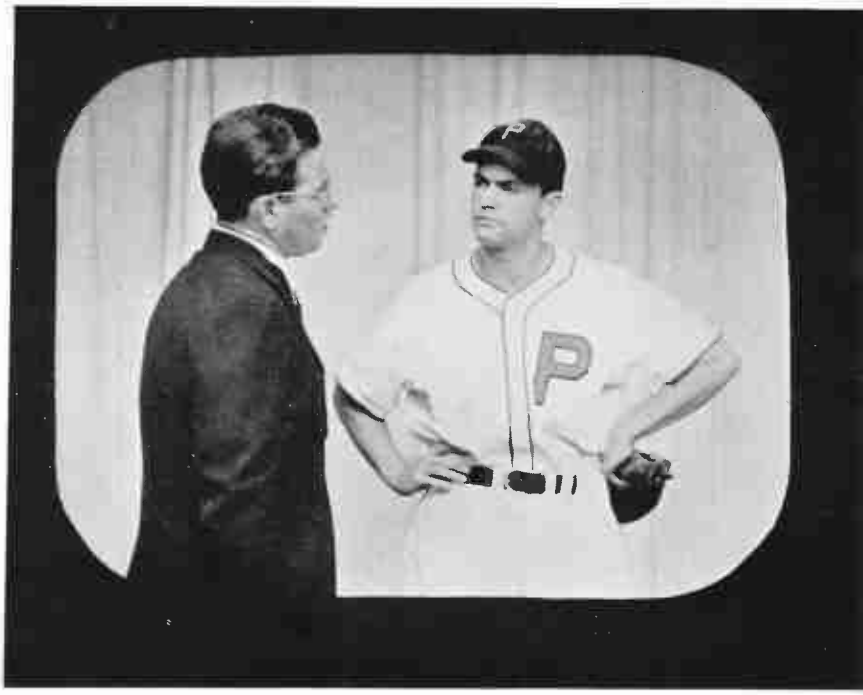


FIG. 16. SPORTS INTERVIEWS ARE POPULAR AMONG TELEVISION AUDIENCES. HERE, KIRBY HIGBEE, FORMERLY OF THE PHILLIES, DISCUSSES THE CLUB'S CHANCES

the present, we originated from the Arena an impressive number of sporting events, including tennis, ice hockey, wrestling and boxing. In addition, such outstanding entertainment highlights as "The Ice Carnival" and "The Ice Follies of 1941" were televised.

Mummers' Parade ★ For years, the world-renowned Philadelphia Mummers' Parade has been a "must" on the entertainment menu of hundreds of thousands on the Eastern seaboard. Heretofore, it was traditional to literally freeze while witnessing this event. This was, of course, before the advent of Philco television. On January 1, 1941, for the first time in history, Philco televised in its entirety this northern counterpart of the New Orleans Mardi Gras. Those fortunate Philadelphians who possessed television receivers relaxed in the comfort of their own homes while

FIG. 17. NEW TECHNIQUES OF STAGING PLAYS HAVE BEEN DEVELOPED. THIS SCENE IS FROM "THE TEACHER OF NAZARETH". NOTE THAT THE CHARACTERS OCCUPY THE FULL AREA OF THE SCREEN

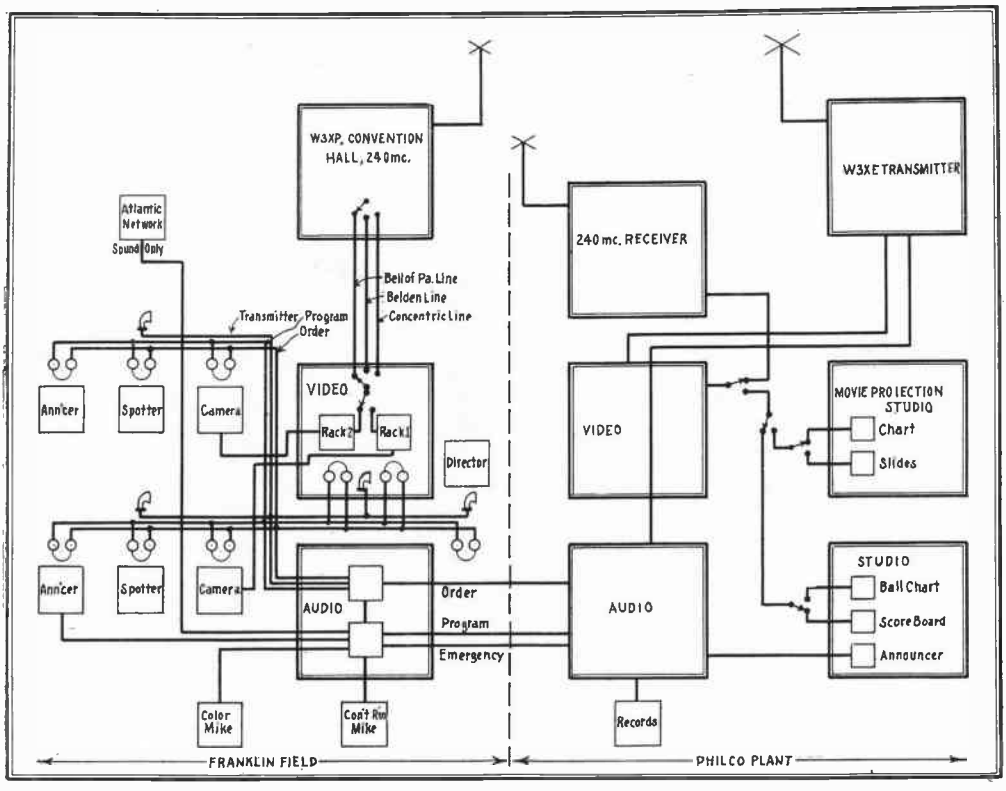


FIG. 21. BLOCK DIAGRAM OF FRANKLIN FIELD REMOTE INSTALLATION, SHOWING ESSENTIAL EQUIPMENT FOR A TYPICAL REMOTE TELEVISION BROADCAST

the magic of the television camera gave them, in effect, grandstand seats as the parade, complete with shooters, comics, fancy capes and costumes and string bands, was brought direct to the screens of their television receivers.

We also originated many other remote television broadcasts, including such noteworthy

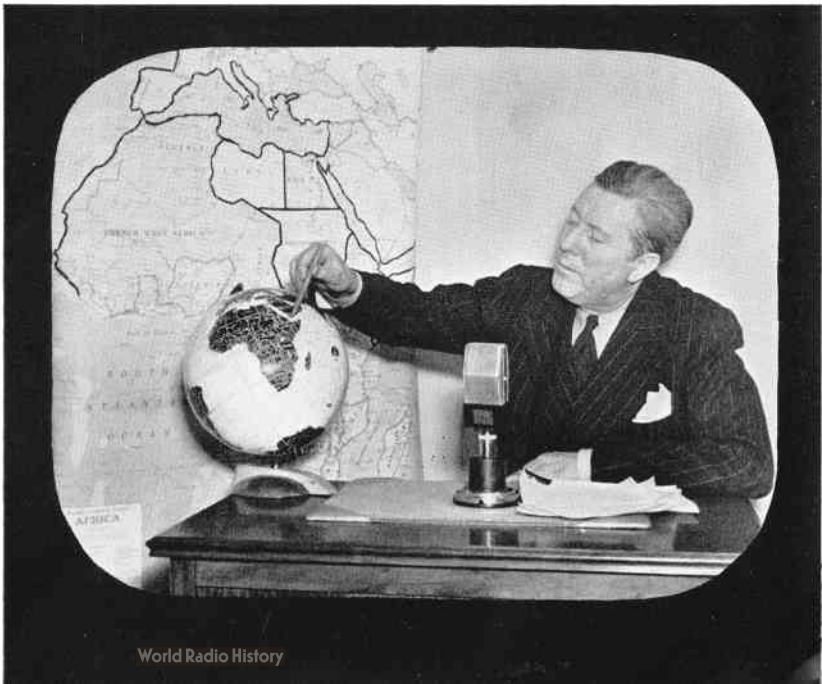


FIG. 18. THE USE OF A GLOBE AND MAPS MAKES FRAZIER HUNT'S COMMENTS ON THE WAR DOUBLY INTERESTING, AND EASIER TO FOLLOW. HERE SIGHT IS AN IMPORTANT ADJUNCT TO SOUND

FIG. 19. HERE, E. N. ALEXANDER, PHILCO PROGRAM DIRECTOR AND AUTHOR OF THIS ARTICLE, INTERVIEWS BESS EHRHART, ICE FOLLIES STAR

events as the Philadelphia Sportsmen's Show and the University of Pennsylvania's 47th Annual Relay Carnival.

