COMMUNICATIONS

FREQUENCY MODULATION

NATIONAL DEFENSE

MARCH

1941

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Writes FRITZ BAUER
Chief Engineer, Radio
Station KGBX

KGBX — FULL TIME 1230 KC — Owned and Operated By SPRINGFIELD BROADCASTING CO.

OPTIONAL RED OR BLUE NETWORK OF THE NATIONAL BROADCASTING COMPANY

SPRINGFIELD, MISSOURI

December 18, 1940

Amperex Electronic Products, Inc.,
79 Washington Street,
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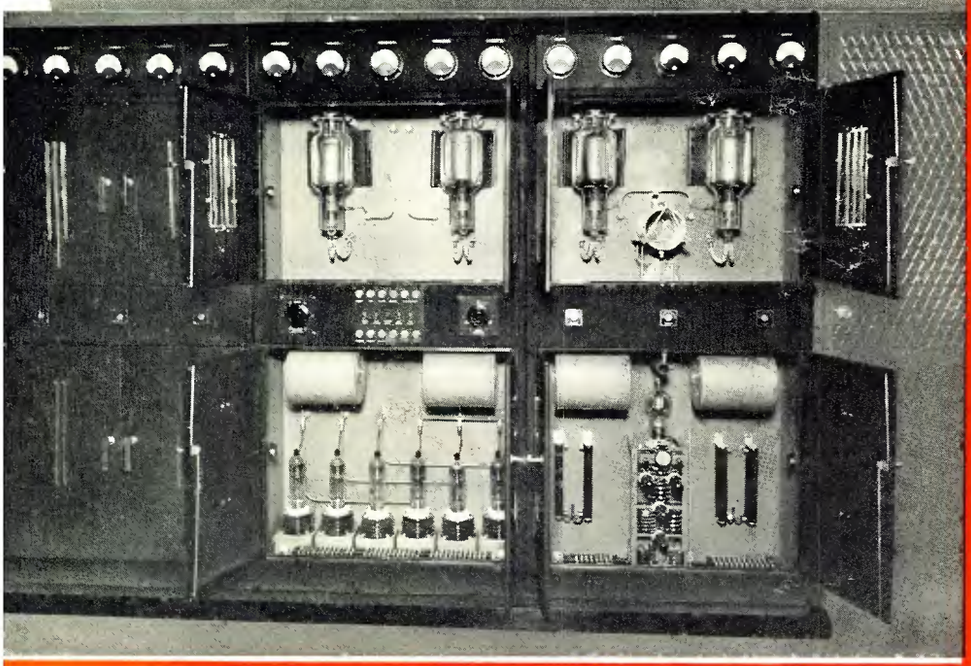
Gentlemen:

Enclosed you will find the photographs of our new **5 Kilowatt Transmitter** which you requested recently. The transmitter is now undergoing tests while we adjust the phasing equipment for our night time directional. **The performance of your HF-3000's as final Class "C" R.F. amplifiers and ZB-3200's as high level modulators, is especially gratifying. The ease with which they can be driven to full output, the extreme simplification of cooling arrangements, the relative immunity to heavy overloads, and the moderate plate voltages required together with the inherent stability of the high level modulated Class "C" system results in a combination that is not easily surpassed for reliable broadcast service.**

The entire 5 Kilowatt transmitter (excepting only the high voltage plate transformers and the modulator transformer and retard) is built into the 2 righthand cabinets. The third cabinet contains the distribution and phasing networks for the directional array.

Yours very truly,
RADIO STATION KGBX
Fritz Bauer
Chief Engineer



AMPEREX

HF-3000 – ZB-3200

$300

AMPEREX ELECTRONIC PRODUCTS, Inc.

