FM

OCTOBER 1941

PRICE—TWENTY-FIVE CENTS

ULTRA-FREQUENCY POWER TUBES FOR FM

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

Announcing

NEW GENERAL ELECTRIC Radio Models

FEATURING GENUINE ARMSTRONG SYSTEM **FM**

MODEL LFC-1228 with noise-free FM

Deluxe automatic record changer with permanent-point sapphire stylus. Motor stops at conclusion of last record. Three built-in Beam-a-scopes receive FM, Standard Broadcasts and Foreign Short-wave. Dynamic speaker with acoustical tone chamber. Three-gang condenser. 12 tubes including rectifier. Figured mahogany veneer cabinet in 18th Century styling.

MODEL LF-115 with noise-free FM

Three built-in Beam-a-scopes receive FM, Standard Broadcasts, and Foreign Short-wave. Dynamic speaker. Three-gang condenser. Tuned R.F. stage on all bands. 11 tubes including rectifier. Charming "chest-on-stand" styled cabinet in American walnut veneers.

MODEL LF-116 with noise-free FM

Three built-in Beam-a-scopes receive FM, Standard Broadcasts and Foreign Short-wave. Dynamic speaker with acoustical tone chamber. Three-gang condenser. Tuned RF. on all bands. 11 tubes including rectifier. Beautifully figured American walnut veneer cabinet.

WHAT IS FM?

The 24-page G-E FM PRIMER with sketches and simple language explains how FM works. It's a store-traffic builder, a hard-hitting sales-maker. See your G-E radio distributor for a supply—today.

MODEL LFC-1128 with noise-free FM

Automatic record changer with lightweight tone arm and permanent-point sapphire stylus. Built-in Beam-a-scopes receive FM, Standard Broadcasts, and Foreign Short-wave. Dynamic speaker. Three-gang condenser. 11 tubes including rectifier. 18th Century styled walnut veneer cabinet.

MODEL LFC-1118 with noise-free FM

Automatic record changer with lightweight tone arm and permanent-point sapphire stylus. Built-in Beam-a-scopes receive FM, Standard Broadcasts, and Foreign Short-wave. Dynamic speaker. Three-gang condenser. 11 tubes including rectifier. Console grande cabinet of American walnut veneers.

And the GE **FM TRANSLATOR**

• This General Electric Translator makes it possible for owners of conventional radio receivers to enjoy FM broadcasts at the lowest possible cost. Easy to install! Profitable to sell!

A MESSAGE FROM A. A. BRANDT

Sales Manager, Receiver Sales

If you have FM broadcasting in your area, start selling FM—now. A moderately-priced radio with FM offers your customers something that the most expensive radio without FM cannot give them.

Even if you don't have FM broadcasting now, you can begin to develop the market. Tell your customers that buying a set which receives FM is a protection for his radio investment. Tell them how rapidly FM is spreading.

General Electric has produced a line of FM receivers every year since 1938. This is our fourth line. General Electric is the only manufacturer building FM receivers who operates a complete "proving ground" FM station and builds complete FM broadcasting station equipment.

In addition, G.E. offers you a complete sales promotion and advertising plan to help you sell FM. Ask your G-E radio distributor about it—today. FM is your opportunity.

GENERAL GE ELECTRIC

Motorola

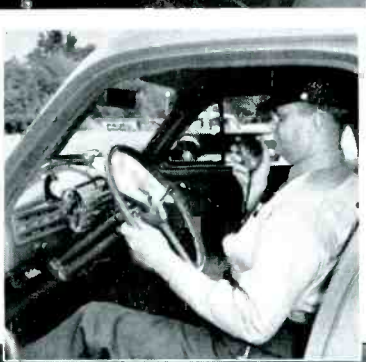
2-WAY F-M RADIO SYSTEM EXPEDITES HANDLING OF ST. LOUIS STREET CAR AND BUS EMERGENCY SITUATIONS

With the aid of Motorola F-M 2-Way Radio Communication System, the Public Service Company of St. Louis is now able to speed up the handling of street car and bus emergency situations... This modern installation of Motorola equipment was made under the direct supervision of Motorola engineers.

In front of central dispatcher is a map showing car and bus routes and the reverse side shows the radio districts into which the system is divided. A mobile supervisor with radio cruises each district. Headway recorders check up on the spacing of street cars. Impulses generated by cars passing over regularly spaced trolley contactors are transmitted by telephone lines to recording instruments. Delays or disruption to service are immediately apparent.

The map shows the dispatcher the radio district in which emergencies arise. 2-way radio contact is established with the supervisor who is instructed to investigate the emergency and report details. Trouble trucks dispatched to the emergency are equipped with 2-way radio.

The Public Service Company of St. Louis has 3 trouble trucks all equipped with Motorola F-M 2-Way Communication Equipment.



The Public Service of St. Louis has 15 cruising supervisor's cars all equipped with Motorola F-M 2-Way Radio Equipment.

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE AND TECHNICAL DATA

GALVIN MFG. CORPORATION ★ CHICAGO, ILL.

MAKERS OF THE FAMOUS MOTOROLA AUTO AND HOME RADIO

FM TUBES

IN order to produce the extraordinarily high degree of vacuum necessary for ultra-frequency power tubes, Eitel-McCullough have developed and perfected a new vacuum pump, shown in action on this month's cover.

The exhausting process employed consists of an extremely long exhaust on high-speed diffusion and oil pumps. The tube is placed in position as shown, with the terminals connected, and the air is pumped out.

During the closing moments, the plate dissipation is run up to ten times the tube rating, so that the elements become far hotter than ever in practice, even during tremendous over-loads, which are bound to occur.

This rough treatment discloses any hidden flaws of workmanship or materials. The control operator makes continual observations on the reaction of the tube at this time.

The small spigots beneath the tube shown are for pumping and checking smaller tubes, several of which can be done at one time. These glass tubes are sealed off during the pumping of the larger tube.

The oven overhead, heated by the gas burner ring below the tube, is lowered during the process of annealing the glass.

FM

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M. B. SLEEPER, *Editor and Publisher*

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The publishers will be pleased to receive articles, particularly those well illustrated with photos and drawings, concerning all phases of FM developments. Manuscripts should be sent to the publication office, at New York City. Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will FM Magazine be responsible for their safe handling in its office or in transit.

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

NEW YORK CITY, THE GREATEST RADIO SET MARKET IN THE WORLD, BRISTLING WITH TOWERS TO CARRY FM BROADCASTING ANTENNAS, DOES NOT HAVE A SINGLE COMMERCIAL STATION OPERATING ON FULL POWER

THE ABSURDITY OF THIS SITUATION IS EMPHASIZED BY THE FACT THAT MORE FM STATION LICENSES HAVE BEEN APPLIED FOR THAN THERE ARE CHANNELS AVAILABLE. MORE C.P.'S. HAVE BEEN ISSUED (11) THAN IN ANY OTHER CITY, TOO, BUT NOTHING HAPPENS

TWO STATIONS MAKE A MARKET

Additional Stations Are Needed in Cities Where Only One FM Transmitter Is Now Operating

BY ARTHUR FREED*

IN CITY after city, the first FM broadcasting station has opened with much fanfare and enthusiasm. Local newspapers have been most generous with space setting forth the glories—and they are real glories—of this thing called Frequency Modulation.

Special, star-studded programs are broadcast by each of the new FM stations when it opens up, and for a few weeks it looks as if Frequency Modulation has been launched in a big way over night.

Then what? After a few weeks have passed, there is nothing more about FM in the papers, the dealers find that A-FM sets won't sell themselves any more than any other quality merchandise does, and listeners settle back to the old programs that wouldn't sound natural without the noise and distortion that they have come to accept as a background for listening.

Of course, that segment of the radio audience called music lovers take their FM programs seriously—so seriously that they write letters of complaint to the stations, particularly to find fault because there is not more first-class live talent, and because FM quality shows up the imperfections in any but the best, high-fidelity recordings.

The single local FM station then replies that they can't afford more good programs until they have some sponsors, and they don't get sponsors because the audience is too small.

There are exceptions to this in some cities, but this is the general picture of the FM situation in cities where there is only one station—the picture as it is seen from the desk of any sales manager who is working to get distribution on A-FM receivers in each new area where an FM station is opened.

Unfortunately, the one-station cities now exceed by far the two-station cities. As a result, the prospects for set sales are limited to those radio fans and music lovers who want the best, and have the means to buy it.

These people are the purchasers of classical recordings, and the radios they are buying now are the expensive A-FM automatic phonograph combinations.

This explains the fact that it is easier for many dealers to sell $250 combinations with FM tuning than to sell $50 AM sets. It also is the reason why dealers in most of the single-station cities say there is no demand for low-priced A-FM sets.

However, FM stations can't put out the kind of programs that FM deserves when their audiences are limited to the top 5% of set purchasers. This is all right so far as my Company is concerned, for we have developed a line of expensive combinations specifically for that market, but the whole industry needs an underlying demand for A-FM sets in the lower brackets.

This market will not develop until additional stations open in the present one-station areas. We can't expect 95% of the radio listeners, now trained to select their programs from a choice of major network stations and one or more local stations to spend real money for A-FM sets which will make available only one additional transmitter, regardless of what that one station may give them.

It is all very interesting to read that the FCC has granted another CP here or there. But what of it? Theoretically, when an applicant is granted a CP, he assumes the obligation of going on the air in the immediate future, and just as quickly as is physically possible.

Actually, this does not appear to be the case. In Hartford, for example, the independent station WDRC has surmounted all the problems of getting its FM outlet W65H into commercial operation, but all the resources of the Travelers Insurance Company have not been adequate to get W53H, the WTIC FM station, past the experimental stage.

It is difficult to answer the radio listener who says that he knows that FM is still only a laboratory experiment, because if it had been perfected, CBS, NBC, and Westinghouse would have been able to get the stations on the air that they announced so many months ago! That certainly makes sense from the point of view of the average set owner.

The one-station cities represent some of the largest markets in the Country. They include Pittsburgh, Baton Rouge, Milwaukee, Boston, Worcester, Detroit, Columbus, Los Angeles, and Nashville.

The greatest source of delay results from the FCC's newspaper-radio investigation, which still shows no prospect of arriving at any con-

*Freed Radio Corp., 39 West 19th Street, New York City.

clusion that will break this log-jam. The unfortunate thing about this delay is that the newspapers have proved to be the most aggressive in getting FM stations on the air after they were granted their CP's, and they have the resources to erect high-power transmitters, to finance good programming, to carry on operation until revenue begins to meet expenses, and to publicize their FM activities.

Strangest of all is the situation in New York City where, at this time of writing, Major Armstrong's station is the only one with power enough to cover its assigned area, WOR's FM station still has only 1 kw. output, NBC's transmitter continues experimentally on low power, and WQXR's station still marks time over a frequency wrangle.

Muzak has a CP, but nothing happens. No information is forthcoming about action from Finch, Loew, or Metropolitan Television. At CBS, FM seems to have been kicked around until it is lost in the shuffle. Frequency Broadcasting didn't get the frequency they wanted, and now they may have lost interest.

In addition to these, at least eight companies have filed applications on which no action has been taken.

The demand in the New York area for the new, high-quality A-FM combinations is so great, despite the limited FM broadcasting service, that the supply of instruments in the bracket above $250 is falling behind retail sales. This is all very impressive, but it will not be healthy until there is a background of quantity sales of sets at $99.50 or somewhat below, indicating interest in FM among average radio listeners.

That will come about in New York and in the one-station areas only when there are two or more FM transmitters on regular commercial operation. Inter-station competition will then build the FM audiences rapidly, and improved programming will result automatically. Dealers will be able to give adequate demonstrations of FM programs to the great mass of "show me" prospects. But even the salesman who wrote the book can't do that when there is only one station to tune in.

No matter how you look at it, one FM station is an interesting novelty, however fine its programs may be. Two or more transmitters are needed to make a market for A-FM sets and a listening audience large enough to attract sponsors who will pay the radio program freight.

PUBLIC PAYS DOUBLE TAX ON RADIO RECEIVING SETS

The general public, and most radio dealers as well, have not been aware that for a number of years back the retail price of every radio set has included a Federal tax paid by the manufacturer.

Specifically, the public has not been aware of the fact that the method used in the radio industry of paying the tax has cost retail purchasers more than twice the amount of the taxes paid to the Government.

Now that the tax has been upped from 5% to 10%, the extra cost to consumers, resulting from the prevailing method of paying the tax is so great that consideration should be given to the current practice by which it is added to retail prices.

To make this clear, let us go through the steps by which the manufacturer's 10% tax is now added to the retail price. As an example, let us figure the retail price of a set for which the manufacturer must get $50. net.

1. MANUFACTURER'S NET $50.00
   Since his selling price to the jobber must include the 10% Federal tax, this makes the
2. NET PRICE TO JOBBER $55.55
   On this selling price, the manufacturer pays
3. 10% FEDERAL TAX $5.55
   This leaves the manufacturer his net (1) of $50.00.
   Now, assuming that the net price to the jobber represents a discount of 50–10% from the list price, since the net jobber price (2) is $55.55, this makes the
4. RETAIL LIST PRICE $123.33
   On the other hand, if there were no tax at all, the (1) manufacturer's net would be the selling price to the jobber and, at 50–10% off the list price, this would give a
5. RETAIL LIST PRICE WITHOUT TAX $111.11
   Accordingly, the present extra cost to the consumer as a result of the imposition of this tax and the method of figuring it into the list price is
6. COST OF TAX TO CONSUMER $12.22
   However, the tax collected by the Federal Government is only (3) $5.55.

Obviously retail purchasers should not pay more than the actual amount of the tax, but in order to conceal the tax, and so avoid discussion of it with purchasers, it has been put into the retail price in the manner set forth above.

The end may have justified the means when

(CONCLUDED ON PAGE 42)

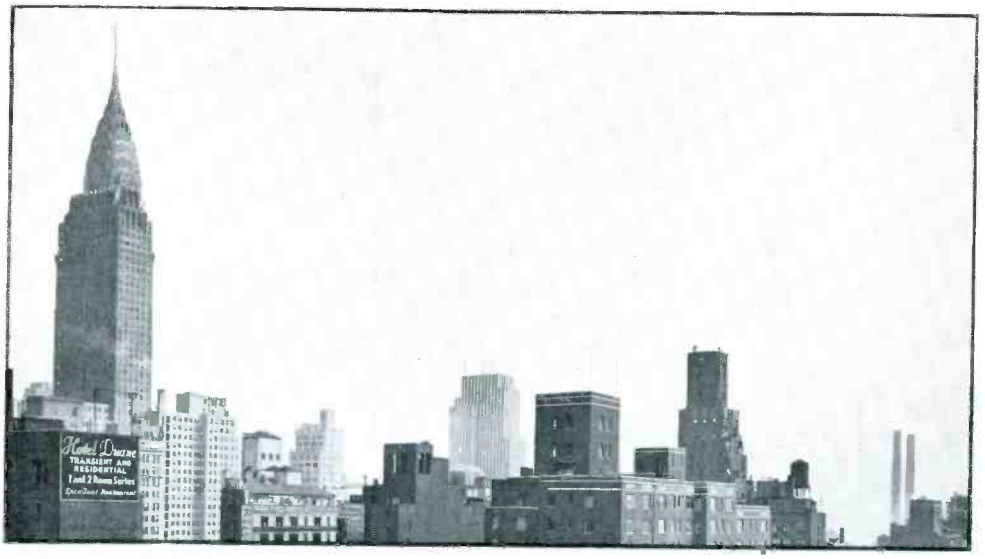


FIG. 1 CENTER, FOREGROUND, ANOTHER A.A.K. APARTMENT SYSTEM, SEEN FROM THE ROOF OF THE JOHN MURRAY HOUSE, IN NEW YORK CITY

Architects Now Specify

A-FM ANTENNA SYSTEMS

New Systems Provide A-FM Reception, and Old Installations Are Being Altered to Meet FM Needs

BY F. A. KLINGENSCHMITT *

MORE than five years ago, when we had developed a wide demand for apartment house antenna systems to replace the dangerous maze of poles and wires that roof-tops had sprouted, Major Armstrong came to us with a new and disturbing idea.

In short, he told us the systems we were installing in New York, and of which we were justifiably proud, would soon become obsolete. The reason, he explained, was that our systems were designed for broadcast and short-wave reception and not for the ultra-high band used by a new method of broadcasting which he described as Frequency Modulation.

At that time, there was no demand for antennas capable of ultra-frequency pick-up, and owners, architects, and builders would not have listened to any discussion of antennas for broadcasting that did not then exist except in a developmental form.

However, our engineers undertook to follow the progress of FM closely, against the time when we would be called upon to supply suitable antenna systems for its reception. In fact experimental work was under way as soon as the first, tentative FM band was set aside by the FCC.

Thus it came about that our work was well along by the time the 42- to 50-mc. band was assigned to FM broadcasting. This was fortunate, indeed, for the first inquiries for antenna systems capable of standard broadcast and short-wave reception plus FM came without warning, and sooner than we expected.

"Our tenants," we were told, "say that they can't get this new FM broadcasting, although their sets work fine on the regular stations and on short waves. What can you do for them?"

This was the start of a large volume of new business from old customers, since it meant new antennas in many cases, and replacement of all the Multicoupler units and antenna matching transformers.

Similarly, the demand for A-FM antennas is being felt in other cities where wide-spread publicity is being given to FM broadcasting.

Typical of the new A-FM installations we

* Amy, Aceves & King, 11 West 42nd Street, New York City.

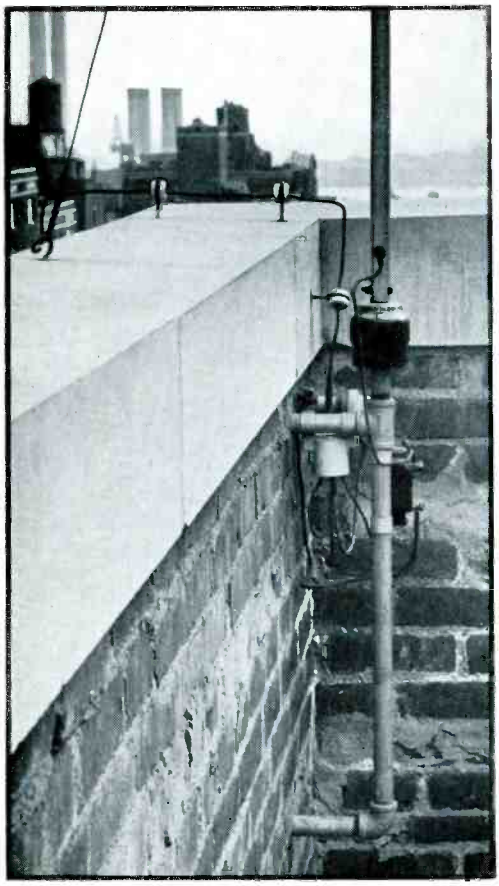
are now making is the system at the John Murray House, a very modern building just completed on Madison Avenue and 38th Street, in New York City. Details are shown in the accompanying illustrations.

Theoretically, Manhattan radio listeners are within the primary service area of the New York stations, so that built-in loops or small lengths of wire should suffice as antennas.

Actually, this is far from the fact. Otherwise, obviously, apartment house owners would not go to the expense of providing antenna systems with individual outlets for each apartment. This is just as true of FM as it is of AM.

Good reception requires, for freedom from interference, an antenna capable of picking up adequate signals. This means that the collector must be above surrounding buildings, and must have a lead to the radio set that will carry the signals without serving as a pick-up for noise.