Other Pertinent Facts ★ Philco equipment at present includes a total of 8 television cameras and associated equipment used as follows:

3 — Studio cameras
2 — Movie cameras
3 — Remote cameras

Six of these cameras are of the Iconoscope type. Two of the three used on portable work are Orthicons.

Our television facilities include a fully equipped television studio with associated control room, engineering laboratories, special effects and sound effects laboratory, scene shop, offices, dressing rooms, and viewing rooms, and one truck and one station wagon. In other words, it is a complete plant.

(CONCLUDED ON PAGE 46)

FIG. 20. OCCUPATIONAL THERAPY IS EXPLAINED IN THIS EDUCATIONAL TELEVISION PROGRAM, WHERE AN ACCIDENT VICTIM IS LEARNING TO BRING HIS INJURED ARM BACK INTO USE

KENNETH GARDNER, CHIEF ENGINEER OF W5IR, ROCHESTER, AT THE DUAL TURNTABLES USED FOR THE TRANSMISSION OF HIGH-FIDELITY RECORDS

RECORDINGS IMPROVED FOR FM

Now Meet High-Fidelity Requirements of FM Stations

ONE of the by-products of FM broadcasting is the new, high-fidelity recordings now produced by improved means and methods. The best of them are, in fact, so perfect that it is practically impossible to recognize them as transcriptions.

All this started when, at the beginning of FM broadcasting, listeners complained that recordings sounded better on AM than on FM.

The reason was that the faults of ordinary recordings lie mainly in the higher frequencies. Since these frequencies are not transmitted by AM stations, nor could they be reproduced by standard broadcast receivers, they made no difference.

However, FM transmitters "hear" all the high-frequency defects, and transmit them, and they come right out of the FM set loudspeakers!

When it was realized that ordinary transcriptions could not be used for FM, companies supplying recordings and recording equipment, recognizing FM stations as important prospective customers, undertook to improve the means and methods which they had been using.

As a result, needle scratch has been cut down and audio quality improved to the point where the FCC permits the use of the new transcriptions on FM stations during the daily periods which must be devoted to full-fidelity programs.

Furthermore, the stations can now obtain libraries of transcriptions so perfect that FM listeners would assume that they were hearing live talent if they were not informed to the contrary by the announcers.

The improved quality cannot be recognized if these transcriptions are used for AM, however, since the presence or absence of the high frequencies makes no difference.

But to FM audiences this marks an important step in better musical entertainment, for anyone would rather hear a fine artist or orchestra by the perfected transcriptions than to get direct reception of the same selections played poorly.

(CONTINUED FROM PAGE 20)

and ears have talked to the main station at as much as 200 miles.

The remarkable success of the Contra Costa system will, undoubtedly, point the way to other applications of FM relay transmitters for extending the range of emergency communications in sections where the terrain is unfavorable.

FM STATIONS List of Stations for Which C.P. Applications Have Been Filed, and Those Granted up to July 17th

EDITOR'S NOTE: *This FM Station Listing, revised from month to month, will be a regular feature of* FM *Magazine. We ask the coöperation of the Station Managers in correcting any errors or omissions which may appear, due to changes in the status of the stations, modifications, or confusion in the source of information.*

Stations are listed alphabetically by states and cities, and in numerical order of frequencies applied for or assigned. If call letters are shown, C.P. has been granted.

CALIFORNIA — Los Angeles

K31LA — Columbia Broadcasting System
43.1 mc.

K45LA — Don Lee Broadcasting System
44.5 — 6,944 sq. mi. — 2,600.000 pop.

Hughes Productions, Inc.
44.5 — 7,315 — 2,575,558

Earle C. Anthony, Inc.
44.9 — 1,371 — 2,252,392

K53LA — Standard Broadcasting Co.
45.3 — 7,000

Echo Park Evangelistic Association
45.5 — 6,972 — 2,396,217

K61LA — Metro-Goldwyn-Mayer Studios, Inc.
46.1 — 7,000

Oakland

Tribune Building Co.
46.5 — 1,216 — 1,250,000

San Bernardino

The Sun Co. of San Bernardino
44.1 — 17,101 — 803,524

San Francisco

Don Lee Broadcasting System
43.5 — 18,050 — 1,098,612

Hughes Productions, Inc.
44.5 — 10,790 — 1,983,802

CONNECTICUT — Hartford

W53H — The Travelers Broadcasting Serv., Inc.
45.3 — 6,100 sq. mi. — 1,036,400 pop.

W65H — WDRC, Inc.
46.5 — 6,100 — 1,119,000

DISTRICT OF COLUMBIA

M.A. Leese Radio Corp.
47.1 — 5,600 sq. mi. — 899,946 pop.

FLORIDA — Fort Lauderdale

Tom M. Bryan
44.5 — 2,150 sq. mi. — 306,000 pop.

ILLINOIS — Chicago

W47C — WJJD, Inc.
44.7 — 10,800 sq. mi. — 4,500,000 pop.

W51C — Zenith Radio Corp.
45.1 — 10,800 — 4,500,000

W59C — WGN, Inc.
45.9 — 10,800 — 4,500,000

W63C — National Broadcasting Co.
46.3 — 10,800 — 4,500,000

W75C — Moody Bible Institute
47.5 — 10,800 — 4,500,000

W67C — Columbia Broadcasting System
46.7 — 10,800 — 4,500,000

Cicero

WHFC, Inc.
46.7 mc. — 2,885 — 3,835,000

Rockford

W71RF — Rockford Broadcasters, Inc.
47.1 — 3,900 — 270,000

INDIANA — Evansville

W45V — Evansville on the Air
44.5 — 8,397 sq. mi. — 465,000 pop.

Fort Wayne

W49FW — Westinghouse Radio Stations, Inc.
44.9 — 6,100 — 420,000

Indianapolis

Indianapolis Broadcasting Co., Inc.
45.3 — 13,640 — 1,017,471

South Bend

W71SB — South Bend Tribune
47.1 — 4,300 — 448,000

IOWA — Cedar Rapids

The Gazette Co.
44.7 — 7,400 sq. mi. — 282,000 pop.

KENTUCKY — Ashland

Ashland Broadcasting Co.
46.1 — 4,160 sq. mi. — 421,990 pop.

Lexington

W51SL — American Broadcasting Corp. of Kentucky
45.1 — 6,298 — 415,501

Louisville

Louisville Courier-Journal & Times Co.
45.7 — 13,200 — 1,004,320

LOUISIANA — Alexandria

Alexandria Broadcasting Co., Inc.
44.7 — 3,025 sq. mi. — 116,119 pop.

Baton Rouge

W45BR — Baton Rouge Broadcasting Co.
44.5 — 8,100 — 361,400

MAINE — Falmouth

Portland Broadcasting System
47.1 — 5,050 sq. mi. — 256,466 pop.

MARYLAND — Baltimore

The A. S. Abell Co.
46.3 — 6,040 sq. mi. — 1,810,159 pop.

MASSACHUSETTS — Boston

Columbia Broadcasting System
44.1 — 16,230 sq. mi. — 5,972,246 pop.

W43B The Yankee Network
44.3 mc. 19,230 6,635,751
Boston Edison Co.
44.7 6,930 3,075,927
W67B Westinghouse Radio Stations, Inc
46.7 6,700 3,075,927

New Bedford

E. Anthony & Sons, Inc.
45.7 1,787 350,250

Springfield

W81SP Westinghouse Radio Stations, Inc.
48.1 2,500 500,000

Worcester

Worcester Telegram Publishing Co.
43.1 20,437 6,606,882

MICHIGAN

Battle Creek

Federated Publications, Inc.
48.1 4,100 sq. mi. 278,739 pop.