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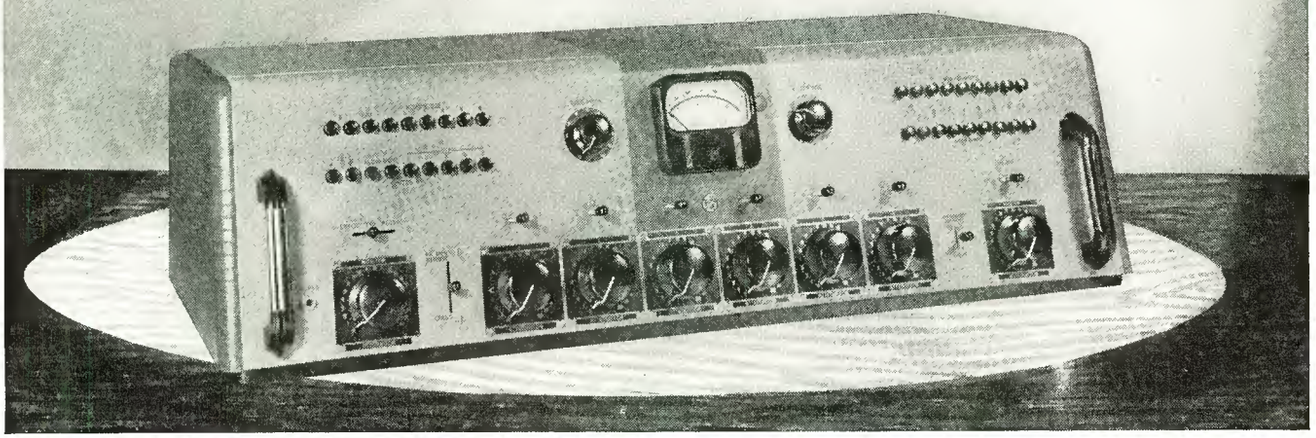
NOW FLAT TO 15,000 CYCLES!

...Meets Every FCC Requirement for FM Broadcasting



RCA 76-B2 Consolette Speech Input System with Interlocked Push-Button Switching

ALL the features that made the RCA Model 76-B1 known the country over . . . *plus* an extended frequency response to over 15,000 cycles! That's the new RCA 76-B2, for *simultaneous broadcasting and auditioning*—with *push-button control* for more circuit combinations with simpler switching operations.

Monitoring, auditioning, cueing, and talk-back are all under push-button control. The *high-fidelity program channel affords 6 mixer controls—4 microphone pre-amplifier input channels with switching control for as many as 6 microphones.* Location of control knobs and correct slope of panel give greatest *visibility and ease of control.* High power output to line and loudspeakers. Hinged top and chassis mounting for instant accessibility of parts.

And all at a price that even the smallest station can afford! Get the facts on RCA 76-B2—write today for complete data.

Use RCA radio tubes in your station for finer performance

- ★ Frequency Response 30 to 15,000 Cycles
- ★ Independent Auditioning and Program Channels
- ★ Talk-back facilities for two studios and remote lines
- ★ Emergency Amplifier and Power Supply Circuit
- ★ 6 Step-by-step Mixers—Dual Turntable Faders
- ★ 6 Remote Inputs—Push-Button Cueing Control
- ★ New Illuminated Scale VU Meter
- ★ Two Line Repeating Transformers
- ★ Plate Current Meter and Relay Power Supply
- ★ Attractive Appearance—Two-Tone Umber Grey Finish

FOR FINER PERFORMANCE... GO RCA ALL THE WAY

Microphones
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COMMUNICATIONS

MARCH 1941

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer.
Registered U. S. Patent Office
Member of Audit Bureau of Circulations

VOLUME 21
NUMBER 3

RAY D. RETTENMEYER
Editor

• Contents •

COVER ILLUSTRATION

Sperry Flight Scorsby. This device simulates the roll and pitch of an airplane in rough air, and is capable of mass testing eighty aeronautical instruments at a time. Devices of this sort are becoming increasingly important as our National Defense Program continues to expand. Photo courtesy Sperry Gyroscope Co.

• Editorial Comment •

THE fourth annual Broadcast Engineering Conference, held at Ohio State University last month, was a distinct success. Over 250 engineers were present at this year's gathering which was held with the official cooperation of the National Association of Broadcasters. This conference has become one of the outstanding engineering gatherings of the year. Much of the success of the Conference is the result of the untiring efforts of W. L. Everitt, director of the gathering, who deserves a great deal of credit.