FIG. 4. DETAILS OF THE MOUNTINGS FOR THE VERTICAL RODS SHOWN IN FIG. 2



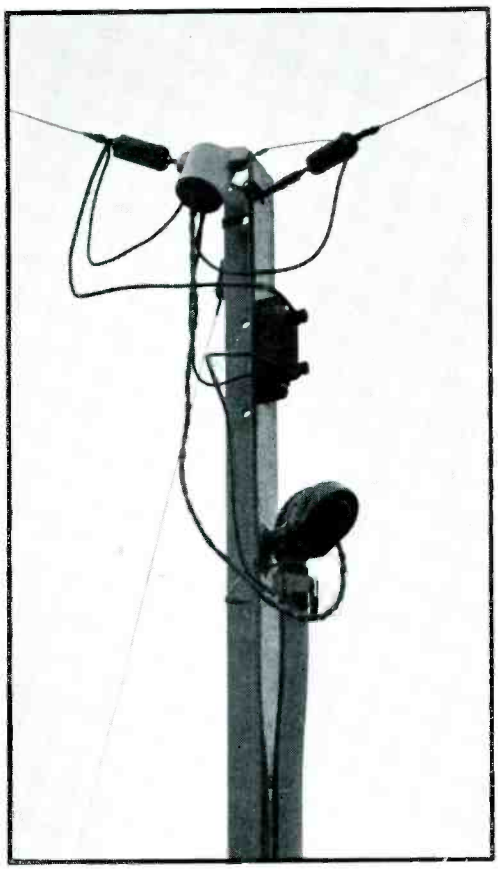


FIG. 5. CLOSE-UP OF ANTENNA DETAILS AT SUPPORTING POST MARKED "D" IN FIG. 3

If tenants are, therefore, to have adequate radio entertainment, the owner of the building must choose between the installation of an antenna system and giving permission to the tenants to run such wires around the roof as they may see fit.

That latter has proved so unsatisfactory, and the former has been found to deliver such high quality reception that, today, the availability of individual radio outlets has become a factor in renting apartments.

At the John Murray House, 11 risers were required to take care of the tenants. A survey of the roof showed that it would be practical to erect 8 horizontal A-FM antennas. These can be seen in the plan drawing, Fig. 3. Each antenna requires a short leg, 15 ft. long, and a second leg either 45 ft. or 75 ft. long.

The two legs are connected to a transformer, as shown in Fig. 5, from which a transmission line runs down through the building in conduit. A lightning arrestor is also provided for each antenna. Running down the building,

the line is connected to a Multicoupler transformer at each floor.

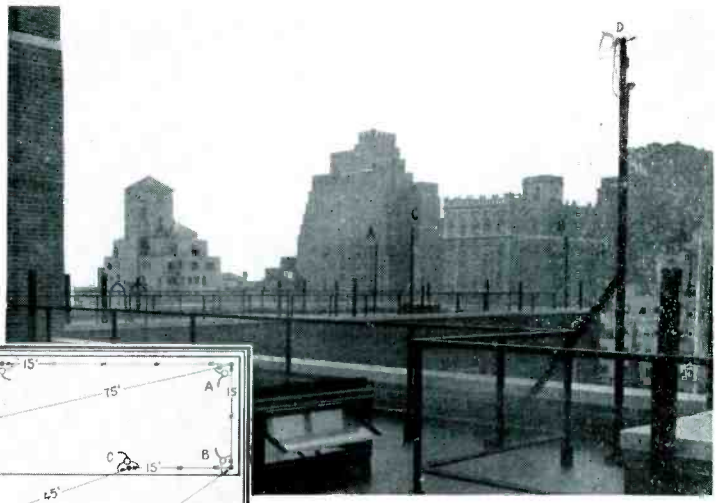
Because of the number of apartments per floor, 3 more risers and corresponding antennas were required. For that reason, 3 vertical antennas were installed on the brick wall which was built around the water tower, as can be seen in Fig. 2. Fig. 4 illustrates the method of anchoring the antenna to the wall, and securing the transformer, lightning arrestor, and the transmission line.

The pickup from the vertical antennas has proved to be about the same as the horizontal wires. That is due, in part, to their greater height, since the wall around the water tank is about 30 ft. above the level of the roof.

Another factor of importance to owners of apartment houses is the protection against lightning afforded by these antenna systems.

For example, the Salmon Tower Building, on West 42nd Street in New York City was struck by lightning repeatedly. We installed an antenna system on this building, and since that time it has never been struck. The cost of the installation has been paid by a charge of $15 for a service connection. Although this is an office building, a number of tenants are associated with radio broadcasting, and they were glad to pay this amount to get satisfactory reception in their offices.

FIG. 2, ABOVE, THE THREE VERTICAL ANTENNAS, ALSO FOR A-FM, ARE MOUNTED ON THE BRICK WALL SURROUNDING THE WATER-TOWER. THESE SERVE THE SAME PURPOSES AS THE HORIZONTAL WIRE ANTENNAS



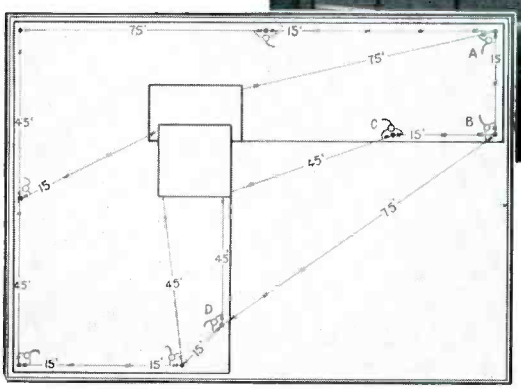


FIG. 3. PLAN OF THE WIRES RUN ABOVE THE ROOF OF THE JOHN MURRAY HOUSE. LETTERS ABOVE ANTENNA SUPPORTS IN PHOTOGRAPH CORRESPOND TO THOSE IN THE DRAWING AT THE LEFT

PORTABLE FREQUENCY MONITORS

Information on the Use of the Link Frequency Monitor

BY F. T. BUDELMAN*

THE 230-B frequency meter and monitor has been designed to fulfill the need for accurately checking the frequencies of transmitters and receivers over specified, limited ranges. Particularly, it is intended to meet the Communications Commission's requirement that police and emergency radio installations must include a satisfactory frequency monitor.

Description ★ This monitor has many features which make it a valuable piece of test equipment, as well as satisfying the fundamental requirement of supplying an accurate frequency check. It can be used for checking frequencies of crystal controlled transmitters, for tuning master-oscillator controlled transmitters to a predetermined frequency, and for checking the actual frequency of operation. It can be used as a variable or fixed-frequency signal generator for testing and aligning receivers and, finally, as a monitoring receiver to check the quality of transmissions.

Two oscillators are provided in the 230-B monitor. One is an aperiodic crystal oscillator, and the other is a stable and accurately calibrated variable oscillator, controlled by a micrometer dial located on the front panel. The crystal oscillator circuit is so designed that no tuning is necessary regardless of the frequency of the crystal used, and wide changes in circuit constants will not affect the frequency of the crystal oscillator. The crystal supplied is ground to a frequency tolerance of .005% of the normal operating frequency. The variable oscillator is designed to normally cover ±2.5% from any of the usual police and emergency frequencies in the 30- to 42-mc. band. It is calibrated accurately and a calibration curve is attached to the inside of the front cover, as shown in the accompanying illustration. Either oscillator can be turned on or off by means of switches located conveniently on the front panel.

To complete the usefulness of the unit, a grid leak detector and audio amplifier are incorporated in the monitor, as well as a power supply for full AC operation. A 30-ft. AC cord and headphones are stored in a compartment at the bottom of the monitor. A short antenna, normally plugged into the top of the monitor, can be removed and clipped into spring holders provided on the inside of the cover. With the front cover in place, the unit can be conveniently carried by means of the leather handle mounted on top of the case.

The physical dimensions of the instrument, with the cover on, are: 16½ ins. high, 8 ins. wide, and 8½ ins. deep.

When the unit is used for aural monitoring of the output of an AM transmitter, both oscillators are turned off. In this condition, the receiver will give good headphone reception even when located a considerable distance from the transmitter.

For checking transmitter frequencies, either oscillator is turned on and the beat note between the received signal and the local oscillator can be heard in the phones. By turning on both oscillators at the same time and tuning the variable oscillator to the crystal frequency, the variable oscillator can be re-calibrated at any time. For this purpose, a vernier adjustment is provided so that the variable oscillator can be set instantly to exact calibration, by referring to the accompanying curve, without worry as to temperature drift, tube ageing, tube replacements, or other considerations. When so adjusted, the monitor is accurate to within .01% for frequencies within 2.5% of the specified operating frequency.

For aligning receivers, either oscillator will emit a carrier wave from the plug-in antenna. The receiver can be brought into tune by means of the variable oscillator and then checked directly against the crystal.

* Chief Engineer, Link Radio Corporation, 125 West 17th Street, New York City.

Thus, this Monitor provides a complete test instrument for servicing and aligning transmitters and receivers, as well as satisfying Federal Communications Commission's requirement for an accurate means of checking transmitter frequencies.

Adjustment ★ The normal operation of the monitor is accomplished as follows: The power cord is plugged into any 110-120 v. 50- to 60-cycle AC source. After allowing a few minutes warm-up time, the main tuning dial is set at 50, a pair of phones and the antenna rod are plugged in, and both the crystal and variable oscillator switches are turned to the ON or up positions. By means of the small knob adjustment to the left of the tuning dial, the beat note, heard in the phones, is adjusted to or near zero beat. This operation puts the variable oscillator in exact calibration at the operating frequency. Other frequencies in the operating range can be read from the calibration curve furnished with the monitor. This curve is furnished for the convenience of the user, and is not expected to be as accurate as the crystal check point.

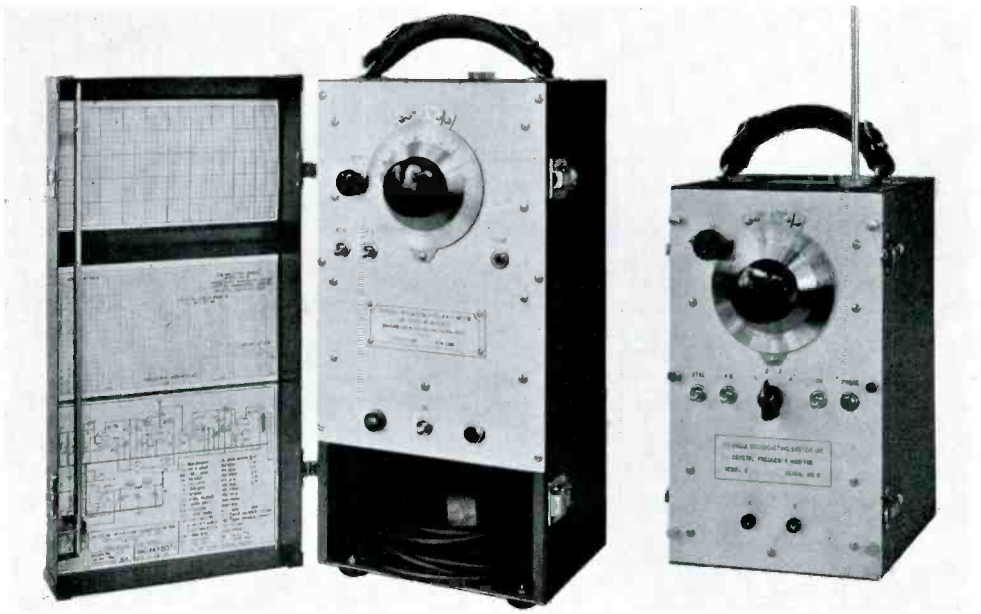
Checking Transmitter ★ To check the frequency of a transmitter, place the monitor close to the transmitter so that a small voltage can be picked up by the monitor antenna. With only the variable oscillator on, tune the monitor to zero beat and read the micrometer dial, after which the correct frequency can be read from the chart.

The micrometer dial furnished with the 230-B has 100 divisions and a micrometer scale for accurately reading to 1/10 division. Since the full scale of the dial represents about 5% of the operating frequency, 1/10 dial division will represent a .005% change in frequency. Thus the monitor can be read to at least twice the guaranteed accuracy of the variable oscillator. It is to be noted that further bandspread, although sometimes desirable, does not necessarily increase the possible accuracy of the frequency reading. For special cases, where greater or less bandspread is required, the monitor can be supplied with any desired frequency coverage.

By proper utilization of crystal oscillator and variable oscillator harmonics, the 230-B monitor can be supplied to measure to the same guaranteed frequency tolerance any frequency between 300 kc. and 300 mc.

A heterodyne frequency meter of this type is equally well suited to measuring the carrier frequency of either an AM or an FM transmitter. In either case it is necessary to make the measurement without modulating the transmitter, in order to get a clean beat note.

Checking FM Modulation ★ The grid leak detector is not suited, of course, for aural monitoring of



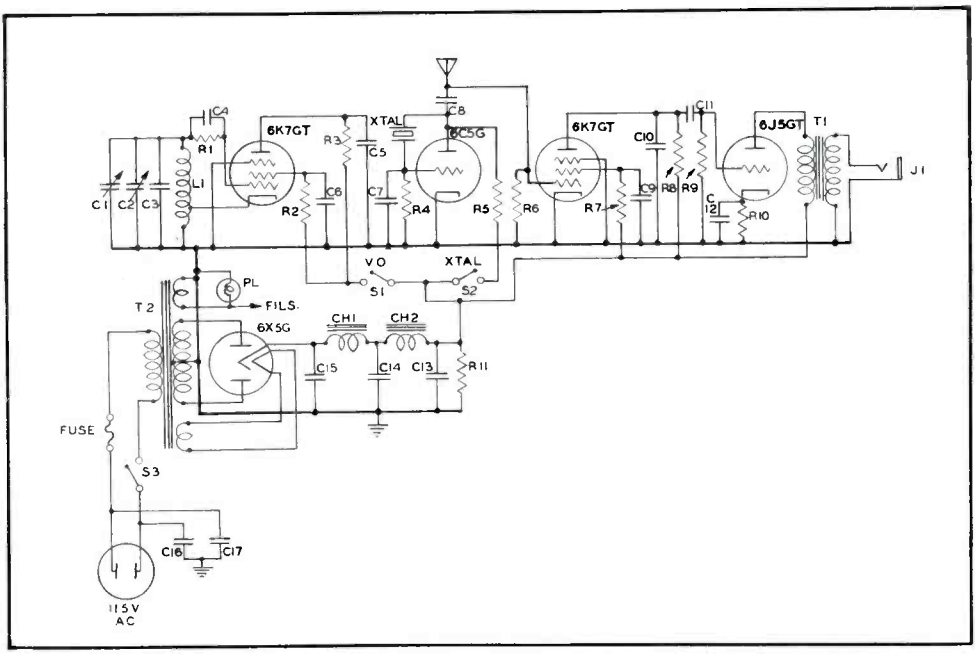
LEFT, MODEL 230-B AC-OPERATED MONITOR, WITH ANTENNA CLIPPED INTO COVER. RIGHT, BATTERY-OPERATED TYPE B, WITH COVER REMOVED

modulation in conjunction with an FM transmitter, but is well adapted to measuring peak frequency deviations by the carrier null method. This method of measuring deviation makes use of the fact that if a certain audio frequency is used to modulate an FM transmitter, the relative magnitude of the carrier and side bands will vary as the amplitude of the modulating frequency is varied. The amplitude of the carrier will reach zero when the peak deviation is 2.40, 5.52, 8.65, etc. times whatever audio frequency is being used to modulate the transmitter.

to the transmitter and gradually increase the audio level. As the level is measured, other heterodyne beats will be heard, but they will be of the order of 6,000 cycles and the ear can easily distinguish the original 500-cycle beat against the carrier.

3. As the audio input is varied a very definite point will be noted where the amplitude of the heterodyne beat against the carrier reaches a null or minimum level. The audio input level at this point will be the value required to cause ±15 kc. deviation.

If the audio input level is increased further,



WIRING DIAGRAM OF THE LINK 230-B PORTABLE FREQUENCY MONITOR

In order to illustrate the technique used to measure deviation in this manner, let us assume a common practical problem. Suppose that it is necessary to determine the audio level required to produce ±15 kc. deviation in a given transmitter. The first carrier null point occurs when the deviation is 2.40 times the modulating frequency. Therefore if we use 15,000 ÷2.40, or 6,250 cycles, as the modulating frequency, the audio input level at the first carrier null point will be the required value. This simple operation is accomplished as follows:

1. Set up the 230-B monitor and adjust the variable oscillator to beat against the transmitter carrier, without modulation. Tune for some easily distinguishable beat note such as 500 cycles.
2. Apply an audio input voltage of 6,250 cycles

other carrier null points can easily be distinguished at 6,250×5.52 or ±34.5 kc., and 6,250×8.65 or ±54 kc. This monitor thus serves the user of FM as well as AM equipment.

Battery Types ★ The 230-B type of monitor, also illustrated here, is frequently supplied for two frequencies, such as for a police system with main-station-to-car on an intermediate frequency and car-to-main-station on an ultra high frequency (30-40 mc.) The monitor is then designated Type 230-B2 and two crystal oscillators are employed.

Another available design is battery-operated with the batteries self-contained in the case. Up to four frequencies, and four crystals, are supplied, making it especially suited to relay broadcast application. The model B functions the same manner as the 230-B and 230-B2.

SKYSCRAPER FM STATION

Discussing Some of the Problems Encountered in Erecting a 50-kw. Station in an Office Building

BY C. H. WESSER *

DETAIL SHOWS FM ANTENNA ABOVE BALL ON PENOBSCOT BUILDING TOWER

W45D, the Frequency Modulation station of The Detroit News, will be on the air with full power, as stipulated in its Construction Permit, and with 124 hours of programs per week, by the time this account appears in print. It is the result of many thousands of hours of operation first as W8XWJ and, since May of this year, as W45D.

The station is located in the Penobscot Building in downtown Detroit, where since 1935 all of The Detroit News' UHF operation has been carried on. This building is in the heart of Detroit and is centrally located in Wayne County, with a dense population surrounding it. The 100-ft. steel tower atop the building was originally only intended to carry a 12-ft. spherical neon beacon but, in addition, it has supported a variety of UHF radiators since 1935.

Because W45D is the first 50-kw. installation made in a typical skyscraper, this article may offer a number of interesting angles from the standpoint of engineers and station owners who find themselves faced with the problems of constructing such a station under similar conditions.

Station Equipment ★ The transmitter, speech input equipment, studio and offices for a complete and independent station staff are located within the same building, on four different floor levels: namely 2nd sub-basement, 45th floor, 46th floor, and penthouse roof. The accompanying floor plans show clearly the physical layout, areas used, and relative locations of floor space. For the reader's convenience, there follows a listing of all major equipment and units, and the floor levels where such equipment is located.

BASEMENT:

4,600-v. primary supply circuit with its associated oil circuit breaker, current and potential transformers, meters, 4,600/440-volt transformers, and air circuit breaker and feeders to the 46th floor.

45TH FLOOR:

REL 3-kw. driver consisting of the modulator unit, power unit and PA unit.

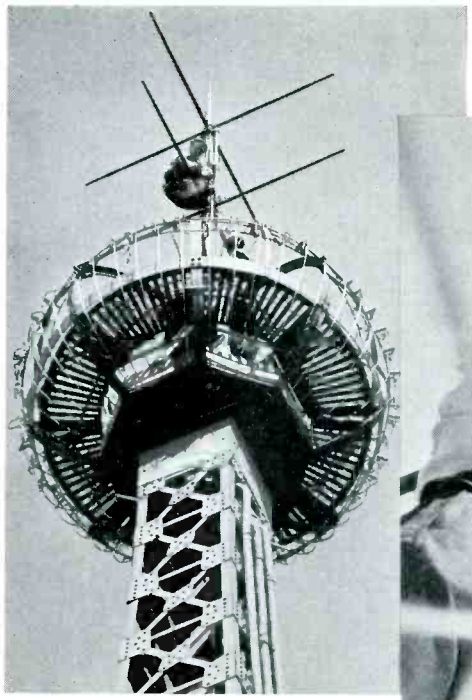
REL 50-kw. amplifier equipment consisting of the power control desk, power control unit, rectifier unit, and 50-kw. amplifier.

All speech input equipment, AF monitoring amplifiers, power supplies, and associated equipment. In addition, the measuring equipment, radio relay receivers, turntables with pre-amplifiers and mixer, test equipment and shop, announce booth with associated control equipment, offices for station staff, and remote equipment storage and locker facilities.