Detroit

W45D The Evening News Association
44.5 6,820 2,498,000
W49D John Lord Booth
44.9 6,800 2,900,000
WJR, The Goodwill Station
45.3 14,144 3,636,615
James F. Hopkins, Inc.
46.5 3,050 2,133,811
King Trendle Broadcasting Co.
47.3 6,750 2,674,580

Grand Rapids

King Trendle Broadcasting Corp.
45.5 4,340 420,384
Federated Publications, Inc.
46 1 5,300 518,766

Lansing

WJIM, Inc.
45.1 4,200 421,000
Federated Publications, Inc.
47.1 3,820 278,162

MISSOURI

Kansas City

Commercial Radio Equipment Co.
44.9 2,995 sq. mi. 673,759 pop.

St. Louis

Columbia Broadcasting System
44.7 12,900 1,847,060
Star-Times Publishing Co.
44.7 12,480 1,748,733
Globe-Democrat Publishing Co.
44.7 15,850 1,858,665
K51L St. Louis University
45.1 mc. 13,000 1,500,000
The Pulitzer Publishing Co.
45.5 11,301 1,797,700

NEW HAMPSHIRE Mount Washington

W39B The Yankee Network
43.9 31,000 sq. mi. 2,000,000 pop.

Manchester

The Radio Voice of New Hampshire
43.5 20,290 4,260,280

NEW JERSEY

Ewing Township

Mercer Broadcasting Co.
44.7 3,700 sq. mi. 910,000 pop.

NEW YORK

Albany

WOKO, Inc.
45.1 7,164 sq. mi. 922,163 pop.

Binghamton

Wylie B. Jones Advertising Agency
44.9 6,500 256,300

New York City

W31NY Major Edwin H. Armstrong
43.1 15,610 12,200,000
W35NY Municipal Broadcasting System
43.5 3,900 11,550,274
W47NY Muzak Corporation
44.7 8,500 10,546,481
News Syndicate Co., Inc.
44.7 mc. 8,500 10,817,455
W51NY National Broadcasting Co.
45.1 8,500 12,000,000
W55NY William G. H. Finch
45.5 8,500 12,000,000
W59NY Interstate Broadcasting Co.
45.9 8,500 10,817,455
W63NY Marcus Loew Booking Agency
46.3 8,500 12,000,000
W67NY Columbia Broadcasting System
46.7 8,500 12,000,000
Wodaam Corporation
46.7 8,500 11,431,600
Bremer Broadcasting Corp.
47.1 8,500 11,325,000
W71NY Bamberger Broadcasting Service, Inc.
47.1 8,500 12,000,000
W75NY Metropolitan Television, Inc.
47.5 8,500 12,000,000
WBNX Broadcasting Co.
47.5 8,730 11,328,743
New Jersey Broadcasting Corp.
47.9 8,900 10,400,000
FM Radio Broadcasting Co., Inc.
48.3 8,600 9,800,000
Knickerbocker Broadcasting Co.
48.3 8,550 10,817,455
The Debs Memorial Radio Fund, Inc.
48.7 8,600 12,300,000
W99NY Frequency Broadcasting Corp.
49.9

Rochester

WHEC, Inc.
44.7 3,200 599,256
W51R Stromberg-Carlson Telephone Mfg. Co.
45.1 3,200 585,000

Schenectady

W47A Capitol Broadcasting Co., Inc.
44.7 6,589 967,000

W57A General Electric Co.
45.7 6,600 968,000

Syracuse

W63SY Central New York Broadcasting Co.
46.3 6,800 600,000

NORTH CAROLINA Winston-Salem

W41MM Gordon Gray
44.1 69,400 sq. mi. 4,346,000 pop.
Piedmont Publishing Co.
46.7 4,600 500,684

OHIO Cleveland

United Broadcasting Co.
48.5 8,420 sq. mi. 1,314,595 pop.

Columbus

W45CM WBNS, Inc.
44.5 12,400 1,100,000

Youngstown

William F. Maag, Jr.
43.5 12,304 4,488,498

PENNSYLVANIA Philadelphia

W49PH Pennsylvania Broadcasting Co.
44.9 9,300 sq. mi. 4,214,336 pop.
W53PH WFIL Broadcasting Corp.
45.3 9,300 3,850,000
W57PH Westinghouse Radio Stations, Inc.
45.7 9,300 4,500,000
Gibraltar Service Corp.
46.1 9,318 3,846,651
W69PH WCAU Broadcasting Co.
46.9 9,300 3,846,651
Seaboard Radio Broadcasting Corp.
48.3 9,400 2,900,000

Pittsburgh

Pittsburgh Radio Supply House
43.9 16,100 3,473,432
W47P Walker-Downing Radio Corporation
44.7 mc 8,400 2,100,000
W75P Westinghouse Radio Stations, Inc.
47.5 8,400 2,100,000

RHODE ISLAND Providence

Cherry & Webb Broadcasting Co.
47.5 6,207 sq. mi. 4,230,838 pop.
The Outlet Company
48.5 4,840

TENNESSEE Nashville

W47NV National Life & Accident Insurance Co.
44.7 16,000 sq. mi. 819,000 pop.

TEXAS Amarillo

Amarillo Broadcasting Corp.
45.1 5,625 sq. mi. 73,734 pop.

UTAH Salt Lake City

K47SL Radio Service Corp. of Utah
44.7 623 sq. mi. 194,000 pop.

WISCONSIN La Crosse

La Crosse Tribune Co.
46.5 4,520 sq. mi. 166,600 pop.

Milwaukee

W55M The Journal Co.
45.5 8,540 1,522,000

Superior

Head of the Lakes Broadcasting Co.
44.5 2,754 168,193

WHAT THE FM BROADCASTERS SAY:

(CONTINUED FROM PAGE 17)

a completely self-contained station. Primary electric power will be supplied by several Diesel driven generators. Programs will be transmitted to the station from Winston-Salem, 105 miles distant, by FM relay. Later on, it is hoped to establish these relays at other remote programs sources.

A mile-long road from Stepps Gap to Clingmans Peak must be constructed and water has to be pumped from a level 800 ft. below the transmitter site. Sufficient land is available for the erection of numerous directional receiving arrays.

Weather conditions at Clingmans, while not as severe as at Mt. Washington, N. H., are nevertheless extreme enough to require precautions against interruptions of service. The highest recorded temperature has been 79 degrees while the lowest has been −20 degrees. This low makes it necessary to bury fuel and water tanks for several months' supply below the frost line, which is approximately 3 ft. Permanent quarters for the staff are planned, as the nearest town is 35 miles by roads which are often impassable during the winter months.

The antenna structure is designed to withstand winds up to 100 miles per hour, and also heavy sleet loading. Several interesting plans for de-icing are under consideration.

If it is possible to carry out the present schedule, the 3-kw. driving unit will be available for such operation as may be authorized in the fall and the 50-kw. amplifier will be ready for operation early next spring.

When completed and in operation, W41MM will serve an area that is considered one of the most rapidly growing regions of the United States and will make available broadcast programs to thousands who otherwise would have to do without.

The FCC has granted General Electric a C.P. for a commercial television station at Schenectady, to operate on 66–72 mc., known as Channel No. 3. Signals will be beamed from the Schenectady studio to W2XB, the main transmitter, located in the Helderberg Mountains. Coverage area is 3,320 square miles, with 572,000 population.

NEW FM EQUIPMENT

FM Station Checking Equipment — 150-Watt Transmitter for 156 to 162 Mc. — Special FM Applications

BY FRANK A. GUNTHER *

SINCE definite specifications for FM transmitter performance have been laid down by the FCC, certain equipment is required for taking measurements when final adjustments are being made before the station goes on the air, and subsequently at regular intervals to assure the maintenance of required characteristics.

For our own use in the final testing of transmitters, we built a rack assembly of apparatus by which all the necessary measurements could be taken. It proved so useful—in fact essential —that similar assemblies have been furnished to FM broadcasting stations.

Readings can be taken on (1) signal-to-noise ratio, with an analysis of types of noises, (2) fidelity, with and without predistortion, (3) spurious frequencies, (4) percentage of modulation or frequency swing, and (5) distortion in the transmitter.