READERS of COMMUNICATIONS should keep the following two conventions in mind: National Association of Broadcasters, May 12-15, New Jefferson Hotel, St. Louis, Missouri—University of Illinois' Radio Interference Conference, May 10, Urbana, Illinois. Programs of these meetings will appear in a later issue.

FOLLOWING the announcement of January 12, the Federal Communications Commission have adopted rules to permit f-m programs to be relayed by radio from the main studio to the transmitter. These STL (studio-transmitter link) stations will employ low power and use highly directional antenna systems. Twenty-three frequencies above 330 megacycles have been allocated to this service. This, we believe, is a step in the right direction, since it will permit operation of f-m transmitters in locations where telephone lines are not always available, or where line installation costs would be uneconomical.

IT is understood that supply sources are refusing to guarantee aluminum for any commercial purpose, the supply apparently being restricted for use in the manufacture of national defense items. Whether or not the shortage is a temporary or permanent condition is not known, although the Priorities Division of the Office of Production Management has suggested that industrial users of aluminum use substitutes wherever possible. While substitutes can be used in certain instances, there are other cases where it is not considered practicable to do so. Various RMA committees are now making a study of the situation.

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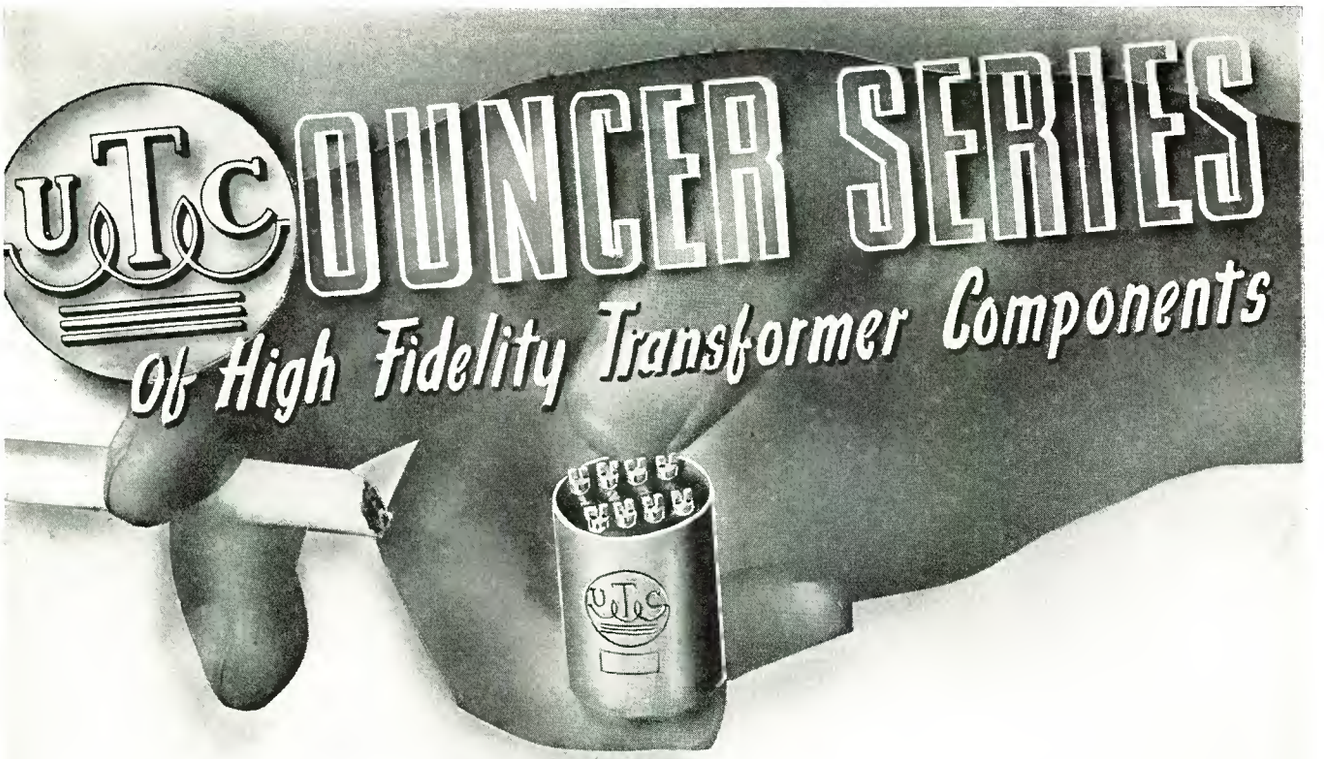