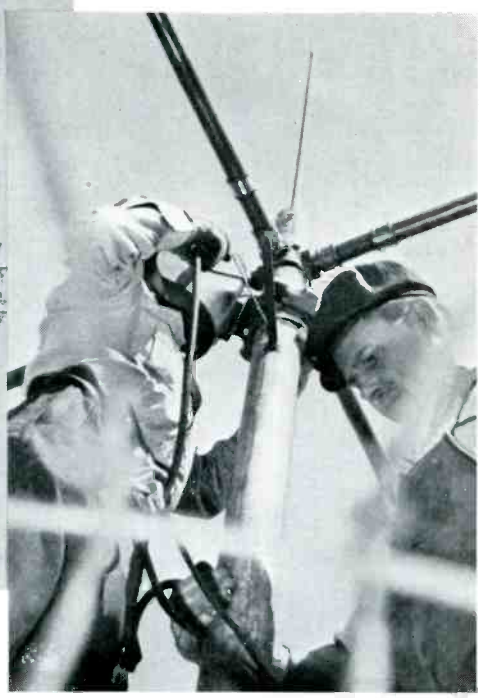
Transformer vault, housing the 440/220-volt supply transformers, plate transformer for 50-kw. stage, voltage regulator for above, plate filter reactor for 50-kw. stage, and emergency supply transformers and switches.

Other equipment on the 46th floor includes the Trane evaporative cooler, sub control cabinet, blower supplying airblast for 50-kw. amplifier, cooling water circulating pumps, filament motor-generator, and gas tanks for transmission line system.

*Chief Engineer, The Detroit News station W45D, Detroit, Mich.



LEFT, W45D USES DE MARS TYPE OF 2-BAY TURNSTILE, 700 FT. ABOVE THE STREET LEVEL



RIGHT, 1-IN. TOBIN BRONZE ROD, 7 FT. LONG, IS EFFECTIVE PROTECTION AGAINST LIGHTNING

PENTHOUSE ROOF:

"Doghouse" which houses phasing and matching section for turnstile radiator.

Power Supply ★ Since the transmitter and its rectifier and power supply equipment are located on the 45th floor of the building, the problem of bringing power to that floor was an important one. Fortunately, an independent 4,600-v. Edison Company feeder, and an unused transformer vault, were available in the basement. After due consideration, it was decided to bring the necessary 225-kva. from the basement to the 46th floor transformer vault at 440 v.

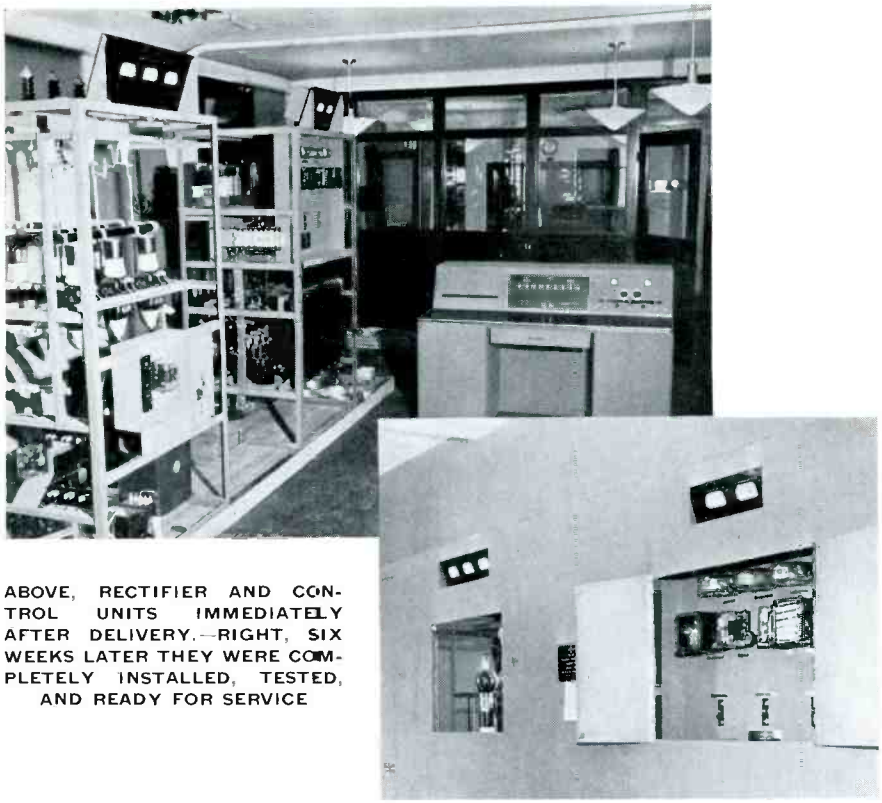
Although all REL equipment requires 220 volts as its supply, the cost of 440/220 transformers on the 46th floor was more than offset by the much lower cost of material and labor of the installation of a 440-v. supply link between basement and top floor, a run of approximately 800 ft.

Most of this run is, of course, vertical, and requires frequent snubbing and anchoring of the three supply wires, which are run in a 3-in. steel conduit, with pull boxes on every other floor. Of all installation cost items, this one was decidedly the greatest, as a sufficient amount of power was brought up to supply not only the 50-kw. transmitter, but also all other power and light needs of the station.

Normally lights and speech equipment are supplied from the building's 110-v. circuit, but emergency switching arrangements permit several methods of operation of the station equipment and lights. For instance, it is possible, by throwing two switches, to operate the 3-kw. driver either from the 225-kva. supply circuit, or from the building's 440-v. supply on the 46th floor. This would permit operation on low power in case of failure of either the 50-kw. amplifier or its primary power supply.

Light loads can be switched from one to the other supply as well, while in the basement transformer vault a second Edison Company supply circuit can be substituted for our regular Edison supply feeders by clamping temporary jumpers from the building's 4,600-v. supply to our primary transformers.

This same switching arrangement made it possible to install the 3-kw. driver, and operate it as a complete transmitter, during the construction of the 50-kw. amplifier. This has been done since the middle of May, when W45D went on the air with 3 kw. When the 3-kw. unit was installed and wired, provision was



ABOVE, RECTIFIER AND CONTROL UNITS IMMEDIATELY AFTER DELIVERY.—RIGHT, SIX WEEKS LATER THEY WERE COMPLETELY INSTALLED, TESTED, AND READY FOR SERVICE

made for control and interlock circuits that later had to be tied in with the 50-kw. equipment, without interruption of the service that the driver performed during 10 hours each day, and allowing FM to be brought to the Detroit area long before the final high power installation was completed.

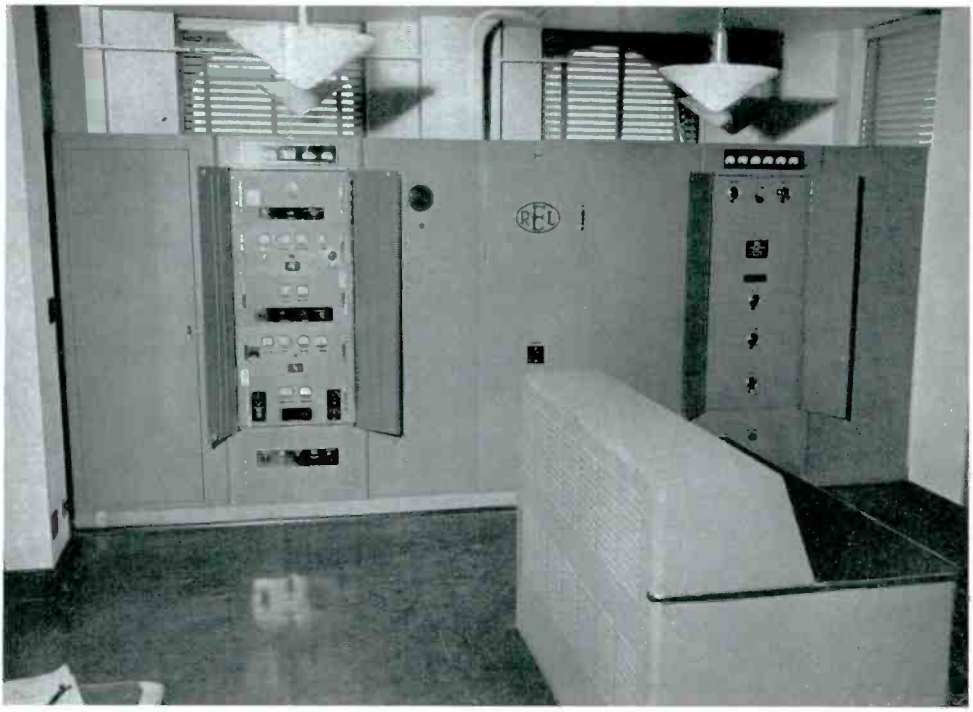
3-kw. Transmitter ★ This unit is a standard REL basic transmitter which becomes the driver for the 50-kw. amplifier when such a unit [1] is used. In our case it was installed on a 4-in. platform that would accommodate all necessary conduits without having to channel into floors, an operation that is frequently not permissible in office buildings. The three units that make up this transmitter are all mounted in line, with alternate blind panels between them, to completely fill the available width of the wing in which they were installed.

The front panels were extended to the ceiling and made airtight, since a fresh air intake and blower exhaust were provided to carry off heat developed by the transmitter. Controls for the exhaust fan were mounted on the front panel of the transmitter and automatic louvres were provided on the outside of the fan panel. A thermometer permits checking the temperature behind the interlocked front of the transmitter.

50-kw. Amplifier ★ The power control desk, with all controls of power circuits for the 3-kw. and the 50-kw. units, is located in the middle of the floor between the 3-kw. driver and the 50-kw. power control unit. The power control unit and the rectifier are lined up along one wall, again with blank panels in between, while the 50-kw. amplifier proper is located in a sound- and heat-insulated room. The front of the amplifier is at right angles to the power control and rectifier panels, separated by an interlocked entrance door into the rectifier and control unit enclosure.

From this enclosure another interlocked door leads into the PA room proper. In one corner of this room is located the filament cabinet which houses two filament transformers and the transfer switch necessary to change from DC to AC for the amplifier filaments. Normally, DC is used on these filaments because it simplifies the problem of reducing carrier noise generated at this point, but AC is provided in case the filament motor-generator set becomes inoperative. Coming into the PA room are power control and interlock circuits,

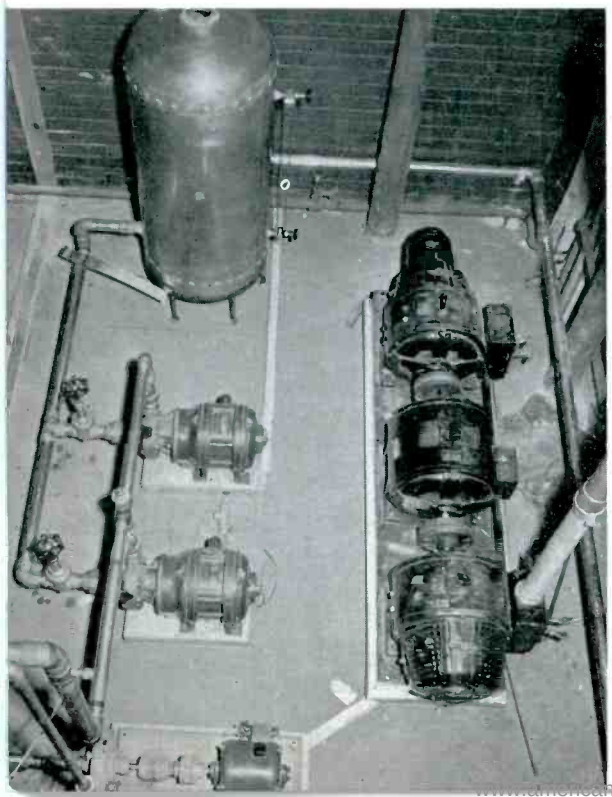
[1] See New REL Equipment, by Frank A. Gunther, *FM* Magazine, June, 1941.



REL MODULATOR, POWER SUPPLY, AND 3-KW. POWER AMPLIFIER

filament supply leads from the motor-generator set on the floor above, 15,000-v. plate supply lead from the rectifier unit, air line from the 46th floor, as well as plate cooling water and air lines, also from the 46th level.

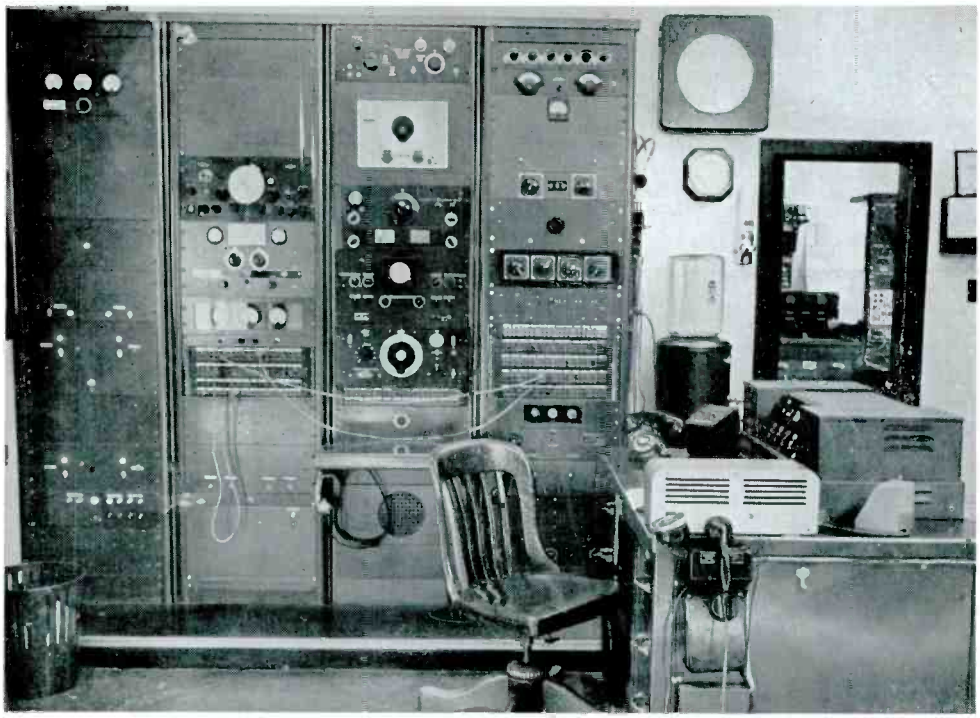
BELOW, WATER PUMPS, TANK, AND M-G SET



Coming into this enclosure are also two 7/8-in. concentric lines from the driver to the grids of the 50-kw. amplifier, while the output of this amplifier is fed to the "doghouse" on the roof through two 3 1/8-in. concentric lines. More about these lines and their installation later.

The PA room was constructed in a wing of the building by erecting an 8-in. cinder block and plaster wall across its open end. A double glass window is provided in front of the amplifier itself which is floodlighted by six 150-w. lamps in an overhead trough. The room itself was very carefully shielded by sheet copper and fine mesh bronze screen on the walls, ceiling, and floor, as well as all windows. All 110-v. light and base outlet circuits in this space were cleared out and sealed over as a protection against the chance of feeding RF back into the building light circuits. The only 110-v. circuit remaining in this room is that supplying the floodlights, and the front of the trough that holds these lights is also carefully shielded by a bronze wire screen.

The final finish of this room consists of 2-in. Thermax on walls and ceiling with battleship linoleum on the floor. This arrangement confines both heat and noise within this enclosure, while excess heat is taken out by a 2-speed ex-



CONTROL ROOM, SHOWING FOUR BAYS AND WESTERN ELECTRIC CONSOLE

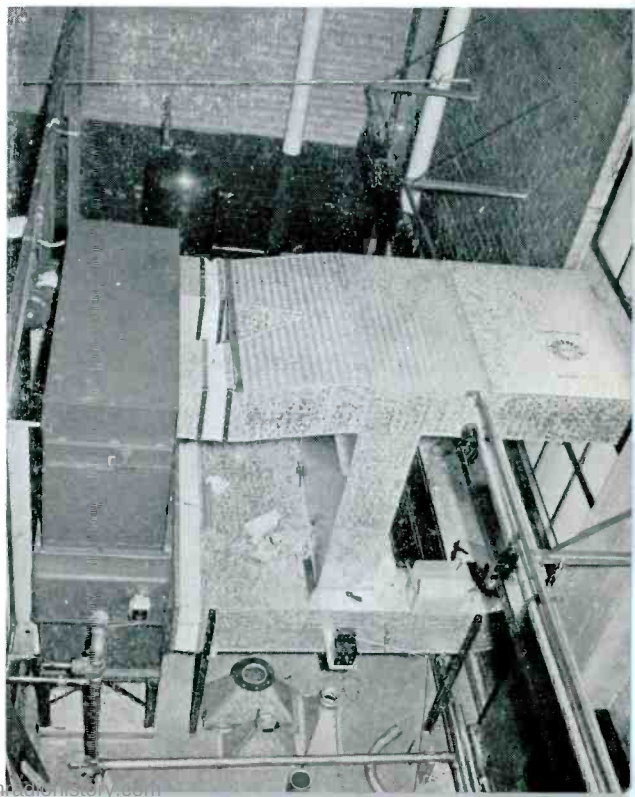
haust fan, mounted in a window, and controlled either thermostatically or manually from the power control desk.

Recently, when the switch from a temporary radiator to the permanent 2-bay turnstile was made, two sections of concentric line were made into jumpers to short around the 50-kw. amplifier from its grid to plate circuit, while at the same time the output of the driver was connected to the two 7/8-in. lines that later were to feed the 50-kw. grids instead of its going into a single 7/8-in. line that formerly fed the 3-kw. output to a temporary radiator.

The entire switch-over required less than 4 hours. The two concentric jumpers were saved and will be kept handy in case the 50-kw. amplifier should ever become inoperative. The time required to install the jumpers is less than 15 minutes, and they are much more satisfactory than any magnetically operated device since such an arrangement must be capable of handling the currents and voltages that occur in the 3-in. lines during 50-kw. operation, and jumpers allow extremely short sections of exposed inner conductors, an item of importance on the ultra highs.

The rectifier and power control units are conventional except for their placement. They are mounted on another 4-in. platform to allow interconnecting conduits to be run without channeling of the floor, and also to distribute the weight of these units over an area large enough to meet maximum floor load requirements of the building. Five 1-in. copper pipes

COOLING SYSTEM ON THE 46TH FLOOR



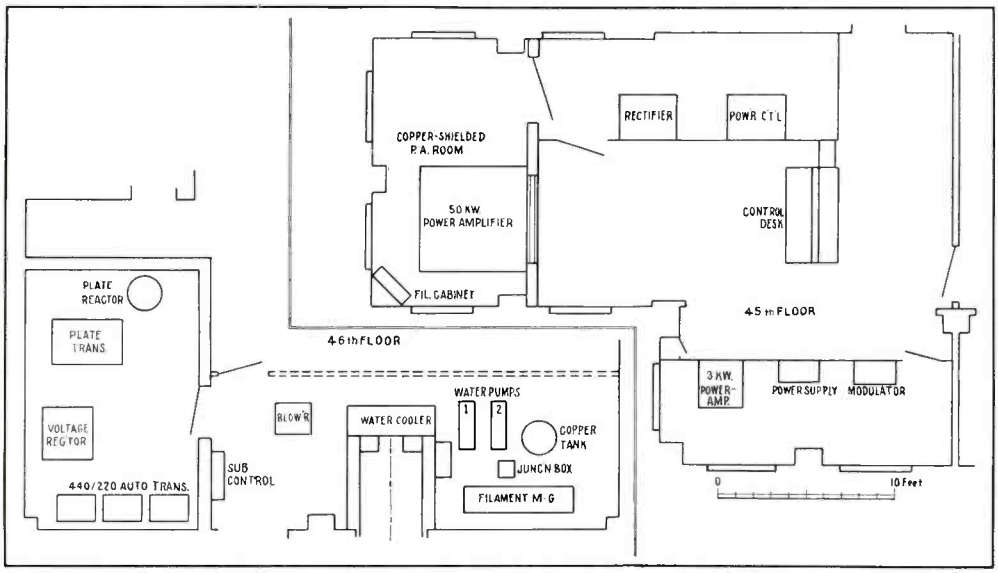
run from the top of the rectifier unit through a hole that was cut in the ceiling, giving access to the transformer vault on the floor above. Again, as in the case of the 3-kw. driver, all panels were extended to the ceiling to improve appearance and to confine noise and heat behind the panels.