At the bottom of the rack there is a low-gain, distortion-free receiver, designed for wide band-pass. This feeds a flat-response amplifier, above. This combination serves as a station monitor, when used with a suitable loudspeaker. It is also used for exploring noises, either by ear or by means of the oscilloscope mounted at the top, left.

Next, is a heterodyne frequency meter, used to check the frequency swing or percentage of modulation, and to adjust the intermediate circuits of the transmitter.

Above the frequency meter is a beat frequency oscillator with a range of 20 to 17,000 cycles, providing a source of modulated voltage to feed into the transmitter. This is used in conjunction with the oscilloscope.

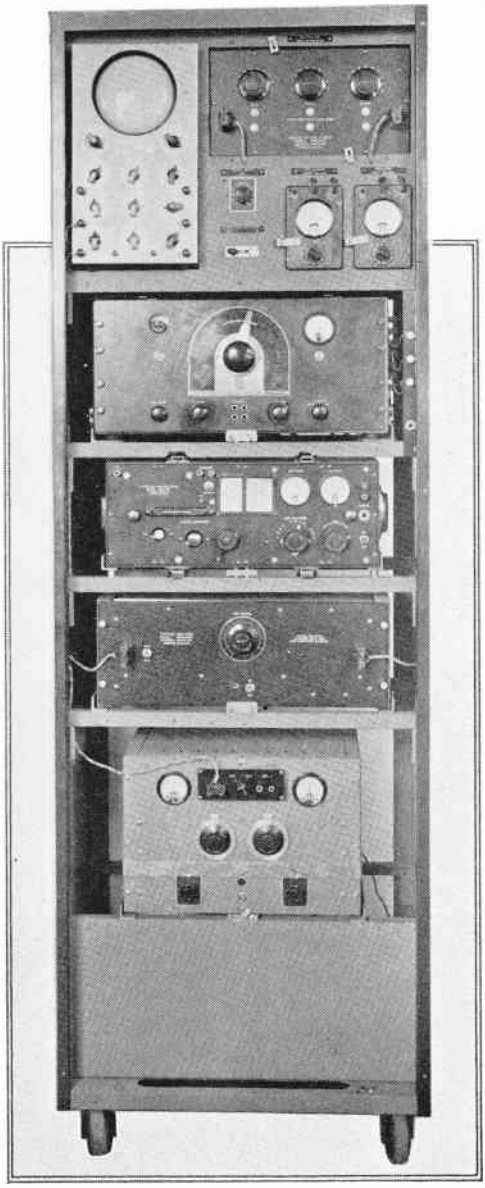
Two matched db meters show the input to the transmitter and the output of the monitor receiver.

At the top, right, is a calibrated attenuation network for signal-to-noise measurements.

The rack is mounted on rubber-tired wheels, so that it can be moved around the station, because a considerable number of special uses will be found for this equipment, in addition to those mentioned here.

FIGS. 2 and 3 show the construction of a newly designed 150-watt FM transmitter for any predetermined frequency between 156 and 162 mc., adaptable to various applications in the communications field.

FIG. 1. FM STATION TEST EQUIPMENT RACK



*Chief Engineer, Radio Engineering, Laboratories, Inc., Long Island City, N. Y.

It employs direct crystal control, with a total swing of 100 kc. for 100% modulation. The input is at zero level, 500 ohms, 6 milliwatts. Response is flat within 2 db from 50 to 15,000 cycles. The transmitter output is designed to operate into a balanced concentric line. A special receiver is provided to match the characteristics of this transmitter.

Mechanical details of this transmitter are particularly interesting. Intended for continuous 24-hour operation with all doors closed, filtered-air cooling is provided by a motor-driven blower. The blower, air filters, and ducts can be seen in the rear view, Fig. 3. This illustration also shows the power supply equipment at the bottom of the cabinet.

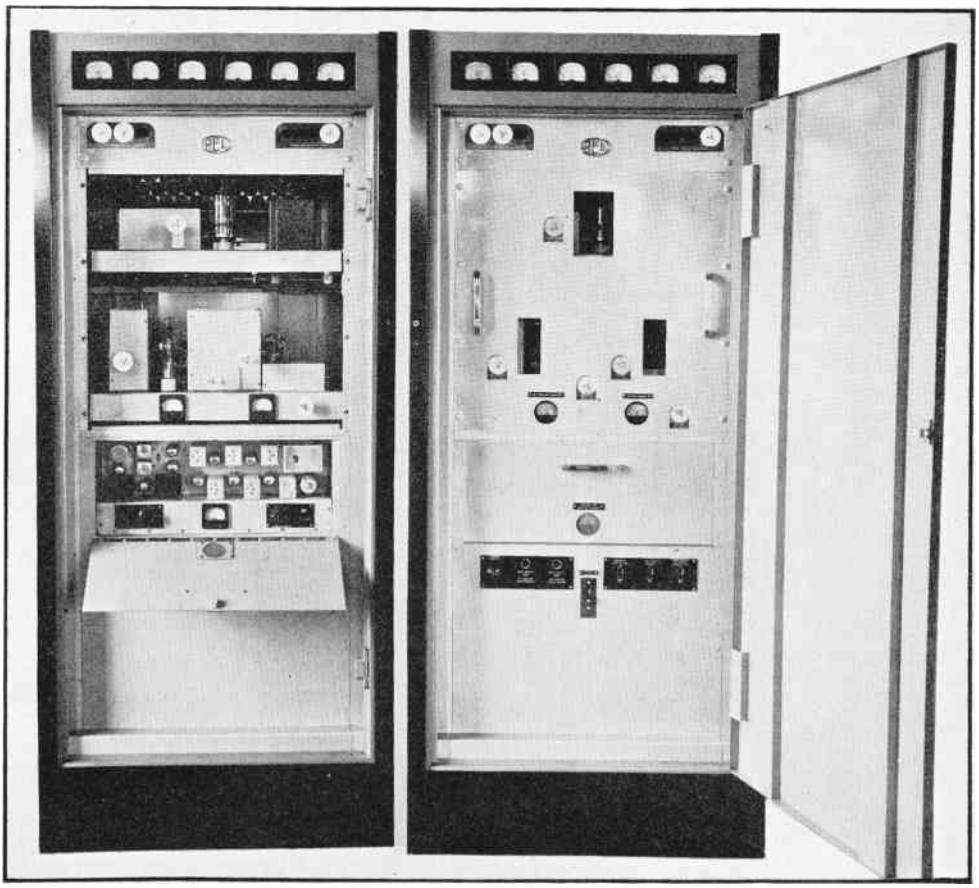
In the front views, Fig. 2, the balanced modulator, mounted behind a safety door, can be seen. This unit, with its multiplier circuits, raises the frequency to 5.8 mc. Following, above, are the first tripler, with two 807 RCA tubes, and the intermediate tripler, with two 75-T Eimac tubes, stepping the frequency up first to 17.4 and then 52.2 mc. The final power tripler, in the top section, has two 152-TL Eimac tubes.

Fig. 3 shows the power tube plate lines, and the folded hairpin coupling loop for the antenna circuit.

Because this transmitter is intended for continuous operation, Hardwick-Hindle plug-in resistors are used throughout, and special attention has been given to the mechanical design so that all units and components are readily accessible for replacement or repair.

Elaborate precautions have been taken to assure the safety of those who may be working around the transmitter cabinet. Such meters as must be observed in routine operation and checking are located across the top of the cabinet. Under all ordinary circumstances, therefore, it is not necessary to open the outer front door.

When special adjustments are found necessary, the controls and associated meters can be reached by opening the outer door. Protection is still afforded by the inner safety doors, however. The latter are never touched under



all ordinary circumstances, and then only by an engineer or expert familiar with the locations of the high-voltage parts.

AS engineers become more familiar with FM transmission and reception, its possibilities for many kinds of remote control applications will be more widely utilized.

Already, of course, facsimile apparatus and teletype machines have been operated simultaneously with voice circuits.

One of the great drawbacks to the employment of remote radio controls has been the fact static impulses on AM circuits are liable to actuate the apparatus at the receiving end. This has been true of devices operated by the transmission of different audio frequencies which can be separated and filtered to perform individual functions at the receiving end.