The UTC OUNCER series represents the acme in compact quality transformer practice. These units weigh approximately one ounce and those which do not carry D. C. have high fidelity characteristics suitable for broadcast and similar applications. The OUNCER transformers are ideal for hearing aid, aircraft, glider, portable, concealed service, and similar applications.

The overall dimensions of these units are 7/8" diameter by 1-3/16" height, including lugs. Mounting is effected by two screws, opposite the terminal board side, spaced 13/16".

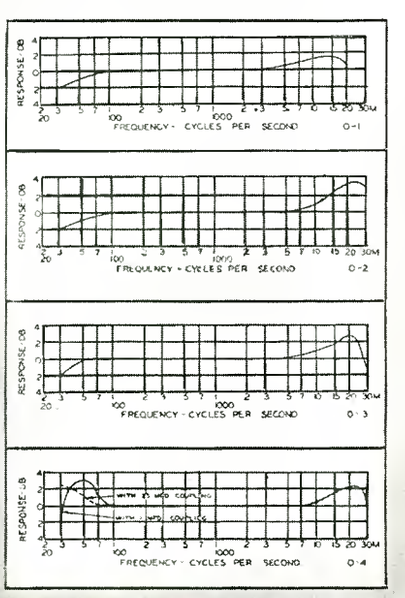
The frequency response of these units is illustrated in the curves below, uniform response being obtainable from 40 to 15,000 cycles. The useful range of the 0-14 and 0-15 units is 150 to 4,000 cycles. Due to the very small size of the transformers, hum pickup is comparatively low.

OUNCER HIGH FIDELITY AUDIO UNITS

(MAX. LEVEL 0 DB)

200 ohm balonced winding may be used for 250 ohms.

Type No.	Applicotion	Pri. Imp.	Sec. Imp.	List Price
0-1	Mike, pickup or line to 1 grid	50, 200, 500	50,000	$10.00
0-2	Mike, pickup or line to 2 grids	50, 200, 500	50,000	10.00
0-3	Dynomic mike to 1 grid	7.5/30	50,000	9.00
0-4	Single plote to 1 grid	8,000 to 15,000	60,000	8.00
0-5	Single plate to 1 grid, D.C. in Pri.	8,000 to 15,000	60,000	8.00
0-6	Single plote to 2 grids	8,000 to 15,000	95,000	9.00
0-7	Single plate to 2 grids, D.C. in Pri.	8,000 to 15,000	95,000	9.00
0-8	Single plote to line	8,000 to 15,000	50, 200, 500	10.00
0-9	Single plote to line, D.C. in Pri.	8,000 to 15,000	50, 200, 500	10.00
0-10	Push pull plates to line	8,000 to 15,000 each side	50, 200, 500	10.00
0-11	Crystal mike or pickup to line	50,000	50, 200, 500	10.00
0-12	Mixing ond motching	50,200	50, 200, 500	9.00
0-13	Reoctor, 200 Hys.—no D.C.; 50 Hys.—2 MA. D.C., 6,000 ohms			7.00
0-14	50:1 mike or line to 1 grid	200	1/2 megohm	10.00
0-15	10:1 single plate to 1 grid	8,000 to 15,000	1 megohm	10.00



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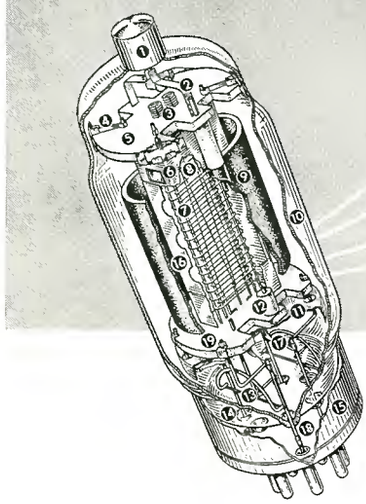
RCA-813

BEAM POWER AMPLIFIER

360 Watts Input with Less Than 1 Watt Driving Power!

Amateur Net $22.00

(Reduced from $28.50, April 1, 1940)



BIG-TIME PERFORMER OF THE BEAM TUBE LINE!