Speech Input Equipment ★ The heart of the speech control unit is a Western Electric 23-B console, modified in a number of ways to accommodate our own as well as the FCC frequency response and noise requirements. It controls mike circuits in the studio, announce booth, control room and turn table room. Provisions are made for rehearsing in the studio while any other program may be on the air, or being fed outside, while the announcer has his own mike control switch and fader which allows him to control any program that is on the air, although provision is also made to transfer these controls back to the main control operator by operating a key added to the 23-B console for that purpose.

In the remote bay, directly beside the main control desk, are mounted several line amplifiers, rehearse amplifier, nine specially built equalizers, jack panels, etc. The next bay contains monitor amplifiers and their associated selectors and relays that allow monitoring of program on air, remote rehearsals, studio rehearsals, NBC incoming loop, incoming loops from WWJ, The Detroit News AM station, as well as the output of several radio receivers. The selection of the channel to be monitored is done simply by dialing the proper channel number on small units that were constructed and installed by the staff and which are located in several of the offices and in the announce booth. In the offices, the program appears on Jensen concentric speakers, while in the announce booth the output terminates at a loudspeaker and a single headphone, to allow the announcer to monitor while his own mike is being used.

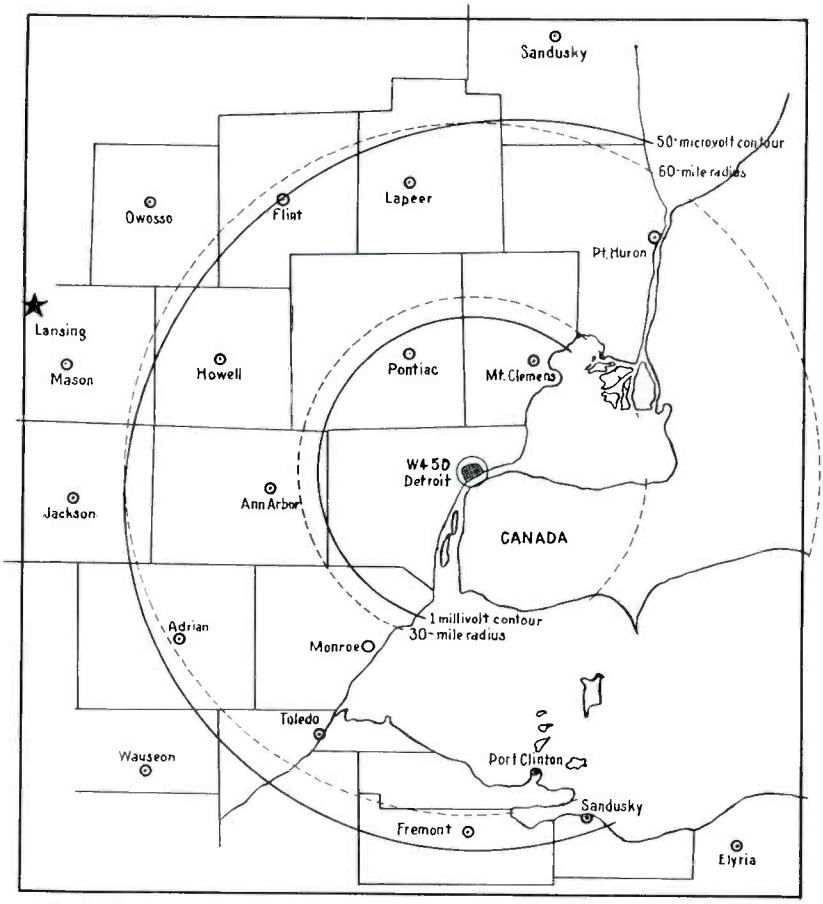
Another bay accommodates necessary measuring equipment, including an HRO receiver which normally stays tuned to WWV for checking a General Radio 620-A frequency meter, and various other meters, oscillators, and scope.

Number 4 bay carries plate supply units for all amplifiers and receivers, with appropriate meters and selector switches so that all measuring and checking of plate supply units can be done at one point, and away from the amplifiers that are supplied by these units. It was found necessary to remove these units from the amplifiers to reduce the noise level well below the FCC requirements. In order to keep this noise level well down and to anticipate, if possible, the failure of high capacity filter and bypass condensers, all these units are of the plug-in type, which not only allows quick replacement in case of failure, but also permits regular periodic checking in a tester developed by our staff for that purpose. Records are kept of the condition of all condensers each time they are checked. All relays involved in speech circuit switching are also of the plug-in type, with spares kept handy in case of failure.



PLANS SHOWING EQUIPMENT INSTALLED ON THE 45TH AND 46TH FLOORS

Turntable Room ★ In the turntable room are two RCA 2-speed turntables, with vertical and lateral heads, the necessary mixer-amplifier, with an announce mike channel which can be used from that point, as well as all record storage and monitor speakers. To facilitate the cueing-up of records, a small self-contained amplifier and power supply is built into each of the turntables. The outputs of these amplifiers terminate on a key in the control unit which allows either output to be put on a headphone.



CALCULATED CONTOURS OF W45D. ACTUAL RANGE IS SUBSTANTIALLY GREATER

Auxiliary Equipment ★ A small bank vault adjacent to the control room was converted into a work shop which also houses a bay of test equipment, a well filtered MG set supplying relay current and talk current for the phone inter-communication system, as well as a simple audio oscillator and one-stage amplifier which furnish a source of AF energy used in a code inter-communication system which links eight widely separated points where communication is often necessary. Small portable units were built with a small loudspeaker, telegraph key, switches and phone jacks, and these units can be plugged in at the various points of communication, permitting either voice or code communication at the flip of a switch. Jack pairs into which these units can be plugged are located in the control room, at the power control desk, in the basement transformer vault, in the doghouse, at the tower top, on the 46th floor and in the Chief Engineer's office.

Remote equipment, at the present, consists of a Collins 12X amplifier-mixer and a composite unit, while two additional units are being built by REL to our specifications. Also on order is a 156-mc. relay transmitter and receiver which will be used as a portable or mobile transmitter in a car or truck. To receive this transmitter at W45D, a rotatable high gain array is planned at that point.

The 46th floor, which houses all building machines such as elevator motors, pumps, etc., provides space at the north end for all standard

(CONTINUED ON PAGE 40)

WHAT THE FM BROADCASTERS HAVE TO SAY:

A Statement Concerning W59NY by John V. L. Hogan, President, Interstate Broadcasting Company, New York City

ALTHOUGH W2XQR was the first FM station directly affiliated with a broadcaster in New York City, its coverage has been somewhat limited, and we have not yet been able to extend our program service to the 8,500 square miles officially set up as the New York area.

A little of the time-table of the past may help to explain this situation and to interpret our FM plans for the future. W2XR, the predecessor of WQXR, was licensed to me personally as an experimental high fidelity broadcasting station on June 20, 1934. It was probably the first high fidelity broadcast station in the world, and its experimental operations demonstrated that there was a substantial audience for good music realistically reproduced. On May 21, 1936, W2XR was transferred to Interstate Broadcasting Co., Inc., which I had incorporated to develop the public service and business sides of the venture, and in January, 1937, the station became a full fledged commercial broadcaster with call letters WQXR. The power was initially 1 kw.; it was increased to 5 kw. on November 1, 1940, and now WQXR has a construction permit for 10 kw. power day and night.

When Major Armstrong's famous FM station W2XMN needed high fidelity programs, music from the WQXR studios was piped to him over a special wide-band line which he installed for the purpose. Meanwhile, on January 7, 1939, I applied for an experimental FM license, and the C.P. was granted October 3, 1939, with call letters W2XQR. Our 1 kw. REL transmitter was installed at once and equipment and program tests began November 8, 1939. The license was granted and regular operation commenced on December 11, 1939. Thus, I believe that W2XQR was the first New York City FM station to begin regular programming. Several hours of the WQXR programs, usually from 5 to 10 p.m., have been transmitted on FM daily ever since that time. W2XQR was probably the first FM station to broadcast a full symphonic program when it, along with WQXR, on November 27, 1939, transmitted the NBC Symphony Orchestra playing from the stage of Madison Square Garden.

From these earliest days, and particularly because of the favorable attitude shown toward FM by the FCC after the 1940 hearings, we have been anxious to extend the coverage and programming of W2XQR. Its service area is now severely limited by its power of 1 kw. and antenna height of only 150 ft. A suitable site at a New York City office building, over 600 ft. high, was finally obtained and an application for a commercial construction permit was filed by Interstate on April 18, 1941, proposing the deletion of W2XQR as licensed to myself, and the transfer of its equipment to Interstate so as to maintain continuity of operation. As a result of the Commission's reëxamination of the New York FM allocation problem, it granted Interstate's application,

(CONCLUDED ON PAGE 42)

LFC-1228, 10-TUBE, 3-BAND A-FM AUTOMATIC COMBINATION. RIGHT, HARRY DEINES WITH FLASHING NOISE MAKER WHICH DEMONSTRATES STATIC-FREE FM RECEPTION

"LISTEN—IT'S FM"

Accelerating Demand for A-FM Sets Should Build Radio Sales Volume and Show Highest Unit of Sales Since 1929

BY A. A. BRANDT *

THERE is always something new in radio because it's a business having a tremendous vitality, a business in which science and engineering are constantly pressing on the heels of manufacturing, a business in which the public feels the impact of new development within a few short months—not years later.

FM is here—now—for a third of the people in the United States and is coming along fast for the rest. Dealers who have FM broadcasting in their areas now have nothing to wait for—if they haven't gone into action they are late already. A moderately priced receiver with frequency modulation offers a customer something that the most expensive receiver, without FM, can never offer. FM will help a dealer increase his unit sale because it has something extra that a customer will buy if he has the opportunity. FM is coming to dealers at a time when spending money is more plentiful than radio sets. In the face of a possible merchandise shortage, dealers who learn to sell FM now will find it far easier to maintain their dollar volume than will those who do not. And even if a dealer does not have FM in his territory now, he can, with the right kind of selling, begin to develop his market.

Whenever a prospect expresses a desire for a top quality console or combination, he should be told the advantages of FM. He should be told how rapidly the FM system of broadcasting is spreading and that a set designed and built to high-quality FM standards means finer reception of all programs. He should be told that buying a set which receives FM is a protection for his radio investment.

The growth of frequency modulation radio has to be rapid because it renders a real service to the public. It removes the limitations in radio which have been present since its inception—static, noise, distortion, fading, unnatural tone.

The General Electric Company has produced a line of FM home receivers every year since 1938. We are in the business to stay

H. L. ANDREWS

DR. W. R. G. BAKER

G. E. executives taking part in introduction of FM line to jobbers

*Sales Manager, Radio and Television Department, General Electric Company, Bridgeport, Conn.

and every year we have improved performance and lowered prices. We built the first group of receivers used by Major Armstrong and in Schenectady we operate a complete "proving ground" FM station, the doors of which are open to every one interested in FM broadcasting. We build complete broadcasting equipment. I mention these facts to indicate that we do not regard FM as a short-term, flash-in-the-pan business, but one that deserves as thorough, ambitious and inspired a sales and promotion program from here on out as this industry can muster—a program that will serve to deserve the fine development and engineering that has preceded it.

A. A. BRANDT
Sales manager, radio receivers

A substantial part of the advertising and sales promotion of the 1942 line of General Electric radios is designed to do an educational job on the advantages of frequency modulation radio. National magazine, coöperative newspaper, and standard broadcast radio advertising are planned, and a variety of promotional items for frequency modulation have been prepared. The entire program is keyed to a pace for continuous and steady promotion of FM.

The first national magazine space is scheduled for late October and early November, with full-page, two-color advertisements in Life, Saturday Evening Post, and Esquire. The copy will present the advantages of FM, and the fact that in areas where FM broadcasting is not now available it probably will be soon. Two types of advertisements are prepared for coöperative newspaper advertising. One, designed for markets where FM is already on the air, will go all out for FM. For general use, there will be other newspaper ads in which FM is mentioned but not featured.

P. A. TILLEY
Assistant manager, radio and television

Because radio advertising will be used on standard broadcast stations in areas where FM service is available, transcribed programs have been prepared. An effort was made to choose talent and material worthy of a live-talent network show. The result was a series of five-minute programs entitled "Swing to FM," featuring Hazel Scott, an outstanding pianist who has her own subtle way of swinging the classics, and the Golden Gate Quartet, story-song and rhythm artists who rose to national fame, with an assist from Mrs. Eleanor Roosevelt, at the gala inaugural concert in Washington's Constitution Hall.

A new twist in commercials are their story-songs, which tell what the advantages of FM mean to such popular characters as Casey Jones, Noah, and the Man on the Flying Trapeze.

LEFT, LFC-1118 IS 10-TUBE, 3-BAND A-FM AUTOMATIC COMBINATION. RIGHT, LF-116 CONSOLE, 10-TUBE, 3-BAND A-FM SET WITH ACOUSTICAL TONE CHAMBER

Missionary work for FM, carried on for several years by GE field demonstrations, will be greatly expanded through a color and sound motion picture and a complete FM demonstration kit which includes both miniature FM and AM transmitters.

"Listen--It's FM," is a 20-minute color sound movie that gives a clear explanation of the advantages of FM over AM in simple, animated drawings. This will be shown to both dealer and consumer groups as an educational movie.

HARRY DEINES
Radio sale's promotion, advertising

The miniature-station demonstrator will also be used at both distributors' and dealers' salesmen meetings and at consumer gatherings. It is a compact, portable unit, making it possible to give a convincing demonstration of the static-eliminating and high-fidelity qualities of FM wherever current is available. The miniature FM and AM stations broadcast the same program continuously. High-fidelity recordings and several static-makers are used in the demonstration.

To do a similar job for dealers, FM static-maker display has been prepared. This consists of a large background which illustrates graphically the advantages of FM and is equipped with switches to demonstrate FM reception in conjunction with an FM receiver. One switch is for changing from AM to FM programs. The other switch turns on a vibrator to set up interference. When the vibrator is turned on, a window in the background is illuminated to show flashes of lightning.

There is a great consumer story in frequency modulation, one that should be told to luncheon clubs, chambers of commerce, music clubs, schools and fraternal organizations — wherever people congregate. Such organizations are made up of the substantial citizens of the community, the ones with purchasing power and influence. They should not be approached in hit-or-miss fashion but in an organized manner. Reasonable effort put into educating the FM market now will pay off tenfold. This type of creative selling is not theory alone. It has been used successfully many times.

W. ANGUS
In charge, receiver design

There is a real thrill to selling A-FM receivers because it is so easy to show prospective purchasers the value to them, in their homes, of the additional entertainment and the improved quality of reception provided by FM broadcasting.

Radio without FM is incomplete. The leaders in FM production, promotion and sales are going to be the leaders in radio when the smoke clears away. It is time to start now.

LEFT, LOWEST IN PRICE IS LF-115, WITH 10 TUBES, 3 BANDS, FOR A-FM. RIGHT, LFC-1228 IS MOST EXPENSIVE 10-TUBE, 3-BAND A-FM AUTOMATIC COMBINATION

FM SPOT NEWS

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

1,000: Estimated daily production of A-FM receivers by Armstrong licensees. Still this is not enough, for manufacturers are unable to increase deliveries in step with mounting public demand.

FM Orchestra: Formed by Chicago Tribune's W59C, will provide live-talent programs of fine music. Director and first violin is Jan Tomasow, with Hazel Simms pianist, Richard Beidel cellist, Edmund Weingart second violin, and Preston Sellers at the Hammond organ.

St. Louis: Dealers are cold to announcement that CBS has been granted a CP for an FM transmitter to be erected on the Mart Building, for operation on 45.9 mc. Station will cover 13,000 square miles, 1,800,000 population if and when. Local opinion is that CBS is collecting FM CP's in competition with Major Bowes' police cards.

Tom Stewart: Terry, son of W47NV's program director, has a new sister, Mary Ritch Stewart.

Schenectady: New GE tube plant, being erected on the westerly side of the main works, will have 120,000 sq. ft. on one floor, with a 2-story office section of 15,000 sq. ft. Manufacturing operations are due to start in February, according to Dr. W. R. G. Baker.

FREED MODEL 70 IS A 21-TUBE A-FM AUTOMATIC PHONO WITH 3 BANDS, 2 SPEAKERS, AND AN OUTPUT OF 18 W.

Chicago: New and larger quarters will house all production facilities and offices of Consolidated Wire and Associated Corporations at 1635 S. Clinton Street. Purpose of the change, says J. G. Mann, treasurer, is to coördinate production facilities and speed up shipments.

Milwaukee: Photo received just too late for publication in this issue of *FM* shows the W55M antenna and transmitter house practically complete, even to fall planting around the entrance. This station will have a much greater service area than the present 1-kw. station now located in downtown Milwaukee.

E. K. Andrews: Head of music division, J. L. Hudson & Company, Detroit, is the man pictured with Lloyd Spencer on page 14 of *FM* Magazine, September issue.

DuMont: Now furnishes the type 208 oscillograph with control scales finished in luminous paint, so that they can be read in the dark. Scales are luminous for several minutes after exposure to ordinary light, and can be seen in the darkness for about an hour.

Pittsburgh: Pennsylvania's first commercial FM station is W47P, affiliate of Walker-Downing's WWSW. With 3 kw. covering an area of 8,400 square miles, W47P will soon have a larger audience than WWSW!

Co-axial Speakers: U. S. Patent Office has allowed claims filed on co-axial speaker design by Benjamn Olney, Director of Research for Stromberg-Carlson. Technical data on the co-axial speaker was disclosed by Olney in *FM* Magazine, April, 1941.

Sprague: New line of Koolohm resistors with ferrule-type terminals for fuse-clip mounting are designed to meet Navy specification No. RE13A372J. Extended range of ratings and resistance values, either inductive or non-inductive, are listed in new Type F catalog. Address: Sprague Specialties, North Adams, Mass.

New York City: Amplifier Company of America has tripled its production space at 17 W. 20th Street. Increased output will be on industrial and defense items.

Nancy Grey: Of WTMJ and W55M is doing a smart job by going out after interviews with transcription equipment, and thus taking important personalities to the studio on wax. Program is called "Personality Parade."

(CONTINUED ON PAGE 44)

NEWS PICTURE

"Most FM-Conscious Area in America" is slogan of Chicago dealers at meeting sponsored by W59C and WGN. Said Frank Schreiber, station operations manager: "We shall use strong continuous promotion to keep before the public the outstanding FM entertainment available over W59C." Below: Also attending dealer rally were Commander McDonald, president of Zenith Radio, E. G. Hermann, Zenith sales manager, and A. H. R. Barker of Chicago Tribune.

DAVID GRIMES

ONE OF RADIO'S BEST-KNOWN OLD-TIMERS, HE IS STILL REMEMBERED FOR THE THRILLS AND HEADACHES OF THE GRIMES INVERSE DUPLEX WHICH PERFORMED MARVELS FOR THOSE WHO MASTERED IT. AS PHILCO'S CHIEF ENGINEER, HE IS SCORNFUL OF THOSE WHO THINK THAT PREVAILING CONDITIONS MAY PREVENT THE RAPID EXPANSION OF FM AND TELEVISION

THE MANUFACTURERS SAY:

A Statement by David Grimes, Chief Engineer, Philco Corporation, Philadelphia, Pa.

ALL the evidence coming to hand indicates that interest in FM is increasing at a rapid rate. Today it is greater than ever before.

More people are buying FM receivers, more FM broadcasters are going on the air to reach this audience, and advertisers are beginning to sponsor commercial FM programs.

It is a significant fact, in our judgment, that this increased interest has coincided with the introduction of the first low-priced FM-AM receiving sets last June. Because some low-priced receivers are on the market and others probably will be introduced, it is now possible for large numbers of people to enjoy this improved kind of radio reception, along with standard broadcasts, for the first time.

Thousands of people therefore have a direct, instead of an academic interest, in FM and FM programs, because they can now enjoy them in their own homes.