With AM transmission, a static impulse can readily overload the filters, with the result that all the devices are actuated. This effect is more pronounced if the static impulse occurs at a time when one audio frequency is being received, since the static breaks up the pure note of the AF signal, and disturbs all the individual audio filters.

Now, with FM transmission, this handicap can be overcome, and various devices can be kept under direct control of the audio frequencies sent out from the transmitting end.

Thus, a new field of radio-mechanical development is opened up to engineers.

Of the 50-odd construction permits issued for FM broadcasting stations, 10 have been issued to newspapers or organizations affiliated with newspapers.

Among the 60 applications for FM permits still awaiting FCC action, 20 belong to the same classification.

This has been a logical development, for the advent of FM, opening up new opportunities to enter the broadcasting field at a time when no new licenses could be obtained for AM stations in the larger cities, gives the newspapers a chance to recover advertising revenue which they have been losing to radio stations.

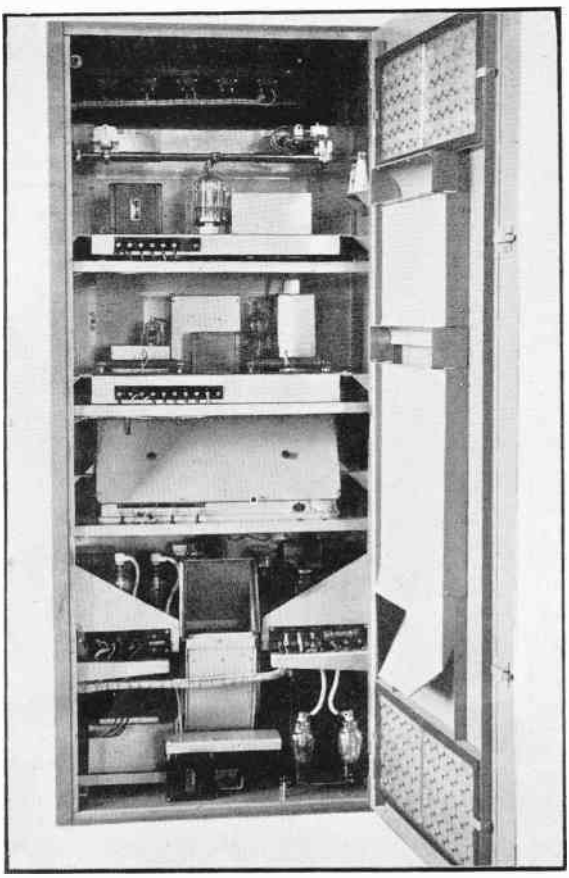
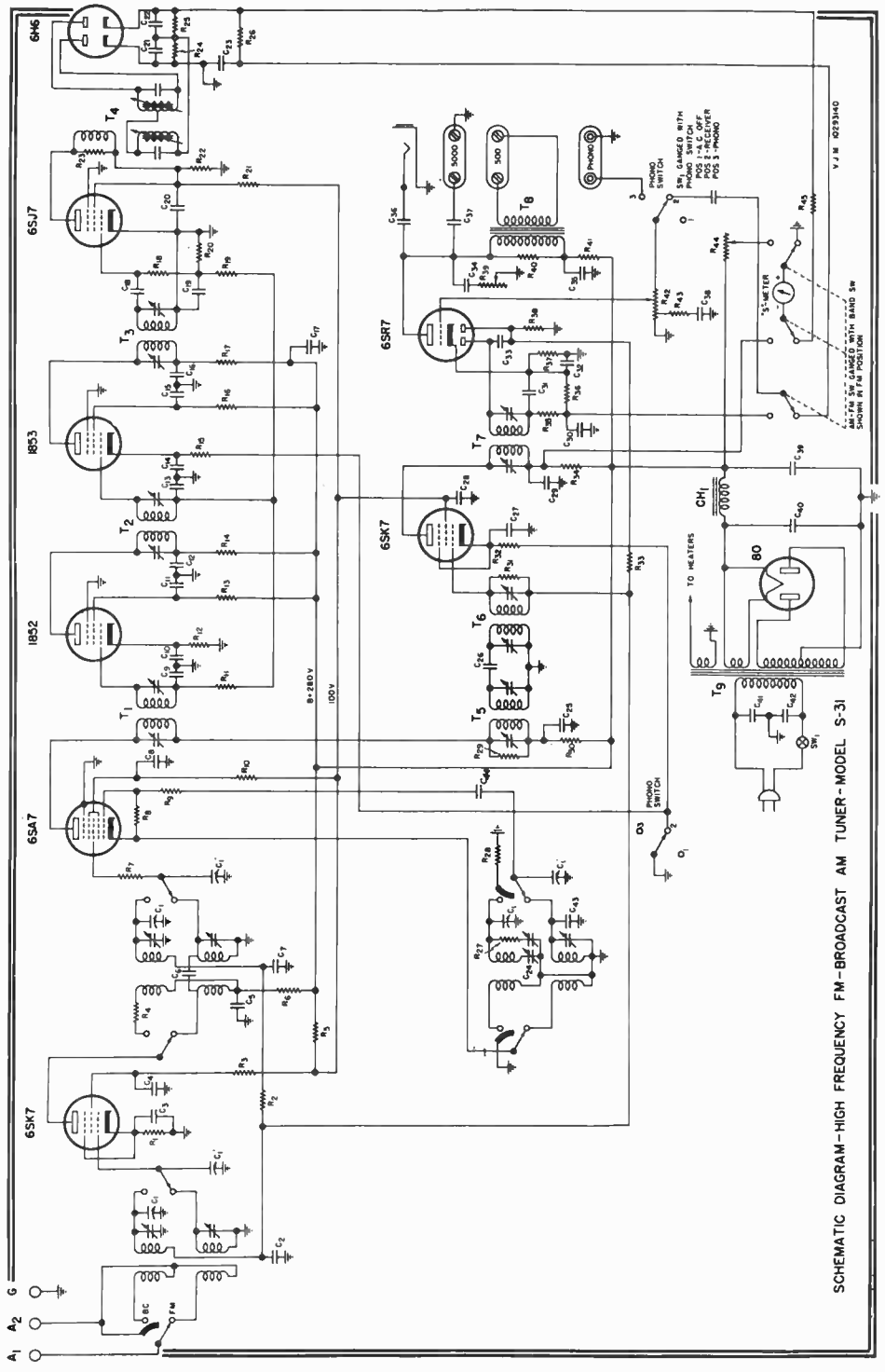


FIG. 2, LEFT. TWO VIEWS OF THE 156-MC. FM TRANSMITTER. WHEN THE OUTER DOOR IS OPEN, METERS INDICATING THE FUNCTIONING OF THE VARIOUS CIRCUITS CAN BE SEEN, AND THE ESSENTIAL ADJUSTMENTS CAN BE MADE. ADDITIONAL SAFETY DOORS ARE PROVIDED, WITH INTERLOCK SWITCHES, FOR ACCESS TO THE BALANCE MODULATOR AND TRIPLERS.

FIG. 3, RIGHT. REAR OF THE TRANSMITTER, SHOWING THE AIR FILTERS AND DUCTS OF THE VENTILATING SYSTEM.



SCHEMATIC DIAGRAM OF THE A-FM HALLICRAFTERS MODEL S-31 RECEIVER. THIS 2-BAND CIRCUIT, WITH TUNED RF AMPLIFICATION ON BOTH BROADCAST AND FM, IS EXCELLENT FOR COMPARING RECEPTION OF THE TWO METHODS OF BROADCASTING

THE A-FM MODEL S-31 CAN BE FURNISHED WITH A PANEL FOR RACK MOUNTING

2-BAND HALLICRAFTERS MODEL S-31

Service Data on the Hallicrafters' A-FM Receiver*

CARRYING out its characteristic styling in the manner of communications type receivers, Hallicrafters have produced a model which has a special appeal to those who want to have their sets look like radio equipment rather than furniture. At the same time, this receiver, model S-31, is a convenient type for special installations where, for one reason or another, standard rack mounting, in conjunction with other apparatus, is required. The S-31 is fitted with output terminals to work into 500 or 5,000 ohms. A separate power amplifier is required, since none is built into the tuning chassis.