NOTE THESE FEATURES

1. Medium Metal Cap
2. Short Ribbon Plate Connector
3. Filament Support Springs
4. Mount Support
5. Top Ceramic Mount Support
6. Top Shield
7. Aligned-Turn Control and Screen Grid
8. Heavy-Duty Thoriated-Tungsten Filament
9. Large Sturdy Graphite Plate
10. Hard Glass Bulb with Mount-Aligning Dome
11. Bottom Shield Disc
12. Ceramic Plate-Support Spacer
13. Directive-Type Getter Container
14. Dish Type Stem
15. Ceramic-Insert Giant Base
16. Beam-Forming Plate
17. Filament Connector
18. Tungsten-to-Glass Seal
19. Bottom Ceramic Mount Support

For transmitters requiring exceptional overall efficiency—for ultra-modern intermediate and final stages that need no neutralizing adjustments, units that can switch channels in a flash—for high-power transmitters with few tuning controls, requiring a minimum of driver equipment—use the RCA-813. The largest of the glass air-cooled "beams", it can handle more big-time jobs than any other tube of its size or class.

As a straight amplifier in class C telegraph service RCA-813 takes 360 watts (CCS) with less than a watt of drive. As a final in plate-modulated service, it takes 240 watts with only 1.2 watts of drive. Moreover, it doubles, triples and quadruples with unusually high efficiency and high harmonic output. It can be operated at full ratings up to 30 Mc—at reduced ratings up to 60 Mc. Power sensitivity is extremely high. Grid-plate capacitance for the power-handling ability of the tube is low. Screen current requirements are very low. Short internal leads provide low lead inductance.

In brief, the RCA-813 gives you real circuit simplification — real economy — excellent performance in a variety of applications. And it makes possible efficient and flexible high-gain stages at a cost comparable with that of equipment using ordinary tube combinations.

Direct Interelectrode Capacitances:

Grid-Plate (with external shielding)	0.2 max.	μμf
Input	16.3	μμf
Output	14	μμf

Typical Operation Class C Telegraphy (CCS)

Filament voltage, 10 volts; filament current, 5 a.; d-c plate volts, 2,000; d-c screen volts, 400; d-c grid volts, -90; d-c plate current, 180 ma.; d-c screen current, 15 ma.; driving power, 0.5 watt; power output, 260 watts.

RCA-826 . . . A NEW THREE-ELECTRODE TRIODE FOR THE ULTRA-HIGHS

Operating at maximum ratings at frequencies as high as 250 Mc and at reduced ratings as high as 300 Mc, the RCA-826 fills a long felt need. It is specifically designed as an oscillator, r-f power amplifier, or frequency multiplier at the ultra-high frequencies. Internal lead inductance is reduced to a minimum. All terminals at one end of bulb make possible the use of short leads in neutralizing circuits.

Typical Operation as R-F Power Amplifier and Oscillator—Class C Telegraphy: d-c plate voltage, 1,000; d-c grid voltage, -70; d-c plate current, 125 ma.; d-c grid current, approx. 35 ma.; driving power, approx. 5.8 watts; power output, approx. 86 watts. *Price* $19.00.