Philco's decision to pioneer in making and selling low-priced FM-AM receivers is sound from an economic point of view, and it is sound from the point of view of the best interests of the radio art. The history of American business contains countless instances of how a new product has been brought into general use by making it available at low cost. The development of AM radio is a case in point. It was less than a dozen years ago that some of the leading engineers in the industry were firmly of the opinion that a satisfactory superheterodyne receiver could not be made to sell for less than $150. If they had not been prevailed upon to change their minds, the public generally would never have enjoyed the advantages of this radio circuit. Similarly, if the automobile industry had contented itself with manufacturing $3,000 automobiles, use of the motor car would have been limited to a small number of well-to-do families; there never would have been anything like the 30,000,000 registered motor vehicles we have in service today.

Tests have clearly demonstrated that FM reception has definite advantages within its range as compared with standard broadcasting. The most pronounced of these is in the relative freedom from static and interfering noises. A musical program is therefore more enjoyable if it is heard on FM. It seems not only unwise but unfair to limit this improved reception of musical programs to those who are able to pay several hundred dollars for a receiver. Many of the most talented music lovers are not, and probably never will be, in a position to enjoy FM at such a price.

From the point of view of the broadcasters, the growth of the automobile industry holds another interesting parallel for FM. When the first motor cars appeared, there were only rough, bumpy roads for them to travel over. Only after hundreds of thousands of automobiles came into use did the cities, counties, and states begin the construction of our modern system of roads and highways, with the result that the area in which the motor car may be used is today practically co-extensive with our geographical boundaries.

The same process—broadening the area of service—is already under way in FM. As thousands of families equip themselves to receive FM broadcasts, there will be a greater incentive to initiate FM programs, transmitting power of present FM stations will be increased, new stations will go on the air, and withal a far greater variety and diversity of program material will become available. This series of developments, in turn, promises to cause more people to purchase receivers, thereby further increasing the listening audience.

Philco is extremely optimistic about FM and the improved service it renders. When television standards were under discussion, Philco strongly urged and voted in favor of the use of FM on the sound channel — a recommendation which has since been adopted. It continues to be our view, however, that FM will become an important factor in radio only when large numbers of people own FM receiving sets—and this means low prices. General recognition of the economic factors involved will do more to accelerate popular appreciation of FM than any other development.

SELECTIVE RADIO CALLING

Selective Signalling Systems Using FM Are Important Field for New Developments and Applications of Radio Communications

ONE of the most important fields of application for radio signalling, and so far the least developed, is the remote control of mechanical devices. An endless variety of operations can be performed by such equipment, but radio waves can be entrusted with such responsibilities only to the extent that freedom from static interference is assured.

For that reason, there has been only a limited use of radio-mechanical systems under AM control. Now, however, with the FM system of transmission available, remote radio control becomes entirely practical.

The RCA selective calling equipment is a most interesting example of a radio-mechanical system, for it is suited to many commercial applications, to emergency signalling systems, and to calling and warning systems for the defense of our larger cities.

Through the courtesy of the RCA Manufacturing Company, Inc., details of their selective calling equipment are presented here. This apparatus, it should be noted, is applicable to either AM or FM transmission, since the output of the transmitter coding circuits is connected in place of a microphone, and the decoding circuits are operated by the audio output of any receiver.

Transmitter Coding Equipment ★ This coding apparatus produces a code signal for reception by the mobile decoding receiver, the coded output varying from 0 to 10 milliwatts. It is designed to connect into a 600-ohm transmission line between a microphone amplifier and its associated transmitter. Neither the amplifier nor the transmitter is furnished with this equipment.

The station transmitter coding equipment consists of a group of four associated component units, Fig. 1, designed for mounting on a standard relay or cabinet rack for compactness and easy interconnection. The principle functions and construction of these units are:

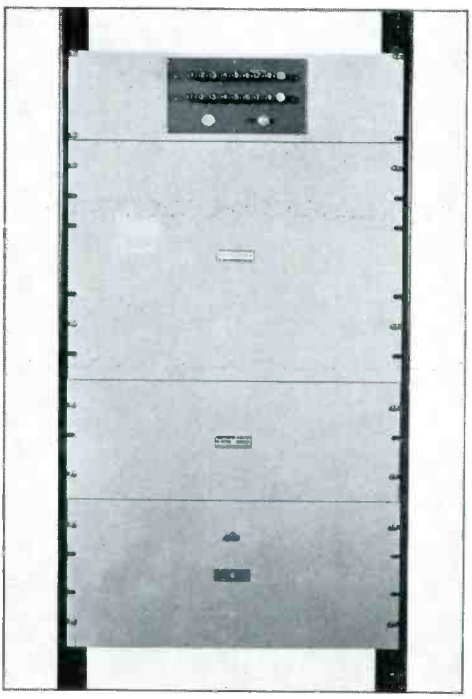
1. CODING DISTRIBUTOR UNIT: This unit, Fig. 2, automatically sends and repeats the calls as set up on the control unit buttons. It also serves to limit the number of calls transmitted as described subsequently.

The unit consists of two code distributors, Nos. 1 and 2, and a switching unit. The code distributors send two separate calls, each distributor sending one call. An associated timer is set to repeat these calls from one to six times before automatically shutting down.

Each code distributor is equipped with a low-speed synchronous motor A1 which drives a commutator type rotary switch S2. This switch momentarily connects a ground potential in sequence to segments 22, 23, 24, 1, 2, etc., up to and including 17, while rotating in a counter-clockwise direction. The ground circuit is opened when the switch rotates in a clockwise direction. A micro-switch S1 is provided with a screw adjustment which permits variation of the START position of the contact arm on the rotary switch S2. A motor-start relay E1 is provided for stopping the rotation of motor A1 when the contact arm of switch S2 reaches the START position. A motor-reversing relay E2 is provided for reversing the direction of rotation of the motor.

The switching unit coördinates the operation of the two code distributors. It contains a relay E3 which alternately starts and stops the operation of

FIG. 1. TRANSMITTER CODING EQUIPMENT



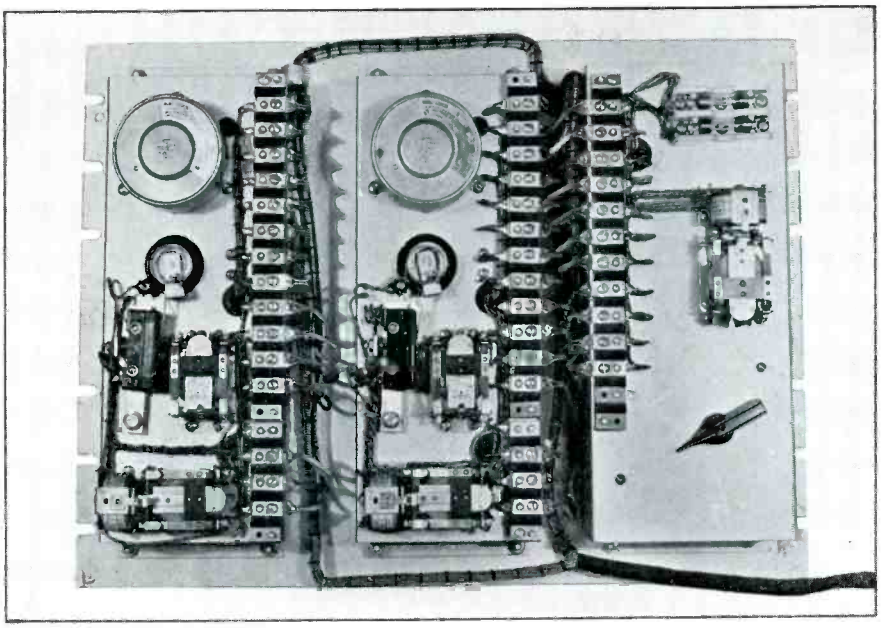


FIG. 2. THE CODING DISTRIBUTOR UNIT IS ACTUATED BY THE PUSH BUTTONS SHOWN IN FIG. 1, AT THE TOP OF THE RELAY RACK

the two code distributors. The unit also includes a timer which determines the number of calls that are transmitted. The timer, which is driven by motor A2, is arranged to open the circuit of the motor-start relay E1 of code distributor No. 1. This circuit is held open for the duration of its present time cycle. A knob provided on the timer is used for pre-setting this time cycle to govern the number of calls to be transmitted. Turning the knob clockwise increases the number of calls while turning it counter-clockwise decreases the number of calls.

2. TONE GENERATOR UNIT: This unit, Fig. 4, supplies a tone signal to the transmitter input line. It is controlled by the code distributors 1 and the control unit 3.

The unit consists of a stable oscillator and amplifier using a 6F8-G tube V1, a volume control R1 with an output transformer T1, and a line-matching transformer T2. It also includes a filter Z1 for removing the harmonic content from the oscillator-amplifier output. This filter also removes from the voice channel a narrow band of frequencies centered at 1,000 cycles.

3. CONTROL UNIT: This unit serves as the control point for the coding equipment. The call numbers of the field units desired are set up on this unit.

The unit consists of two rows of lock-in type switches operated by push-buttons which are numbered from 1 to 8 inclusive. This arrangement permits setting up the equipment for two calls, one on each row of switches, these calls being alternately transmitted by the code distributors described above. A reset button is provided on each row of switches. The unit also provides a push-button type switch S9 which operates the clutch on the timer, thus starting operation of the code distributors.

4. REGULATED POWER UNIT: This unit, Fig. 5, operates from a 110-v. AC power supply and furnishes 150 volts DC to both code distributors, to the switching unit, and to the tone generator. It also furnishes 6.3 v. AC for the heater of the 6F8-G tube V1 of the tone generator unit. The 90-v. tap on the power unit is not used with this equipment.

The complete circuit arrangement of the power unit is schematically shown in Fig. 3.

Before attempting to analyze the operation of the regulating circuits as a whole, it is necessary that the action of the 874 voltage regulator tube, V2, be understood thoroughly. The 874 tube is a two-element tube of the gaseous type which operates as a voltage regulator due to the fact that its internal resistance varies inversely with the applied voltage. This is an automatic function with the result that the tube drop is maintained approximately constant regardless of variations in line voltage or load current. In operation, the tube drop is 90 volts, although a breakdown potential of 125 volts is required for starting.

Operation of the power unit without the 874

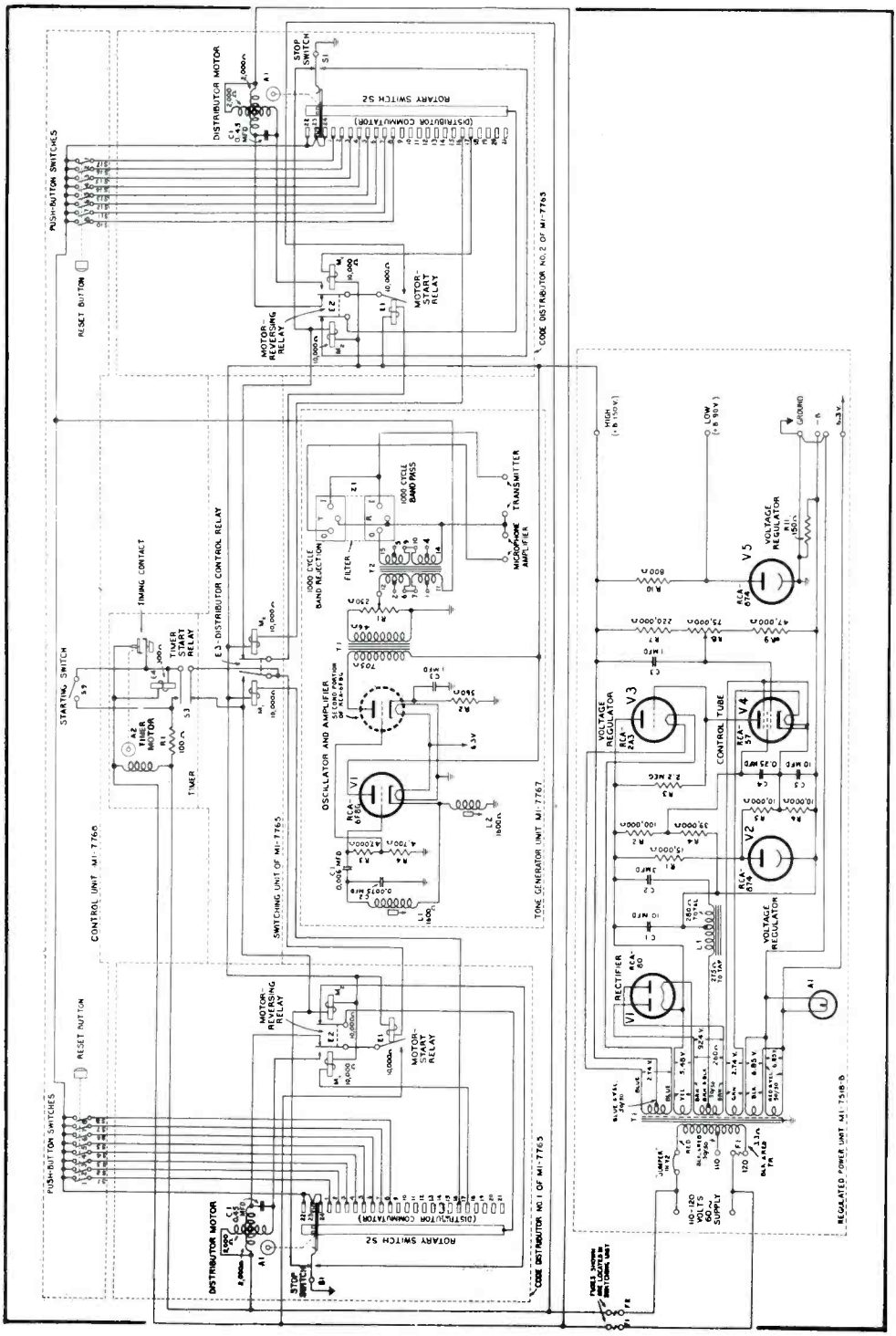


FIG. 3. TRANSMITTER CODING CIRCUIT. DOTTED LINES INDICATE SEPARATE UNITS

regulator tube in place is prevented by means of an electrical interlock at the tube socket. This is a protective feature, to avoid dangerous overloads which would otherwise occur through the removal of the load of the regulator tube.

The rectifier and filter circuit of this power unit operates in the usual manner, with full-wave rectifier tube V1 and a tapped choke L1.

Referring to Fig. 3, the voltage-regulating feature consists of an arrangement of four tubes V2, V3, V4, V5 which function as interdependent stages of the system. The general purpose of each of these tubes is as follows:

The first 874, V2, is a voltage-regulator tube maintaining a fairly constant voltage across resistors R5 and R6. This voltage is known as the reference voltage and a portion of it comprises the grid voltage of the RCA-57 tube V4.

The 57, V4, is a control tube for changing the grid voltage of the 2A3 tube, V3, in accordance with voltage variations.

The 2A3, V3, is a voltage-regulating tube which functions as a series resistor in the output line. The resistance presented by this tube is governed by the value of the applied grid voltage.

The second 874, V5, is a voltage-regulator tube that is used only when the 90-volt tap is employed.

The functioning of the circuit may best be explained by considering its action when a variation in line voltage or load occurs. This is illustrated by the following example:

Assume that the voltage at a particular instant is reduced across the −B and +B taps shown in Fig. 3, either because of high load current or low AC line voltage. This would cause a reduced voltage from ground to the arm of the voltage-adjusting potentiometer R8, the arm being connected to the grid of tube V4. Inasmuch as tube V2 maintains a constant voltage across resistors R5 and R6, which voltage is normally higher than that from the potentiometer arm to ground, reduction of this voltage will cause an increased negative voltage to be applied between the cathode and grid of tube V4.

Increasing the negative potential on the grid of tube V4 reduces its plate current and consequently the voltage drop across resistor R3. This causes the grid of tube V3 to become less negative and its resistance less. This reduces the voltage drop across tube V3 and results in an increased voltage at the output, thereby compensating for the reduction caused by high load current or low line voltage.

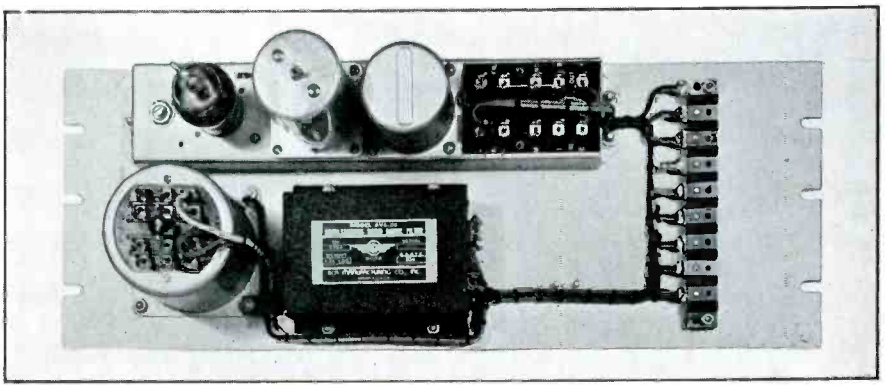


FIG. 4. TONE GENERATOR UNIT SUPPLIES AUDIO FREQUENCY MODULATION

As this action occurs very rapidly, the effect is a constant voltage output at all times. While only a portion of the DC output is applied to the grid of tube V4, the full ripple voltage is applied through capacitor C3. The regulating action of the circuit also functions on this ripple voltage to cause a further hum reduction beyond that of the filter circuits in the power unit shown in Fig. 3. This results in a DC output almost entirely free from ripple voltage.

CIRCUIT OPERATION: Referring to Fig. 3, let it be assumed that the power is on, and that the power unit is energized. With the power on, the timer motor A2 is in operation. Also, all the relays of the equipment are in their normal positions except the motor-start relays E1 of both code distributors which, as shown, are in their respective operating positions. With the power unit energized, the heater of the tube V1 of the tone generator unit is on. This places the tone generator in condition for operation.

Let it be further assumed that the timer is set to allow operation for a given number of calls and that the call numbers of the field units are, for example, "36" and "15."

The numbers "36" and "15" are set up on

the push buttons on the top and bottom rows respectively, thereby closing certain of the code circuits. The button of the starting switch S9 is then momentarily depressed to operate the timer start relay E4. Operation of this relay closes an auxiliary circuit across switch S9 which serves to keep the starting circuit closed when the button is released. Simultaneously, this relay opens the circuit of the motor-start relay E1 of code distributor No. 1, thereby closing the circuit which starts motor A1 of that distributor.

As motor A1 starts, it drives the distributor brush in a counter-clockwise direction. As the brush starts moving, the switch S1 moves and closes a circuit which applies ground to the brush. An impulse of 1,000-cycle tone is transmitted as the brush passes over segments 23 and 24, one impulse for each of these segments. Other similar impulses are transmitted in sequence as the brush passes over segments 3 and 6. As the brush passes over segment 16, the magnet L1 of the distributor-control relay E3 operates and opens the circuit of relay E1 of code distributor No. 2. This releases the latter relay which closes the circuit for its associated distributor motor A1, thereby causing the motor to start and operate code distributor No. 2.

During operation of code distributor No. 1, the associated brush, upon reaching segment 18, closes the circuit for magnet L1 of the motor-reversing relay E2 of distributor No. 1. As a result, magnet L1 is operated and opens the ground circuit of the distributor brush. At the same time, magnet L1 switches the contacts of the circuit controlling the motor A1 of distributor No. 1 and reverses its direction of rotation. The motor then rotates until it reaches the start position where it operates the micro- or stop-switch S1. This, in turn, closes the circuits which operate relay E1 and magnet L1 of relay E2, both of distributor No. 1. This causes relay E1 to open the circit of motor A1, thereby causing the motor and its associated distributor No. 1 to stop, while relay E2 transfers the contacts to reverse the direction of rotation of the motor. The latter is done in anticipation of the next future operation of the equipment. Relay E1 of distributor No. 1 is released when the brush of distributor No. 2 closes a circuit upon contacting segment 16.