SPECIFICATIONS

Type of Circuit: Armstrong wide-band Frequency Modulation, and Superheterodyne
Tuning Range:
Broadcast, 540–1,650 kc.
FM, 40–51 mc.
Types of Tubes:
6SK7 RF amplifier
6SA7 Detector-oscillator
1852 (6AC7) 1st IF amplifier (4.3 mc.)
1852 (6AB7) 2nd IF amplifier (4.3 mc.)
6SJ7 Limiter
6H6 Discriminator
6SK7 IF amplifier (455 kc.)
6SR7 2nd detector, AVC, audio output
Power Output: 130 milliwatts undistorted
Power Supply: 115 volts, 60 cycles
Power Consumption: 50 watts
Chassis: Length 16¾ ins., depth 10¾ ins., height 8⅜ ins.
Output: 5,000 ohms and 500 ohms.

*As given in the Hallicrafters service manual.

ALIGNMENT DATA

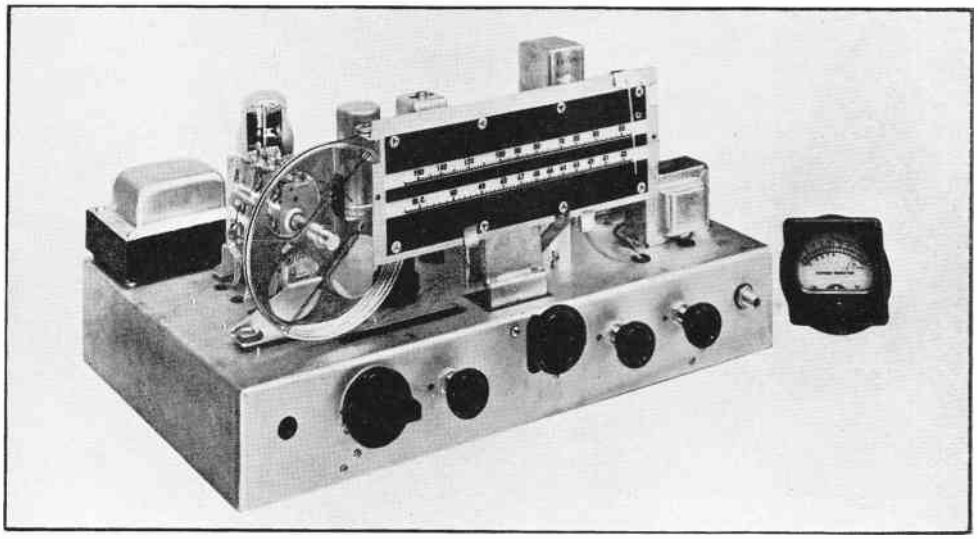
Note ★ All adjustments should be made with the volume control at maximum, and the tone control in the extreme clock-wise position. Connect the output testing meter across the primary of the output transformer. Use dummy antennas of 100 ohms and .1 mfd. Allow the chassis and signal generator to heat up for several minutes before making adjustments. Connect the low side of the generator to the chassis.

AM IF Alignment ★ Tune the signal generator to 455 kc. Connect the signal generator to the 6SK7 IF tube (455 kc.) through .1 mfd. condenser. Set the gang condenser at minimum capacity.

Align T7 for maximum output.

Connect the signal generator to either stator lug on the center section of the gang condenser through a .1 mfd. condenser.

Align T5 and T6 for maximum output. Do not realign T7.



CHASSIS OF THE S-31, WITH THE FRONT PANEL REMOVED. S METER IS AT THE RIGHT

AM RF Alignment ★ Tune the signal generator to 1,400 kc. Connect the signal generator through 100 ohms to A1–Ground A2.

Set the receiver dial at 1,400 kc., and adjust CA, CB, and CC for maximum output.

Set the signal generator and receiver dial at 600 kc., and adjust CD for maximum output.

Repeat the alignment at 1,400 kc. described above.

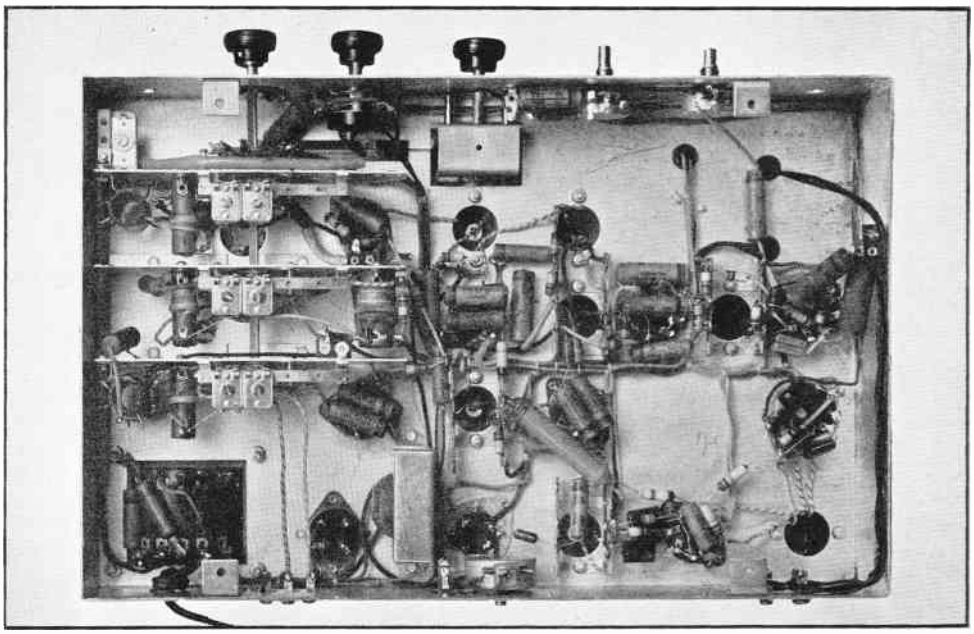
FM Alignment ★ Set the band switch on position 2 (FM), and disconnect the lead from the high side of the volume control.

Disconnect the discriminator plate lead (white with blue tracer) from plate pin 8 of the 6SJ7 limiter.

Connect a 100,000-ohm resistor and a .002 mfd. condenser in series from plate pin 8 of the

(CONCLUDED ON PAGE 46)

UNDER SIDE OF THE S-31 CHASSIS IS MUCH LESS COMPLICATED THAN MIGHT BE EXPECTED



EIMAC TUBES
occupy the key sockets

A pair of Eimac 1000UHF *tubes in the final and an Eimac* 250TH *in the exciter stage.*

First choice in most all the new developments in radio communications, Eimac tubes have been continuously used by the pioneers in Frequency Modulation. This "Link" 3000-UFS 3 Kilowatt FM transmitter, built for the emergency services utilizes a pair of Eimac 1000UHF tubes in the final class "C" stage. The tubes operate at 40 megacycles and work well within their normal ratings. The standard "Link" 250-UFS 250 watt FM transmitter is used as an exciter for the final stage and uses an Eimac 250-TH in its output.

Long recognized for its record of producing high quality transmitting equipment, the Fred M. Link organization has had and continues to have outstanding success with Eimac tubes. Unusual performance capabilities, long life and complete freedom from premature failures caused by gas released internally . . . they're unconditionally guaranteed against such failures . . . has made them first choice among the world's leading radio engineers.

Follow the Leaders to **Eimac TUBES**

Eitel-McCullough, Inc. • San Bruno, California

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Export Agents: Frazar & Co., Ltd., 301 Clay Street, San Francisco

To Those Who Have Friends in the Armed Forces

★ ★ ★ ★ ★ ★ ★

You have at least one friend who is serving in the Armed Forces as a radio officer, technician, instructor or operator. Radio literature, other than the service manuals, is scarce and difficult to obtain.

Those of us who were in the last war remember how completely we were cut off from outside news of engineering progress and developments.

Any radio man you know who is now in the service will be everlastingly grateful to you if you will have FM MAGAZINE sent to him from month to month. So will his friends, for the few radio magazines which reach the camps and schools are shared by many.