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Transmitting Tubes

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From microphone to antenna

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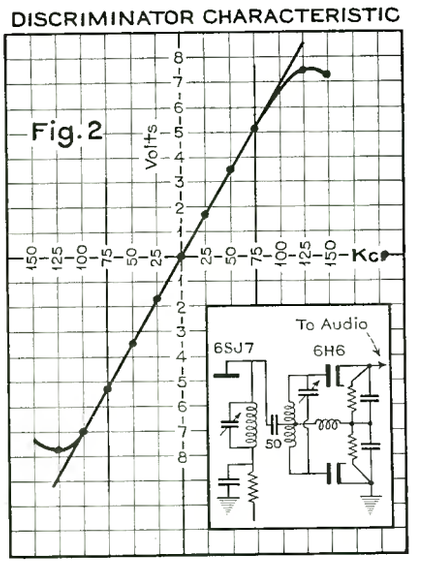
FREQUENCY-MODULATION RECEIVERS

By M. L. LEVY
Engineer in Charge
Radio Development Laboratory
Stromberg-Carlson Telephone Mfg. Co.

F-M RECEIVERS have now been developed for commercial operation, since May 1940 when the rules were laid down by the FCC freezing the standards. Prior to that time, receivers were designed to cover that range of 42.4 to 43.6 mc which was assigned for experimental transmissions. A number of manufacturers offered for sale receivers which would respond to that band and covered what seemed to be at that time the likely part of the range that f-m would grow into, viz., 40-44 mc. No manufacturer saw the turn of events at the f-m hearing, and the subsequent decision of the FCC to move the then first television band to make room for f-m. Prior to that time the portion of the band from 40 to 41 mc was taken by government services and the 41 to 42 mc band was reserved for educational purposes, so that the Commission had to find room for f-m. The result of all the data submitted at the f-m hearing convinced the FCC of the feasibility and desirability of f-m as a commercial broadcast service and the commercial f-m range is now set from 43 to 50 mc, with 42 to 43 mc reserved for non-commercial educational f-m stations. Further the FCC on the basis of the data presented at the hearing have set the channel width at 200 kc.

Thus wide-band f-m is standard. The FCC also set up the standard that the modulation deviation on the carrier shall not exceed ±75 kc, so that ±75 kc deviation is considered as 100% modulation in the terminology of amplitude modulation. The guard band is then 25 kc on each side of the carrier and modulation. The FCC also set down as a rule the pre-emphasis in the transmitter to be 100 microseconds which is the same value as is used on the sound channel in experimental television. Thus the receiver designer has all the facts at hand to design a commercial receiver which will work with all commercial transmitters which are



Circuit and characteristic of frequency detector.

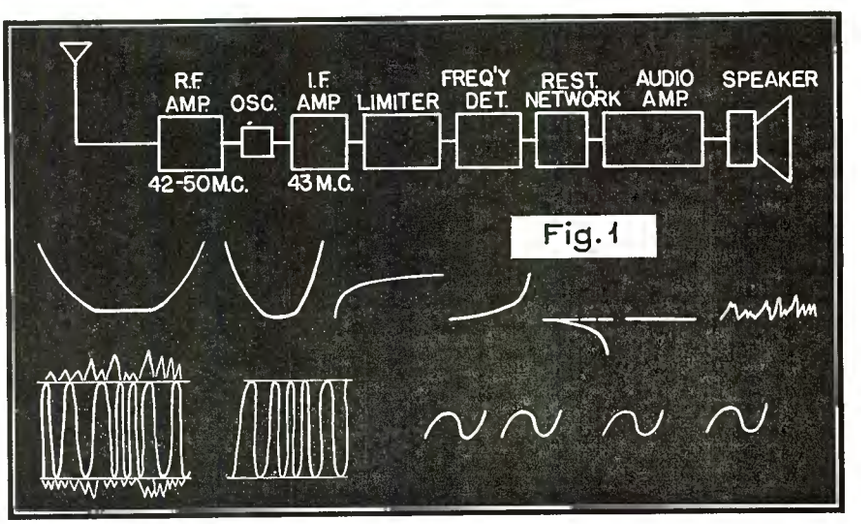
governed under the rules of FCC for f-m transmission—

42-50 mc band
200 kc channel width
±75 kc deviation or modulation.
pre-emphasis is 100 useconds.