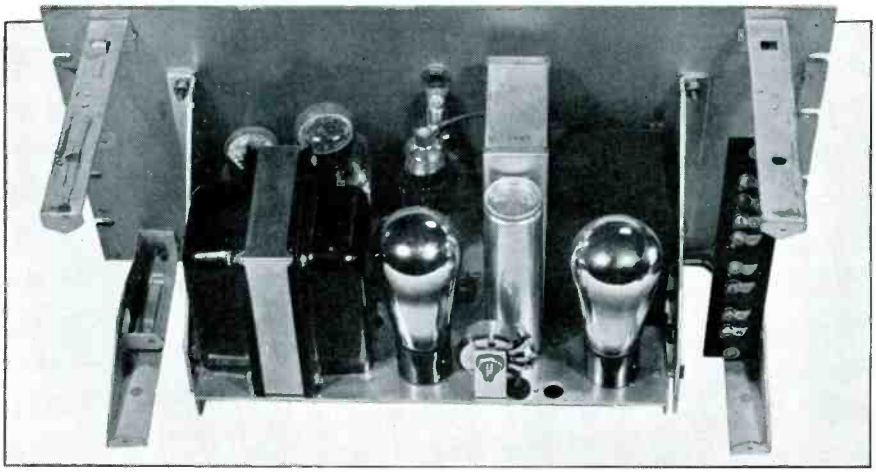


FIG. 5. REGULATED POWER UNIT SUPPLIES VOLTAGES FOR THE OTHER UNITS

During operation of distributor No. 2, a tone impulse signal is transmitted as the brush traverses segments 23, 24, 1 and 5. Otherwise its operation is the same as the of distributor No. 1. The calls are repeated as each distributor trips off the other until the timer-start relay E4 is released by its pre-set adjustment when the given number of calls are completed. Upon completion of the final call by distributor No. 2, the brush arm of distributor No. 1 trips its stop switch S1, thereby closing the circuit to relay E1 and causing the relay to remain in its operating position. The system then remains at standby until the start button is operated again.

Mobile Receiver Decoding Unit ★ This unit, Fig. 7, is designed to respond to an individual coded signal and to a general or group-call signal as broadcast by the above station transmitter coding equipment. It causes an alarm to operate when the proper coded signal is received.

Referring to Fig. 6, it will be observed that

the unit operates from the output stage of a radio receiver. For this purpose, a receiver which supplies a required input signal ranging from 20 to 150 volts should be employed. The decoder requires an external DC power supply providing 6.3 v. and 1.7 amps. and 235 v. at 0.015 amps, for the selecting operation. In standby condition, it requires a DC power supply of 6.3 v. at 0.7 amp. and 235 v. at 0.003 amp.

The decoder unit consists of the following principal elements: An input amplifier using a 6SJ7 tube V1, a 1,000-cycle filter including a 6SC7 tube V2, a limiter amplifier which comprises the second half of tube V1, a voltage-regular circuit utilizing a 991 tube V3, an RCA-OA4G relay tube V4, and a 115-cycle non-synchronous vibrator E9, two single-impulse relays E1, E2, two alarm cancellation relays, E3, E4, a battery-control relay E5, a signal "lock-in" relay E6, an alarm relay E7, a motor-drive circuit including a 60-cycle constant-frequency vibrator E8, a transformer T1, and a synchronous motor A1 for driving a rotary switch S1.

Operative Adjustment: Being designed to respond to two separate calls, the unit embodies two code selectors, Nos. 1 and 2, both of which are located under the top cover. Each code selector consists of a pair of code buses and a series of eight selector strips. These strips are pre-set with screws to make selective contact with the buses as required to effect the desired code.

To set up a code, one screw must be placed in each selector strip to make firm contact with one or the other of the code buses as indicated in Fig. 6. This diagram shows the code selectors as set up for two calls. The upper selector, in the diagram, is set up for call "36" and the lower one for "15," the screws being so located in the top bus as to correspond with each digit of the call number and in the lower bus for each remaining code selector. The view shown in the schematic diagram of Fig. 6 indicates the relative appearance of the code selectors in the unit when facing the vibrators E8, 9.

Circuit Operation: A high-level audio signal consisting of one or any combination of voice, noise or tone is received at input terminal 1 and amplified by the input tube V1. However, since this tube is saturated by a signal of only a few volts, it further acts as a voltage limiter, thereby protecting the feedback filter which includes tube V2 and preventing overloading of tube V2. This filter, having the tube V2 combined with a resistor-capacitor type of band eliminator network used in a negative feed-back circuit, is arranged so that the overall effect is an amplifier permitting the passage of a narrow band of frequencies centered at 1,000 cycles.

The output of this filter circuit is fed into the limiter amplifier which is the second triode in tube V1. This triode is biased to the saturation point by the voltage drop across the bleeder resistor R14. Due to the saturation of this triode, low-level signals are not passed on to the control anode of the relay tube V4. However, the 1,000-cycle tone signals are permitted to pass by the filter amplifier at such a level as to overcome this bias, thereby passing a signal on to energize the relay tube V4. The bias voltages of tubes V1 and V4 are stabilized by the voltage regulator tube V3.

The 0A4G relay tube V4 is a thyratron or gaseous tube depending upon ionization of the gas to cause conduction of the plate current through the tube. This tube requires approximately 85 volts positive bias on the control anode to cause the gas to ionize. A permanent DC voltage of + 62 volts is supplied to this anode. The 1,000-cycle signal superimposes an AC voltage on this DC voltage to cause the tube V4 to conduct. Current flowing through this tube energizes the two signal-impulse relays E1, E2.

When the relay E2 is energized, the ground is removed from its back contact, thereby releasing the battery-control relay E5 which is normally energized. Releasing of relay E5 causes a circuit to close applying 6.3 volts to the coils of the relays E3, E4, thereby preparing them for immediate subsequent operation. At the same time, this voltage is also applied to the motor-drive circuit causing the motor A1 to rotate and to the vibrator E9 which then starts vibrating.

Due to its thyratron characteristic, the tube V4 continues to pass current (after the initial firing) until the plate voltage is removed. The vibrator E9 is arranged to connect momentarily the plate voltage of the relay tube V4 to ground through capacitor C11 and resistor R20 at each closure of the contacts. This causes the relay tube to deionize until the next cycle of the 1,000-cycle signal impulse is received. The relays E1, E2 remain in their operating positions, receiving impulses at the rate of vibration of vibrator E9. The capacitor C10 acts as a filter to prevent the relays from chattering during these impulses. Thus the signal-impulse relays E1, E2 are energized only when a tone signal of 1,000 cycles is received.

As the motor A1 rotates, it operates the switch S1. In its operation, the switch S1 removes the shorting contact between "D" and "12" of Section 3, thus preventing the normally-energized battery-control relay E5 from operating again until this circuit is closed at the completion of the revolution of switch S1. As this switch rotates from left to right, the contact arms of Sections 1 and 2 move together and pass in sequence over the contacts "1" to

"8" inclusive. This successively connects the selector strips of the code selectors to the coils of the alarm-cancellation relays E3, E4, these relays being respectively associated with code selectors Nos. 1 and 2.

Should the circuits close through the contact arms of switch S1, through the code selectors and through the contacts of the signal-impulse alarm relay "locked in" through a closed contact of the external momentary-contact switch.

SELECTIVE CALLING: Let it be assumed that the code selector No. 1 on a particular decoder unit is set up for call "36." Let it be further assumed that the push-buttons at the transmitter are set up only for call "36" on the top row, that the start button has been depressed

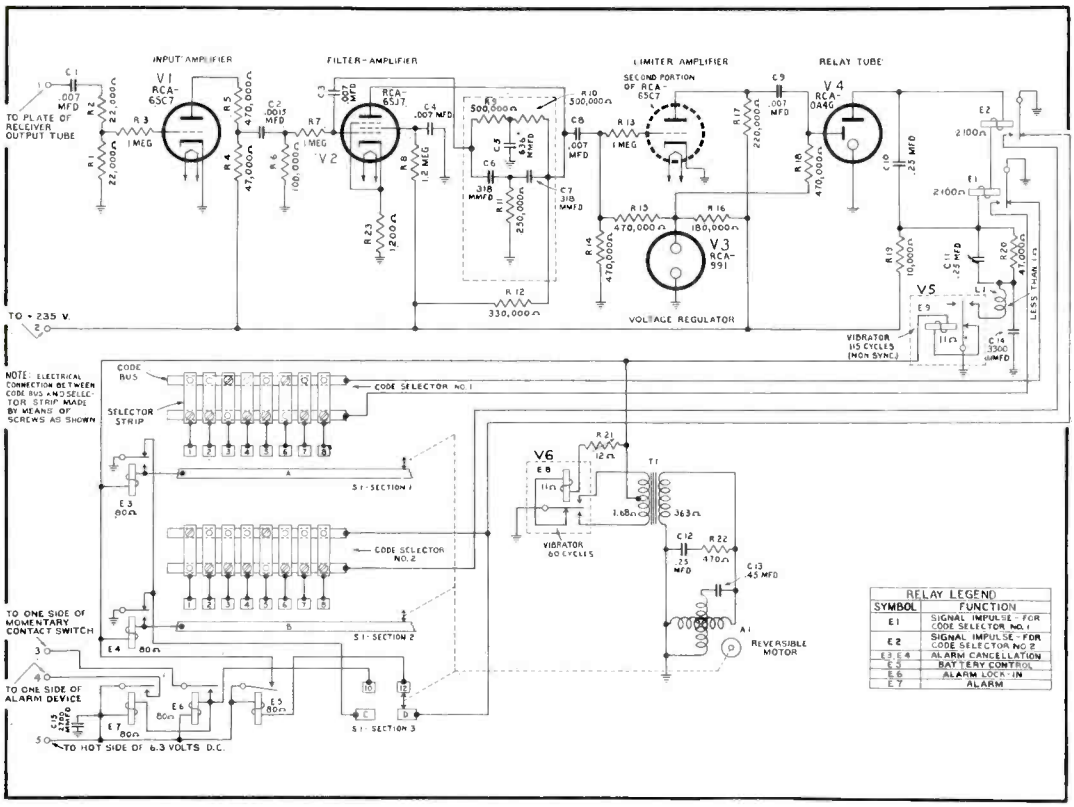


FIG. 6. SCHEMATIC DIAGRAM OF DECODING UNIT SHOWN IN FIG. 7. THIS MECHANISM CAN BE OPERATED BY THE OUTPUT OF AN FM OR AM RECEIVER

relays E1, E2, the alarm-cancellation relays will operate. The latter relays remain locked up due to the ground potential supplied through their make contacts and hold this position until the battery-control relay E5 opens the circuit at the end of the revolution of the switch S1.

However, if either one of the relays E3, E4 remains unoperated as the switch contact arms pass over contacts "1" to "8" inclusive a ground potential is applied through contact "10" of section 3, thereby operating the alarm relay E7 and the signal "lock-in" relay E6. As a result, the alarm relay closes a circuit which causes the alarm device to operate, while the signal "lock-in" relay holds itself and the and that the coding distributor has just started to operate.

As the brush of code distributor No. 1 passes over segments 23 and 24, a 1,000-cycle tone signal is received at the decoder (see Figs. 3 and 6). This tone signal causes the signal-impulse relays E1, E2 to operate thereby causing the release of battery-control relay E5 which results in starting of the vibrators E8, E9 and the motor A1, as described above. The switch S1 starts and continues to rotate in synchronism with the code distributor at the transmitter due to the fact that the motor A1 is of a synchronous type and is driven by the constant-frequency vibrator E8. As the brush of the code distributor leaves segment

24, the 1,000-cycle signal is cut off. At the same instant, the contact arms of the decoder switch S1 start traversing their respective contacts beginning with contact "1."

When the tone signal terminates, the signal-impulse relays E1, E2 become released and transfer the ground potential from their front to their back contacts. At this time, upon tracing the circuit from the coil of relay E3, through Switch S1 of section 1, through code selector No. 1 (connected through the associated selector strip) the screw and the code mains locked up. As the code distributor switch S2 and decoder switch S1 continue their rotation over the remaining contacts, it will be seen that, through the arrangement of the screws in the code selector (No. 1), the coil circuit of relay E3 is held open as relay E1 is operated and released by the tone signal. In its rotation, the decoder switch S1 makes contact between "C" and "10" of section 3, thereby causing the relays E6, E7 to be operated by the ground potential supplied by the back contact of relay E3, as previously described.

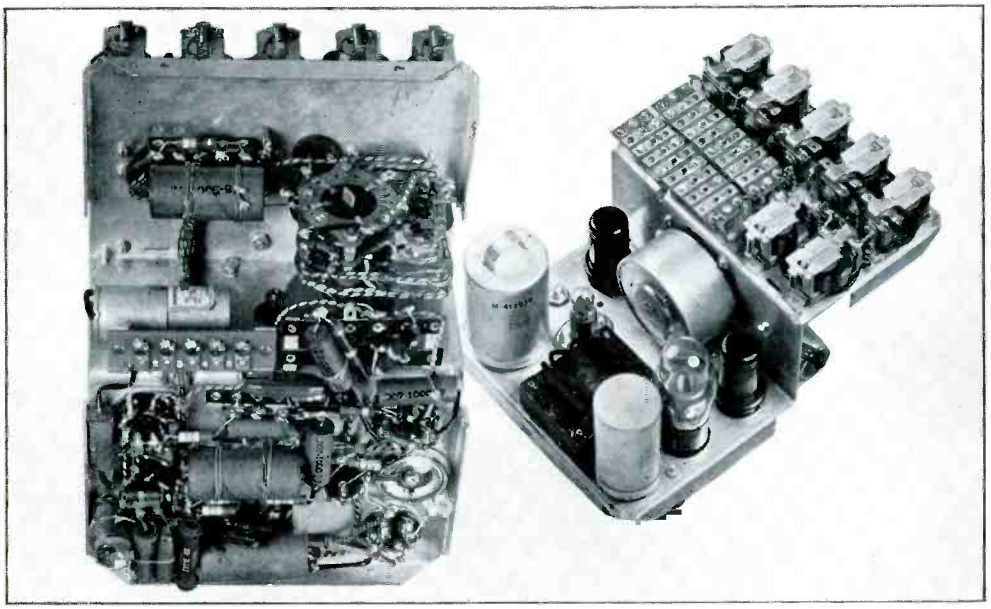


FIG. 7. BOTTOM AND TOP VIEWS OF THE RECEIVED SIGNAL DECODING UNIT

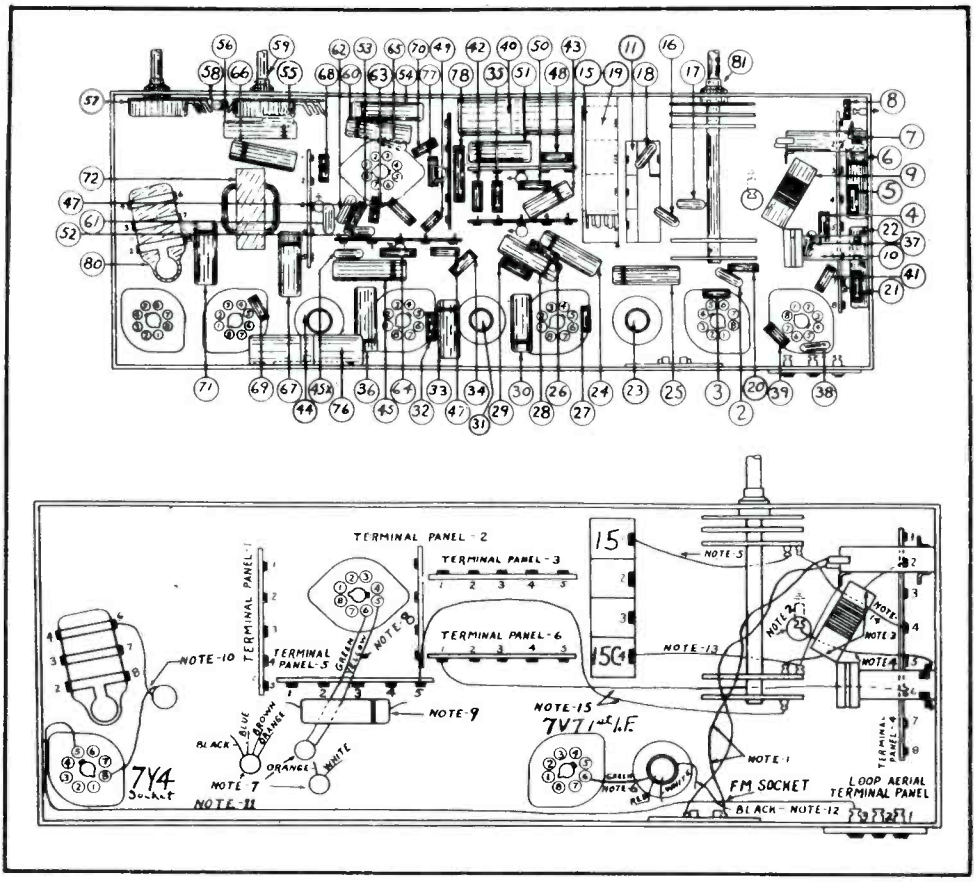
bus to the contact on relay E1, it will be seen that the circuit is open at the front contact of relay E1. However, on tracing the circuit from the coil of relay E4 in the same manner as from the coil of relay E3, it will be seen that this circuit is closed, a ground potential being applied to relay E4 from the back contact of relay E2. With the circuit for relay E4 thus closed, that relay E4 operates and locks up its own contact and remains in this position for the duration of the revolution of switch S1.

As code distributor No. 1 continues to rotate, its brush makes contact with segment 2, thereby causing a second tone signal to be transmitted. At the same instant, the decoder switch S1 of section 1 makes contact with contact "2." In tracing the coil circuits of the relays E3, E4 as previously done, it will be seen that, as before, the circuit is open for relay E3 and closed for relay E4. Therefore, relay E3 remains unoperated and relay E4 re-

Operation of code distributor No. 2 at the end of operation of code distributor No. 1 has no effect on the signal "lock-in" and alarm relays E6, E7 respectively of the particular unit described herein. These relays remain operated until they are released through the manual operation of the momentary contact switch.

It is to be noted that either code selector in the decoder unit will effect a response to the setting of either row of push buttons when these buttons are properly set, the selecting operation in any case being similar to that already described.

While this equipment is primarily intended for selective calling to mobile receivers, it can be used for an endless variety of fixed or mobile applications. Many operations can be performed with simplified versions of this fundamental design. The possibilities are a challenge to electro-mechanical engineers.



ABOVE, LOCATIONS OF PARTS BENEATH CHASSIS. BELOW, CHART OF CRITICAL WIRING, EXPLAINED BY NOTES IN ACCOMPANYING SERVICE DATA

PHILCO MODEL 42-350 CIRCUIT DATA

Circuit and Service Notes on the Philco A-FM Chassis*

SPECIFICATIONS

Voltage:
- 117 volts, 60 cycles
- 117 volts, 25 cycles with special power transformer

Tuning Range:
- Broadcast, 540 to 720 kc.
- Short-wave, 9 to 15 mc.
- FM, 42 to 50 mc.

Types of Tubes:
- XXL Oscillator
- XXL Converter
- 7V7 1st IF
- 7V7 2nd IF
- XXFM 2nd detector, 1st audio
- 7B5 Audio output
- 7Y4 Rectifier

Output: 1.5 watts

Power Consumption: 50 watts

Intermediate Frequency:
- AM, 455 kc.
- FM, 4.3 mc.

ANTENNA CONNECTIONS

This set is equipped with a low-impedance loop for broadcast and short-wave reception, and a separate built-in antenna for FM.

For additional sensitivity on FM reception only, use the Philco No. 45–2926 out-door di-pole. Insert the plug at the end of the antenna transmission line in the socket at the back of the chassis in place of the plug connected to the FM loop.

For additional sensitivity on all bands, use the Philco No. 45–2926 out-door di-pole and

*From official Philco Service Manual.