For our part, we'd like to share the cost with you. Accordingly, we have established a half-price rate of $1.50 for a year's subscription addressed to any man in the U. S. Army, Navy, or Marine Corps.

The cost to you is small. The value to those you will benefit is great. Your thoughtfulness will be long remembered. — Act on this suggestion TODAY!

★ ★ ★ ★ ★ ★ ★

Half-Price Military Subscriptions

Should be Addressed to:

FM MAGAZINE Readers' Service Department
41 Washington Street, Newton, Mass.

(CONTINUED FROM PAGE 23)

Proper limiting is the answer to all these troubles."

Public Must Be Protected ★ The fact that sets for reception of Frequency Modulation broadcasting are being offered which lack the performance features of the Armstrong FM Circuits brings up a very important point.

Circuit names have always played an important part in the merchandising of radio sets. Going back some twenty years, we had a group of names such as the Reinartz receiver, the Cockaday receiver, the Haynes receiver, and others which were set-builders' variations of the fundamental regenerative circuit, and all possessed the same characteristics. No one offered a crystal receiver under one of these names, for example, because a set using a crystal detector could not give regenerative circuit performance.

Next came Prof. Hazeltine's Neutrodyne, and again all sets, regardless of company names or trade names, possessed neutrodyne characteristics if they were offered as neutrodyne sets.

The same thing was true after Major Armstrong's superheterodyne was put on the market for home entertainment use. No manufacturer, even among those who operated briefly without benefit of the patent license, ever offered as a "superheterodyne" a set that was only a regenerative or t.r.f. receiver.

When Major Armstrong made his next contribution to the radio art, he brought out what he called the "FM receiver," possessing certain identifying circuit and performance characteristics, made known to radio listeners by wide-spread publicity, and licensed manufacturers have been producing and selling such sets over a period of years.

Now comes the question: Is it misleading to call a set an "FM receiver" when it lacks all or part of the characteristics the public has learned to associate with that name?

The precedents which apply in this case are well established, and if the Fair Trade Commission is called upon to make a ruling, it seems certain that the description "FM receiver" or "FM circuit" will be considered a misrepresentation if it is applied to a set which lacks the features associated by common usage with that name. Similarly, it would be misrepresentation to offer as a superheterodyne a t.r.f. model with three tuning condensers controlled by a single knob, or a "15-tube" receiver if only 10 tubes performed useful functions.

On the other hand, any kind of a set capable of bringing Frequency Modulation broadcasting, could be identified by a company name, such as the "Jones Receiver" or by a coined name such as the "Frequadyne," since the public would then accept it, or not, according to the merits of its performance.—M.B.S.

TELEVISION PROGRESS

(CONCLUDED FROM PAGE 32)

The television research, engineering and program staffs total more than 50 people with an unusual complement of talents, from script writer to glass blower, from program director to research engineer.

W3XE's sound and picture transmitters now serve a radius of approximately 25 miles from the transmitting tower 230 ft. high. (Reception has been reported as far as 40 miles in unusual instances.) In the near future, Philco plans to increase this power in order to supply a much greater service area.

Our television experience dates back to the inception of electronic television. Our progress has been steady and its accomplishments numerous, and now with the advent of commercial television, we are ready to take our place as a pioneer and leader in this new industry as we have in many other fields of endeavor.

HALLICRAFTERS MODEL S 31

(CONTINUED FROM PAGE 42)

limiter to grid pin 2 of the 6SR7 audio amplifier.

Connect a .0001 mfd. condenser from grid pin 2 of 6SR7 to the chassis. The 6SJ7 will then operate as an AM detector.

Set the signal generator at 4.3 mc., and connect it through a .1 mfd. condenser to the lug on the small center section stator of the gang condenser.

Adjust T1, T2, and T3 for maximum output, keeping the output of the signal generator as low as possible.

Connect the signal generator through a 100-ohm resistor to A1–Ground A2. Set it at 49 mc., and adjust the receiver dial to the same frequency.

Adjust the three outside trimmers on the gang condenser, starting with the antenna section at the rear of the chassis for maximum output.

NOTE: The oscillator tunes to the low frequency side of the signal.

Set the signal generator and receiver dial to 43 mc.

Adjust the positions of the coil leads for maximum output.

Next, repeat the alignment at 49 mc. as above.

Replace the wire on the volume control, remove the resistor-condenser combination from the limiter, and connect the wires as they were.

Reconnect the signal generator as it was for the IF alignment and tune to 4.3 mc. using a strong output signal.

Adjust S1, the lower screw, on T4, the transformer at the rear corner of the chassis, until a null point is found.

Detune the signal generator 100 kc.

Adjust S2, the lower screw on T4, for maximum output.

Turn the signal generator back through resonance to 100 kc. on the other side of the IF frequency. The output should first drop and then rise to an equal value on both sides of the dip.

If the output is not equal on both sides of resonance, readjust S2.

If the output is still not equal, a slight shift of the null point obtained with S1 may be necessary.

FM RECEPTION REPORT

The following report of FM reception was received from Bates Laboratories, 33 Sunset Drive, White Plains, N. Y.:

It will no doubt interest the readers of *FM* Magazine to learn that W47NV was received here for about two hours on the evening of July 16th, with exceptional strength.

For practically the entire time, the signals were strong enough to operate fully the limiter of a Browning tuner.

In the past ten months, all of the following stations have been heard here more than once: W9XZR, W45D, W1XSM, W1XTG, beside all the locals. W43B and W65H are received daily, though the latter is not too strong most of the time. Another occasional is W2XOY.

Yours very truly,

LLEWELLYN BATES KEIM

EDITOR'S NOTE: Several listeners in the vicinity of Boston have reported W47NV, with ample signal strength to operate the limiter, with signals holding strong and steady over a period of several hours.

Today—FM MAGAZINE is the most interesting and useful of all radio engineering publications. That is the general opinion of the executives, engineers, and technicians in all branches of radio broadcasting and communications, manufacturing, sales, and service. That is why circulation is now up to 6,000 monthly.

THE RADIO ENGINEERING NEWS JOURNAL OF BROADCASTING, COMMUNICATIONS AND TELEVISION

Meets
FCC REQUIREMENTS
for both

FM and AM Police, Fire, Public Utility, and other Emergency Transmitters

1. Scale can be read with precision because of wide spread of the dial calibrations.
2. Designed for use by operators of police, fire and emergency radio transmitters.
3. Checks frequencies within any two or three bands specified at time of purchase. Each band is 50 to 1000 kc. wide, depending upon position in the 1.5 to 60 mc. spectrum.
4. Complete stability of standard crystal oscillator and electron-coupled oscillator
5. Cathode ray indicator for accurate visual check against crystal standard as well as against transmitter.
6. 100-kc. crystal ocsillator provides at least two check-points within each band.
7. Fast operation. Less than one minute required to check transmitter frequency exactly.
8. Light in weight — easy to carry — plugs into any 115-volt AC or DC supply.
9. Each instrument precision-built on order, hand-calibrated to better than .01% for each band.