The early experimental receivers offered for sale by various manufacturers during the experimental broadcast period were not too much different fundamentally from those being built now. The range, of course, was not correct for the commercial band. The intermediate frequency now must be different because the band is longer. All of those early receivers were designed for a 200 kc band width with the selectivity curve shape believed to be satisfactory at that time. The receivers had limiters, and fundamentally the same frequency detector as is used now. Following the transmitter design, a restorer circuit was used in the early receivers to compliment the pre-emphasis slightly different than the new standard (75 microseconds) as used in the earlier transmitters. The experience of building and operating those early receivers provided a store of field experience which made this experimental period very valuable. It was found that the limit of sensitivity under operating conditions is the local noise level.

It was found that weak signals in

Block diagram of f-m receiver.



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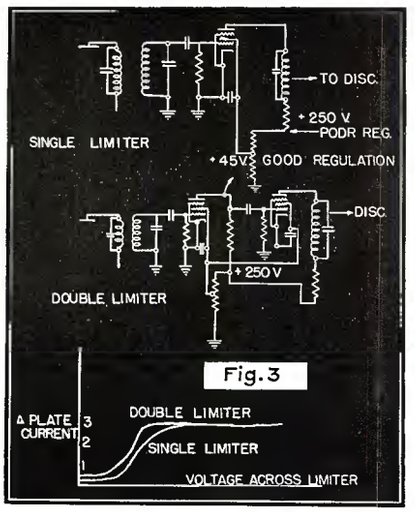
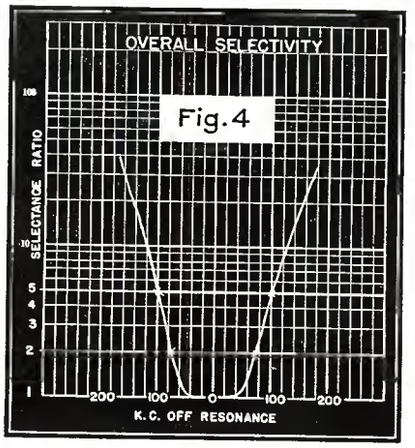


Circuits of single and double limiter.

amplitude practice are very good and useful signals in f-m, so that the sensitivity has been increased this past year from the former value of 25 to 50 uv input signal for limiting to a value of 5 to 10 uv input signal for limiting and newer receivers which will be found in the market in the near future will probably measure down to 1 or 2 microvolts for limiting. The experimental period has shown that the i-f amplifier must be built to produce a broader curve than the earlier models, in order to use signals just below limiting without distortion. Since no locality will have assignments on adjacent channels, the curve is now broadened to provide only about ½ the adjacent channel selectivity used heretofore. Along with the increased sensitivity is this broader i-f curve which allows for the full use of the sensitivity, where noise levels are very low. In order to use a signal of approximately 2uv even on a receiver which will limit at 2uv, the noise level cannot exceed 1 uv. So we see that while a very sensitive receiver is desirable, it may not be useful in too many places because of the noise level at the local point.

The intermediate-frequency used at the present by most manufacturers is 4.3 mc. It has been pointed out by one laboratory doing work with f-m that the spurious response, that is, in common superheterodyne terminology repeat signals, can be improved by using other values of the i-f, 6.25, 8.25 and 11.2 have been suggested as being somewhat better from the standpoint of this phenomenon of spurious responses. The RMA f-m committee tentatively recommended the use of 4.3 mc at the time the FCC fixed the rules, and a subcommittee is now reviewing this suggestion for the purpose of establishing a standard in the near future. Field experience in a number of localities where transmitters are most numerous will be the most valuable data for determining the best intermediate frequency for f-m superheterodynes. It is noted that about ten years of broadcasting and receiver operation were required to standardize the a-m superheterodyne i-f at 455 kc.

The typical f-m receiver is made up as shown in Fig. 1.



Characteristic of intermediate-frequency amplifier.

The discussion of receiver design will be started with the limiter and frequency detector since in order to determine how much gain is necessary preceding the limiter, it is necessary to know how much voltage must be delivered to the limiter. The limiter on the other hand must provide at its limiting voltage enough carrier to the discriminator to allow sufficient recovered audio to drive the audio amplifier to full output at relatively low deviation values. The same problem exists here as in amplitude modulation where 5 or 10% modulation should produce maximum power output with moderate field strengths.