ALIGNING PROCEDURE FOR STANDARD AND SHORT-WAVE BANDS

Operations in Order	*Signal Generator Output Connections*	*Dial Setting*	*Dial Setting*	*Receiver Control Settings*	*Adjust Compensators*	*Special Notes*
1	High side to No. 1 on loop panel	455 kc.	580 kc.	Broadcast Band Volume maximum	44B, 31C, 23A, 23B	
2	Use loop on Generator.	1500 kc.	1500 kc.	Broadcast Band Volume maximum	15A, 11B	Note A
3	Use loop on Generator.	580 kc.	580 kc.	Broadcast Band Volume maximum	11	Roll Condensers Note B
4	Readjust as described in operation No. 2					
5	Use loop on Generator.	1.5 mc.	15 mc.	Band Switch SW	15B, 11A	Note C

FREQUENCY MODULATION ALIGNING PROCEDURE

1	2nd IF, FM input connection	4.3 mc.	580 kc.	FM Band, Vol. maximum	44C 44A	Note D Note E
2	1st IF, FM input connection	4.3 mc.	580 kc.	FM Band, Vol. maximum	31A, 31B	Note F
3	High side to No. 1 contact, FM socket. Ground to No. 2 contact	4.3 mc.	580 kc.	FM Band, Vol. maximum	23D, 23c	Note F
4	Test loop on generator, placed near di-pole	48.5 mc.	85 Note G	FM Band, Vol. maximum	15 15C Roll Condenser when adjusting 15C	Note G Note H
5	Test loop on generator, placed near di-pole	48.5 mc.	85	FM Band, Vol. maximum	15 oscillator	

45–1361 coupler. Plug the coupler into the socket at the back of the chassis in place of the FM loop. Connect the antenna transmission line to the RED and BLACK terminals of the coupler.

For additional sensitivity on the standard broadcast and short-wave bands only, use the Philco No. 40–6370 safety antenna and 45–1361 coupler. Connect the coupler as described above, and connect the antenna lead to the BLACK terminal of the coupler.

ALIGNING RF AND IF COMPENSATORS

Instruments required are: signal generator, output meter, and fibre screwdriver.

Audio Output Meter ★ Terminal 3 is provided on the loop aerial panel for connecting one lead of the audio output meter to the voice coil of the speaker. The other lead of the meter is connected to the chassis. When using these connections, the lowest AC scale of the meter must be used. This is 0 to 10 v.

The audio output meter can be also connected between the plate of the output tube and the chassis.

Signal Generator ★ When adjusting the IF padders, the high side of the signal generator is connected through a .1 mfd. condenser to the points indicated in the column "Output Connections" to the receiver in the tabulations below.

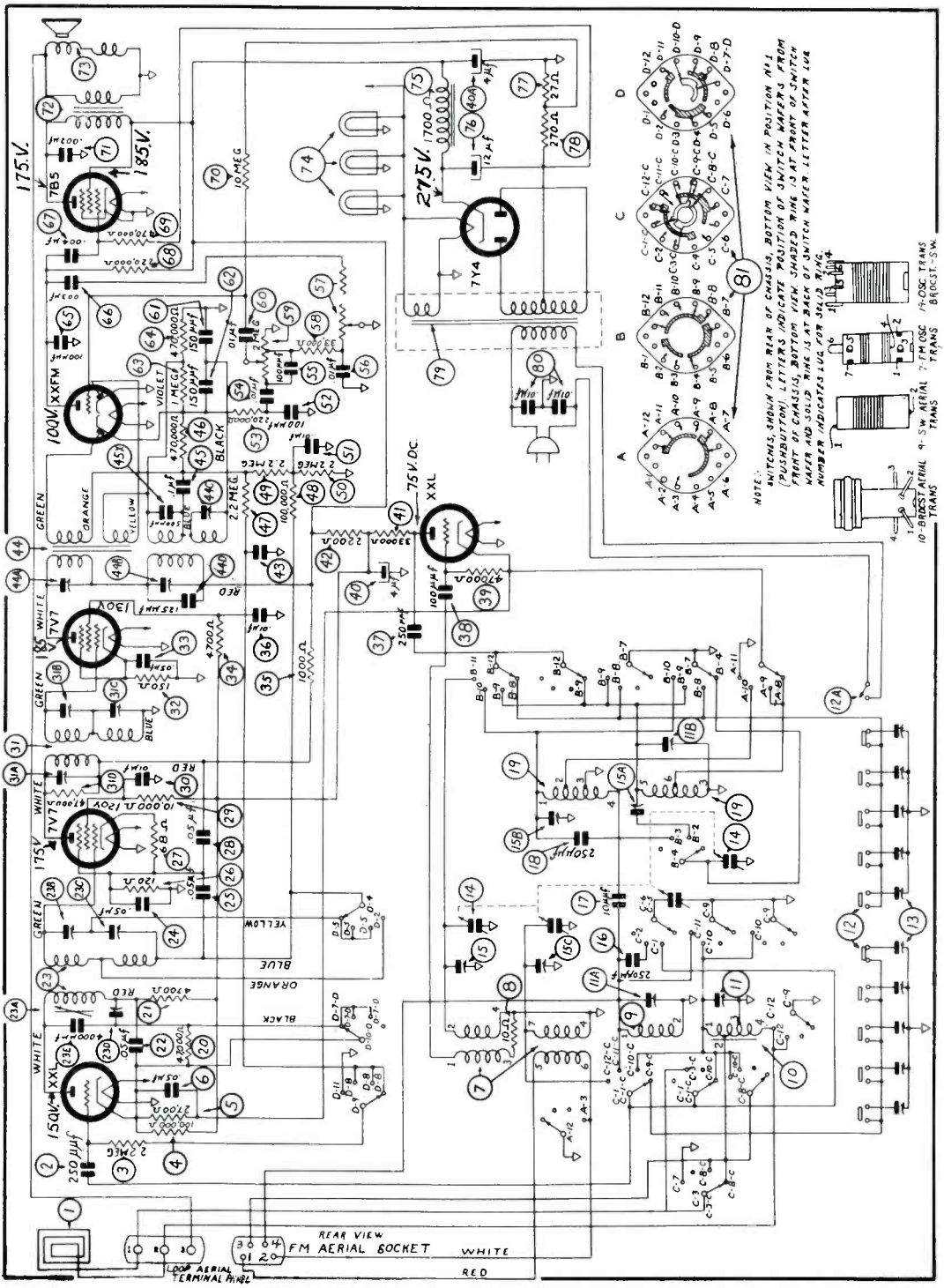
When aligning the RF padders, a loop is made from a few turns of wire and connected to the signal generator output terminals; the loop is then placed two or three feet from the loop in the cabinet or di-pole aerial lead. Do not remove the receiving loops from the cabinet. It is necessary, when adjusting the padders, to leave the receiver in the cabinet.

NOTE A: In order to adjust the receiver properly, the dial pointer must be aligned with the tuning condenser. With the tuning condenser at maximum capacity, set the dial pointer on the extreme left index line at the low-frequency end of the broadcast scale.

NOTE B: When adjusting the low-frequency compensator of the broadcast band, or the aerial padders of the high-frequency tuning range, the tuning condenser must be rolled, or rocked.

NOTE C: Adjust compensator 15B to the second signal peak from the maximum capacity position. The aerial compensator 11A must also be adjusted to maximum on the first signal peak by rolling the tuning condenser.

NOTE D: With the signal generator set to



SCHEMATIC WIRING DIAGRAM OF THE PHILCO 42-350 A-FM CHASSIS

4.3 mc. padder 44C is adjusted to the point where minimum signal indication is observed at the output meter.

NOTE E: Turn the signal generator first to approximately 125 kc. below 4.3 mc. and then 125 kc. above 4.3 mc. A signal peak should be observed on the output meter at approximately each of these points. The two peaks should be of equal reading and equally spaced in frequency each side of 4.3 mc.

If the peaks are unequal in amplitude, padder 44A must be adjusted to make the peaks equal. This is done by changing the padder slightly, and then turning the signal generator above and below 4.3 mc. to observe the peaks.

After equal peaks are obtained, set the signal generator to 4.3 mc. The output meter should show zero reading at 4.3 mc. If a signal indication is observed, readjust the padder 44C until zero reading is obtained on the meter. After this adjustment is made, padder 44A should be reset for equal peaks, as previously explained.

NOTE F: Adjust padders 31A, 31B, 23C, 23D for equal signal peaks and equal frequency spacing each side of 4.3 mc.

NOTE G: The dial scale numbers are listed in tenths of megacycles, less the first number. That is, 49 mc. is 90, or 48.5 is 85. Set the dial pointer at 90 on the FM scale. Adjust padder 15 for minimum indication of the output meter.

NOTE H: To adjust padder 15C, set the signal generator to either the signal peak approximately 125 kc. below 49 mc. or 125 kc. above 49 mc. Adjust the padder 15C to maximum output reading on either of these peak signals. As padder 15C is being adjusted, roll the tuning condenser.

CRITICAL WIRING LOCATIONS

The following wires and parts are critical as to location on the chassis shown in the accompanying drawings:

NOTE 1: Dipole aerial leads from socket to be twisted and dressed over wave switch directly to FM aerial-oscillator transformer 7.

NOTE 2: Ground braid from gang to chassis to be wired and soldered on top side of subbase in such a manner that there is a floating bond between ground and condenser.

NOTE 3: Short-wave aerial transformer No. 9 to be wired directly between terminal panel 4 and band switch contact C-11-C so that there is a minimum of slack in the wires.

NOTE 4: Wire from broadcast aerial transformer No. 10 to ground to be dressed under short-wave aerial transformer No. 9.

NOTE 5: Wire from band switch contact B-11 to compensator 15 to be direct and away from switch and other wires.

NOTE 6: Red and white wires from 1st IF transformer to be dressed on base and not twisted with other wires from same coil. Green wire to be free of other wires and direct to contact 6 of the 7V7 1st IF tube.

NOTE 7: Wires from the 3rd IF transformer 44 to be brought out proper holes and not twisted together inside the can.

NOTE 8: Green and yellow wires of 3rd IF transformer 44 to run from hole in sub-base between terminal panel 5, contacts 2 and 3, and direct to contacts of the XXFM tube 5 and 6. Orange, blue, black, and brown leads to be free of other wires and dressed off base.

NOTE 9: Condenser 45 to be dressed off base.

NOTE 10: AC switch leads to be twisted.

NOTE 11: Wire from prong 5 of the 7Y4 tube to lug 3 of the loop aerial terminal panel to be dressed between electrolytic condenser 76 and mounting strap and to rear of chassis across bottom contacts of FM socket.

NOTE 12: White, red, and black wires of 1st IF transformer to be dressed with excess out of coil shield and toward rear of chassis, close to base. Black lead to be dressed around and under all leads going to XXL converter tube socket. Orange, yellow, green and blue leads to be dressed with excess out of coil shield and away from white, red, and black leads.

NOTE 13: Wire from band switch contacts C-12-C to compensator 15-C to be dressed free from other wires.

NOTE 14: Dress wire from band switch contact B-12 to wiring panel 4, lug 4, with excess toward front of set, under short-wave aerial transformer 9, keeping wire between the terminal panel 4 and wires coming through subbase which connect to FM aerial-oscillator transformer 7 and band switch.

NOTE 15: Keep wires from terminal panel 5, contact 5, to band switch contact D8 and terminal panel 6 to terminal panel 4 between padder strip and mounting stud of 1st IF transformer, so they are clear of leads from the 1st IF transformer.

PARTS LIST

Schem. No.	Description
1.	Loop Aerial
1a.	F.M. Loop Aerial
2.	Mica Condenser (250 mmfd.)
3.	Resistor (2.2 megohms)
4.	Resistor (100,000 ohms)
5.	Resistor (2700 ohms)
6.	Condenser (.05 mfd., 200 volts)
7.	F.M. Oscillator Transformer
8.	Resistor (10 ohms)
9.	Short Wave Aerial Transformer
10.	Broadcast Aerial Transformer
11.	Compensator (Brdcst. Band, 580 K.C.)
11a.	Compensator (S.W. Aerial, 15 M.C.) Part of 11
11b.	Compensator (Brdcst Band, 1500 K.C.) Part of 11
12.	Push-button Switch & A.C. Switch
12a.	A.C. Switch (Part of 12)
13.	Push-button Padder Strip
14.	Tuning Condenser
15.	Compensator (F.M. Osc., 48.5 M.C.)
15a.	Compensator (Brdcst Osc., 1500 K.C.) Part of 15

(CONTINUED ON PAGE 45)

SKYSCRAPER FM STATION

(CONTINUED FROM PAGE 19)

REL units listed earlier, as well as our main supply transformers which reduce the incoming 440 to 220 v., and certain emergency transfer switches. No trouble was experienced in locating all required units in the limited space available. All equipment outside the vault is confined within a screened-in section where the nitrogen supply tanks for the long transmission line system are also located. The photographs of this space show clearly the relative positions of all units.

On the penthouse roof, mounted on a concrete slab, is the sheet steel doghouse which measures approximately 12 ft. by 4 ft. by 4 ft., and has a removable front with two windows that permit the reading of gas gauges on each of the eight 1⅝-in. lines which link the phasing and matching section within this doghouse with each of the eight horizontal arms of the 2-bay turnstile radiator on the tower top. A rather serious problem developed when an attempt was made to make all lines of equal length, but the final system has a maximum differential in line lengths of less than 1 in.!

Antenna ★ The radiator, based on Paul de Mars' design,[1] is supported by a 4-in. steel tube of ½-in. wall thickness, and rises 24 ft. above the top of the steel-frame neon beacon ball atop the tower. Clustered around this spar, and held in brass castings with clamps, are the eight lines, four of which are terminated at the lower bay, while the remaining four continue to the top bay. Climbing spikes were provided, and the men assembling the radiator found no difficulty in performing their work in relative safety, hanging in safety belts.

Since it was impossible to erect a gin-pole on top of the existing tower to raise the completely assembled radiator, the supporting spar was fed through the inside of the tower and ball, and all castings and units were assembled on the spar as it was slowly pushed upward.

Once in place, and secured to a specially constructed saddle inside the ball, it was comparatively simple to raise and mount the matching transformers and lines, and to install the eight radiator elements and all necessary solderless couplings on the lines. Witness the fact that when the system was finally tested for gas leaks, only five such leaks were found, of which number only two were on the tower lines!

Past experience has shown that the source of greatest difficulty with radiators in this location was lightning, which showed a particular affinity to any radiator at this point, 700 ft. above street level. To guard against future trouble of this sort, each 1⅝-in. line now has a ⅜-in. lightning gap across its upper end seal, while the grounded spar itself supports on its top a 1-in. tobin bronze rod which rises 7 ft. above the upper bay. Several severe storms with many direct hits have done no damage of any sort so far, and even overload relays in the amplifier stage feeding the system stayed in without a quiver. Certainly this is a different story from the experience with all previous radiators and transmission lines we used!

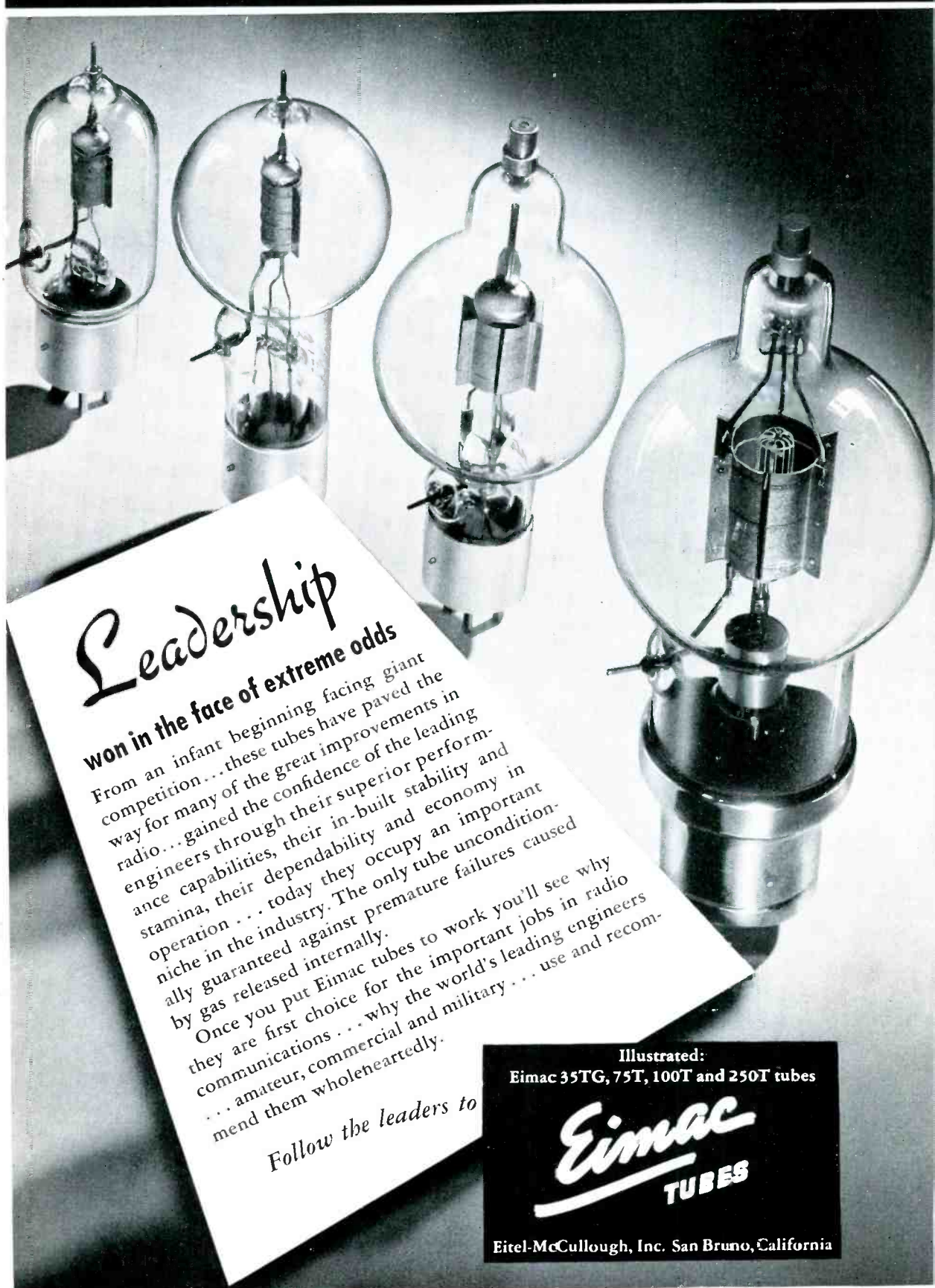
Special Problems ★ It is obvious that, since the entire station was to be located in an existing building that was not laid out for the station, many problems had to be solved and many preparations made even before delivery of the equipment and component parts could be taken. Fine co-operation between REL and the Penobscot Building management made it possible to handle everything without undue difficulty and expense.

Equipment was dismantled and broken down into the smallest possible component parts before shipment. Shipments were made piece-meal to allow plenty of time at the delivery point for unloading, uncrating, and hoisting before the next shipment arrived. All freight was delivered by the transportation companies to the building alley freight entrance, where much of it was uncrated. An elevator lifted the equipment to the fifth floor of the building where it was transferred to the next high-rise elevator which carried it to the 44th floor. From this level on, it was hoisted by chainfalls to the 45th and 46th levels where final assembly and installation was made. Much checking on width of doors, windows, and elevators was necessary, but nothing more than the removal of several door frames was required to complete that portion of the job without incident. The 30-ft. steel radiator spar and the doghouse were the only units that had to be taken up on the outside of the building, and riggers made short work of this job.

Personnel ★ Our engineering staff consists of five men in addition to the chief engineer. One of these men does nothing but remote work, while the other four divide among them the various jobs at the transmitter and studio. While we were on reduced power, with only a 10-hour schedule, two of the four men worked regular transmitter-studio shifts, while the other two were kept busy on the construction of the 50-kw. equipment, and with relieving the other engineers on their off days. All engineers' shifts rotate in four-week periods, and all work 6 days of 6:40 hours each, per week. At present, our program department includes

(CONTINUED ON PAGE 42)

[1] See W1XOJ Exceeds Expectations, by Paul A. de Mars, *FM* Magazine, March, 1941.



SKYSCRAPER FM STATION

(CONTINUED FROM PAGE 40)

the program director and three announcers, a receptionist who will shortly start a series of children's programs, and a stenographer. We also have a woman announcer who does a women's program twice daily, an organist, a vocalist, a salesman, and a promotion man.