PRICE, complete, any two bands, **$107.65** — Any three bands, **$134.70**

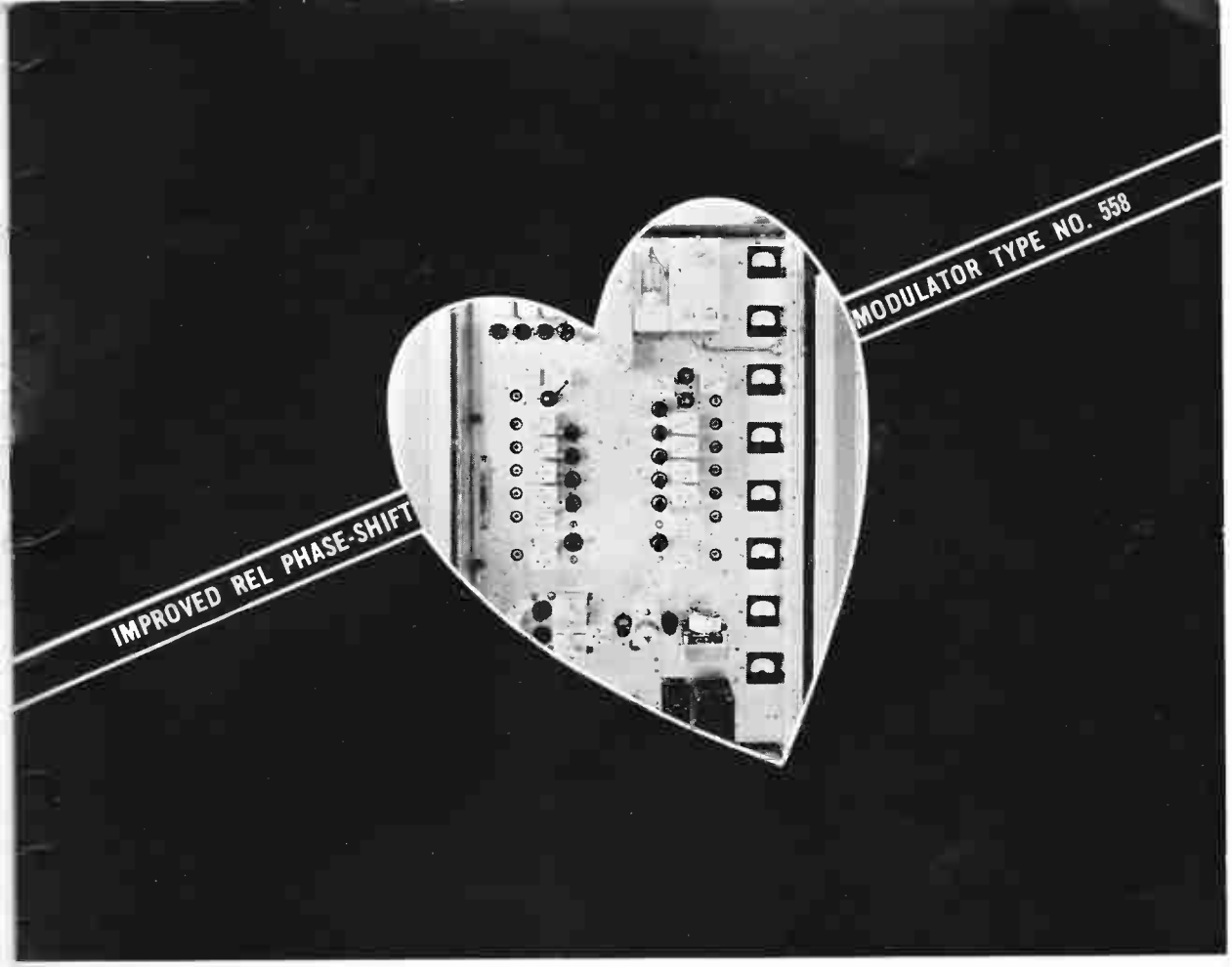
BROWNING FREQUENCY METER

Now Widely Specified as Standard Equipment

Fast Operation: the simplified and improved design of the Browning Frequency Meter saves time in checking emergency transmitters. **Easy Reading:** no need to use a magnifying glass and flashlight to read the clearly calibrated scale. **Accurate:** exceeds the FCC requirements of .01% on each band. **Rugged:** not a delicate instrument, but a sturdy piece of emergency service equipment. **Universal:** the same instrument can be used for checking both FM and AM transmitters. — For additional details, write

BROWNING LABORATORIES, Inc.

755 MAIN STREET **WINCHESTER, MASSACHUSETTS**



Heart of the New DL Transmitter Line

REL is now delivering FM transmitters of five power ratings, from 250 w. to 50 kw. These comprise the new, improved DL line. In design and operating features they excel any FM transmitters ever offered for broadcast or communications service. Built into this equipment are the knowledge and experience gained from having built more FM broadcast transmitters than all other manufacturers combined!

An outstanding contribution to improved performance is the new type 558 Armstrong phase-shift modulator — heart and controlling element of the DL series transmitters.

In frequency stability, signal-to-noise ratio, audio fidelity, and low distortion, it not only exceeds FCC requirements but it establishes new standards for all types of FM transmitters. Following are the specifications in brief:

Frequency Stability — guaranteed to remain within less than 200 cycles of the assigned frequency. **Fidelity** — overall response is within plus or minus 1 db from 30 to 15,000 cycles. **Noise Level** — signal-to-noise ratio is 70 db, measured at the output of a monitor receiver. This is an unweighted measurement with 150 kc. maximum swing and includes hum. **Distortion** — measured r.m.s. harmonic distortion is less than 1% for all frequencies between 50 and 15,000 cycles at 150 kc. swing.

For information on complete FM transmitters for broadcast, communications, emergency, or television sound transmitters, including speech equipment and antennas, address:

REL

RADIO ENGINEERING LABS., Inc.
Long Island City New York

Pacific Coast Sales Offices:

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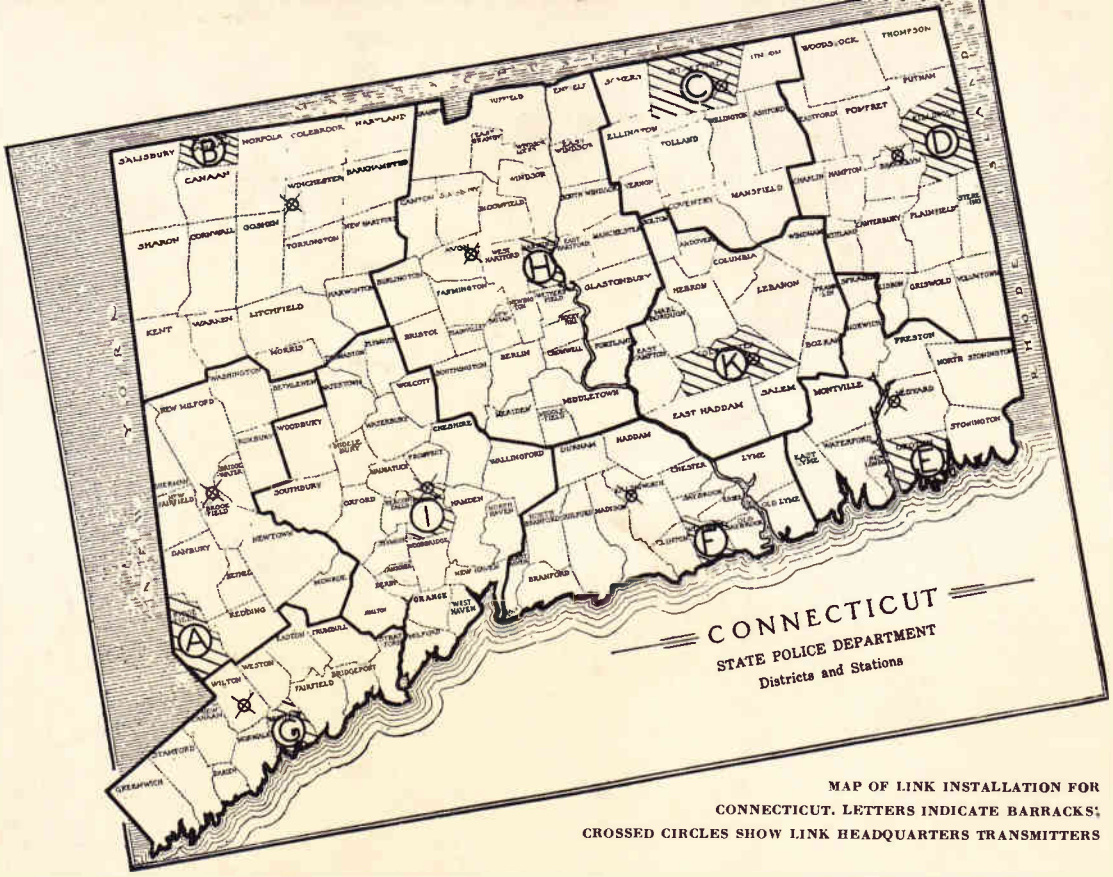
420 Market Street, San Francisco, Calif.



MAP OF LINK INSTALLATION FOR CONNECTICUT. LETTERS INDICATE BARRACKS; CROSSED CIRCLES SHOW LINK HEADQUARTERS TRANSMITTERS

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