On the Air ★ With all engineering problems pretty well solved and under control of W45D's independent engineering staff, the station has now taken its place among the first in the country to provide FM service to a rapidly growing audience within its assigned service area of better than 6,800 square miles, with a population of close to 3,000,000. In this area, it can be said that The Detroit News again pioneers, this time with FM, as it did with AM broadcasting in August, 1920.

WHAT THE FM BROADCASTERS SAY:

(CONCLUDED FROM PAGE 20)

specifying the 45.9 mc. channel in the Construction Permit which was issued June 17, 1941, and assigning call letters W59NY.

We ordered the crystals for the new frequency and were ready to proceed with the job of moving the FM transmitter to New York, installing a high antenna, adding a 10-kw. amplifier, and extending our program service through W59NY. Then, however, we were delayed in going ahead because of a petition filed by another New York FM applicant, which has now been dismissed. While our listeners within ten or fifteen miles have been hearing W2XQR, those in the outlying sections who are anxious to hear the WQXR programs on FM were thus denied that service, by causes beyond their or our control.

We are now proceeding with construction, and if there are no further interruptions we should be able to have W59NY on the air by the first of the year. This is a part of our plan to give FM listeners in the New York City area more and better high fidelity programs.

PUBLIC PAYS DOUBLE TAX

(CONTINUED FROM PAGE 6)

the tax was only 5% but now, as these figures show, the tax costs the consumer an extra 6.67% on a radio set listing at $123.33, while on a phono combination in the $360 class, he would pay over $20 just for the privilege of not knowing that he is being taxed on his purchase!

How else can the tax be figured, then? Well, here is one way:

A. Manufacturer's Net	$50.00
B. 10% Federal Tax	$5.00
C. Net Price to Jobber	$50.00
Plus 10% tax	5.00
Total	$55.00

Assuming that the net price to the jobber represents a discount of 50-10% from the list price, since the net jobber price (C) is $50.00, this makes the

D. Retail List Price	$111.11
Plus 10% tax	5.00
Total	$116.11

This compares with a list price (4) of $123.33 when the tax is figured by the method in current use, with a

E. Saving to Consumer	$7.22

It should be pointed out, moreover, that the amount (E) is greater than the difference between the present cost of the tax to the consumer (6) of $12.22, and the tax paid by the manufacturer (3) of $5.55. That is because, by the present methods of figuring, the manufacturer is paying a tax on the Federal tax he pays! With the increased tax on radio sets, the amount involved is so large that the public will be pleased to have the matter brought out into the open, and to discover the amount to be saved thereby.

W65H, THE FM OUTLET OF WDRC, HARTFORD, IS USING BILLBOARDS AS A PART OF THEIR EFFORTS TO BUILD UP THEIR AUDIENCE. CONNECTICUT DEALERS REPORT FM SET SALES SHOW RESULTING INCREASE

FM SPOT NEWS

(CONTINUED FROM PAGE 24)

Football: A program we'd like to hear just about now would be a varsity game on FM, with the field hooked up to the transmitter by a high-fidelity line or FM radio link. It should give color to the sound such as we've never heard on AM.

Priorities: Amazing are the figures released by the National Association of Broadcasters on the materials required to supply replacements and new equipment for U. S. broadcast stations for one year. For example, transmitting apparatus calls for 164,000 pounds of copper. In addition, 60,000 pounds of copper are needed for antennas, 26,300 pounds for tubes, and 136,000 pounds for transmission lines. Largest copper item, though, is 440,000 pounds for ground systems. Figures are based on 10 percent for replacement and 90 percent for new construction.

Aerovox: Has brought out a new series of still smaller insulated resistors of molded carbon. Both ½- and 1-w. sizes bear the same type numbers and ratings as the larger ones which they replace.

Marshall Field: Is first sponsor on Chicago's W59C. "Perfectionists' Hour" is on Sunday through Friday from 9 to 10 P.M., and on Saturday from 8 to 9 P.M. Meanwhile, the store is featuring A-FM receivers in their radio department.

Philadelphia: First FM station on the air may be WFIL's W53PH. Blaw-Knox tower, 250 ft. high, with 50-ft. Lingo mast are completed atop Widener Building. Total height of 552 ft. above street is 4 ft. above statue of William Penn.

Recordings for Records: Beneath corner stone of The Milwaukee Journal's Radio City building are recordings of speeches made during the ceremony. Walter Damm spread the mortar on the corner stone. FCC chairman Fly, Governor Heil, and Harry J. Grant, Journal board chairman, were among the speakers.

New York City: Board of Estimate has voted $16,000 for FM station to be operated in conjunction with City's WNYC. Construction will begin as soon as equipment can be secured. This will give 24-hour radio facilities, for WNYC, sharing a channel with WCCO, must sign off as early as 5:30 P.M. in the winter.

FMBI: Lists the following public utilities as users of FM emergency equipment:

Detroit Edison Co.
Indiana & Michigan Electric Co.
Indiana General Service Co.
Indianapolis Power & Light
Louisville Gas & Electric
Ohio Edison Co.
Ohio Power Co.
Pennsylvania Electric Co.
Oklahoma Gas & Electric
Duquesne Light Company
San Diego Gas & Electric
San Antonio Public Service
United Illuminating Co. of Conn.
Commonwealth Edison of Chicago
Toledo Edison Co.
Wisconsin, Michigan Power Co.
New England Telephone Co.
Brockton Edison Co. (Boston)
Cleveland Street Railway
City of Toledo Water Dept.
Columbus & Southern Ohio
Corpus Christi Power & Light

About 60 cities and towns use FM for their police communications, in addition to the following State police organizations:

Connecticut State Police
Maryland State Police
Indiana State Police
New Jersey State Police
Ohio State Police
North Carolina State Police
Virginia State Police
Delaware State Police
Michigan State Police
Pennsylvania Turnpike Police

Increase: Chicago is showing the largest gain in A-FM set sales, followed by Los Angeles. Belief is general that total sales will pass the 100,000 mark for the whole country before the end of the year, of manufacturers continue to get materials.

PHILCO MODEL 42-350 DATA

(CONTINUED FROM PAGE 39)

15b. Compensator (S.W. Osc., 15 M.C.) Part of 15
15c. Compensator (F.M. Aerial, 48.5 M.C.) Part of 15
16. Silver Mica Condenser (250 mmfd.)
17. Mica Condenser (10 mmfd.)
18. Mica Condenser (250 mmfd.)
19. Oscillator Transformer (Brdcst., S.W.)
20. Resistor (47,000 ohms)
21. Resistor (4700 ohms)
22. Condenser (.05 mfd., 400 volts)
23. 1st I.F. Transformer
23a. Primary Compensator (455 K.C.) Part of 23
23b. Secondary Compensator (455 K.C.) Part of 23
23c. Secondary Compensator (4.3 M.C.) Part of 23
23d. Primary Compensator (4.3 M.C.) Part of 23
23e. Mica Condenser (4000 mmfd.) Part of 23
24. Condenser (.05 mfd., 200 volts)
25. Condenser (.05 mfd., 200 volts)
26. Resistor (120 ohms)
27. Resistor (68 ohms)
28. Condenser (.05 mfd., 400 volts)
29. Resistor (10,000 ohms)
30. Condenser (.01 mfd., 400 volts)
31. 2nd I.F. Transformer
31a. Primary Compensator (4.3 M.C.) Part of 31
31b. Secondary Compensator (4.3 M.C.) Part of 31
31c. Secondary Compensator (455 K.C.) Part of 31
31d. Resistor (47,000 ohms) Part of 31
32. Resistor (150 ohms)
33. Condenser (.05 mfd., 200 volts)
34. Resistor (4700 ohms)
35. Resistor (1000 ohms)
36. Condenser (.01 mfd., 400 volts)
37. Mica Condenser (250 mmfd.)
38. Mica Condenser (100 mmfd.)
39. Resistor (47,000 ohms)
40. Electrolytic Condenser (4-4 mfd., 400 volts)
40a. Electrolytic Condenser (4 mfd., 400 volts) Part of 40
41. Resistor (33,000 ohms)
42. Resistor (2200 ohms)
43. Condenser (.05 mfd., 200 volts)
44. 3rd I.F. Transformer
44a. Primary Compensator (4.3 M.C.) Part of 44
44b. Primary Compensator (455 K.C.) Part of 44
44c. Secondary Compensator (4.3 M.C.) Part of 44
44d. Mica Condenser (125 mmfd.) Part of 44
45. Condenser (.1 mfd.)
45x. Mica Condenser (500 mfd.)
46. Resistor (470,000 ohms)
47. Resistor (2.2 megohms)
48. Resistor (100,000 ohms)
49. Resistor (2.2 megohms)
50. Resistor (2.2 megohms)
51. Condenser (.01 mfd., 400 volts)
52. Mica Condenser (100 mmfd.)
53. Resistor (220,000 ohms)
54. Condenser (.01 mfd., 400 volts)
55. Mica Condenser (100 mmfd.)
56. Condenser (.01 mfd., 400 volts)
57. Tone Control
58. Resistor (33,000 ohms)
59. Volume Control
60. Condenser (.01 mfd., 400 volts)
61. Mica Condenser (150 mmfd.)
62. Mica Condenser (150 mmfd.)
63. Resistor (1 megohm)
64. Resistor (470,000 ohms)
65. Mica Condenser (100 mmfd.)
66. Condenser (.003 mfd., 1000 volts)
67. Condenser (.004 mfd.)
68. Resistor (220,000 ohms)
69. Resistor (470,000 ohms)
70. Resistor (10 megohms)
71. Condenser (.002 mfd., 600 volts)
72. Output Transformer
73. Speaker
74. Dial and Indicator Lamps
75. Field Coil (Replace Speaker 36-1548)
76. Electrolytic Condenser (12mfd., 400 volts) Mtg. Clip
77. Resistor (27 ohms)
78. Resistor (270 ohms)
79. Power Transformer (115 volts, 60 cycle)
Power Transformer (115 volts, 25 cycles)
Power Transformer (115/230 volts, 60 cycle)
80. Condenser (.01-.01 mfd.)
81. Band Switch

NEW BOUND VOLUMES

Bound volumes of *FM* Magazine for May to October, 1941, are now ready. The binding, of three-quarter pigskin, matches the first bound volume containing the first six issues, November, 1940 to April, 1941. The price is $5.00, postpaid. Orders will be filled in the order they are received. Make remittances payable to FM Company, 112 East 36th Street, New York City.

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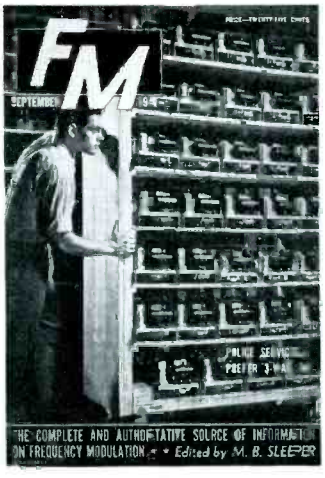

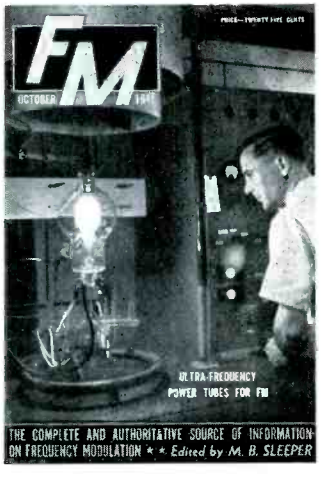

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for both

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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.
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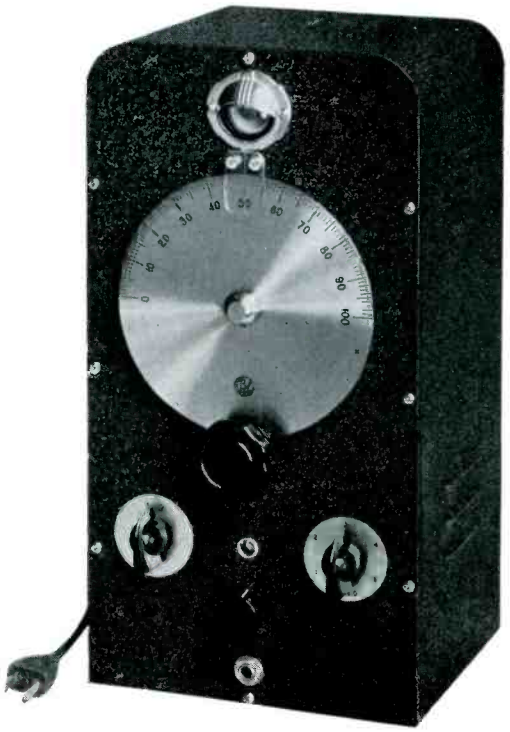
7. Fast operation. Less than one minute required to check transmitter frequency exactly.
8. Light in weight — easy to carry — plugs into any 115-volt AC or DC supply.
9. Each instrument precision-built on order, hand-calibrated to better than .01% for each band.



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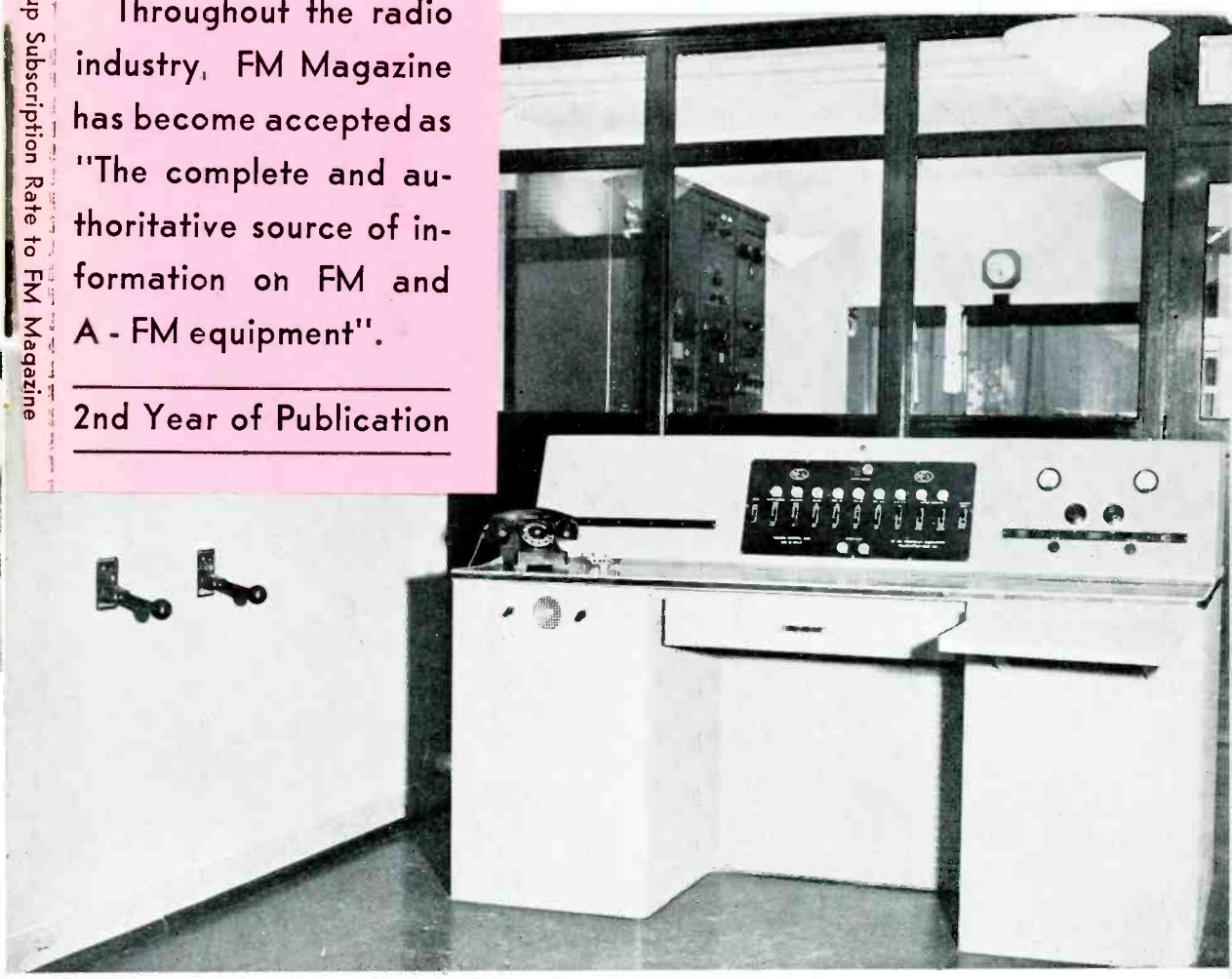

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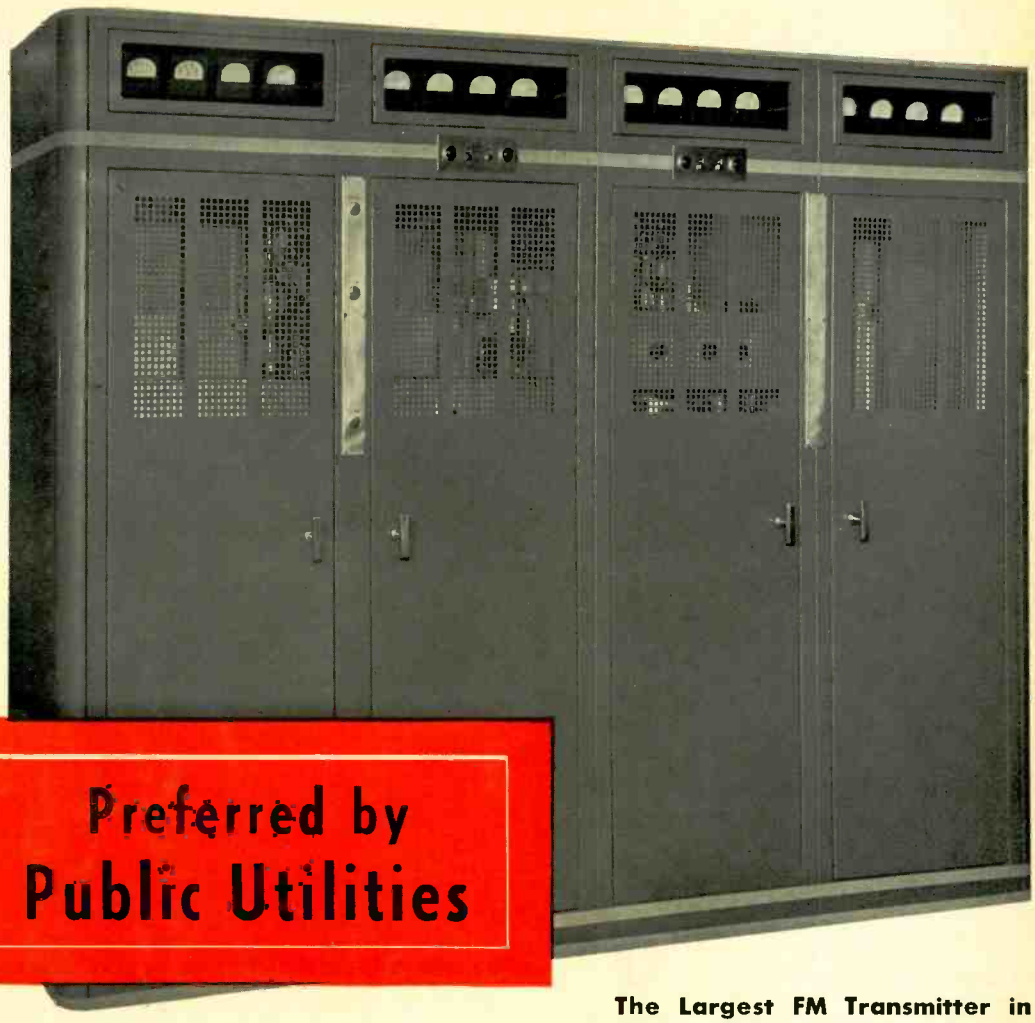

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