Fig. 2 shows the circuit and characteristic of the frequency detector which includes the restorer circuit and the volume control to feed the audio amplifier. The characteristic is the measurement taken from a commercial receiver and it should be noted that the curve is linear for more than ±75 kc. Thus, this characteristic assures linear detection for frequency-modulated signals.

Fig. 3 shows the circuit of two types of limiters commonly used, the single and double limiter. The circuits are shown and the values used in the input and output circuits. The time constants of the two input networks are important to the limiting of impulse noise. The characteristics shown of the limiters are static characteristics which only indicate the action of the limiter. The curves show the characteristics of the limiter presented to the discriminator.

Fig. 4 shows the shape of the i-f amp. characteristic. The circuits look like conventional i-f circuits of the superheterodyne. The r-f amplifier is usually a high gm tube in conventional circuits. The antenna circuit may be fixed tuned or variable tuned.

Fig. 5 shows the overall gain of the receiver. The top line marked limiter is the voltage required to operate the limiter at a minimum point, this point is the point beyond which very little change in plate voltage occurs, as shown on a previous figure.

Here we see that the gain per stage is noted and the overall gain in the receiver is the product of the individual gains. A good check for regeneration, or degeneration is to compare the product of the gains of the individual stages with the result of the measured antenna sensitivity divided into the input limiter voltage. The total amplification in the receiver is about 1 million times from antenna to limiter.

Regeneration is particularly harmful, because of the change in characteristic

• • •

Curves showing signal-noise ratios for various field intensities. These are comparative curves of a number of commercial receivers.

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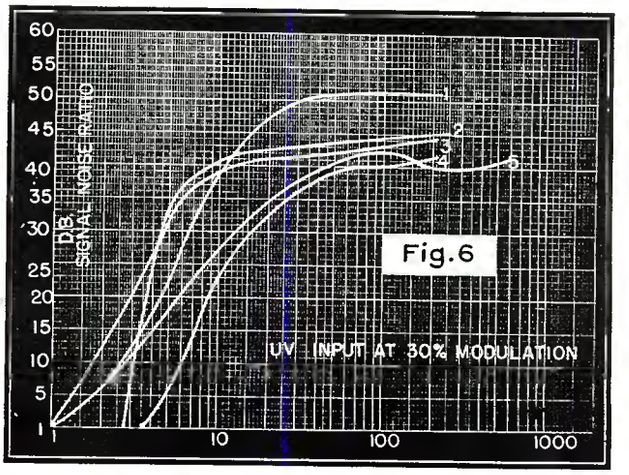

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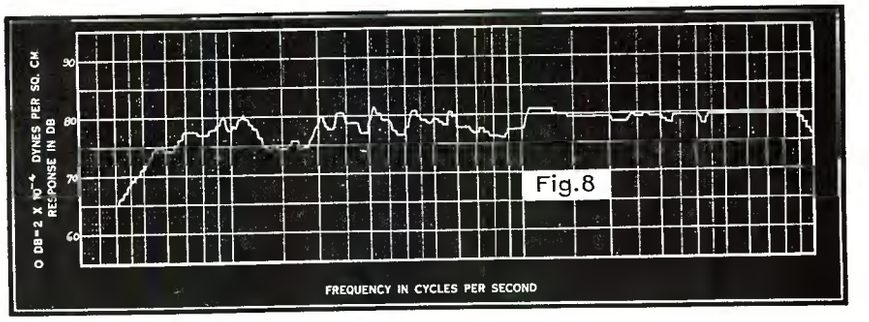
shape from one level to another. Weak signal operation where the limiter may not be effective requires symmetrical curves to help reduce noise and distortion. Where limiter operation is assured, this effect is diminished, but still it is desirable from every standpoint to maintain good stability in the receiver, because if for no other reason, to maintain a uniform product. Degeneration is equally harmful, unless it is very well controlled in each stage. A good and useful method of degeneration in one stage which can be controlled successfully to help prevent regeneration, is to use an unbypassed portion of a cathode resistor. This has a stabilizing effect, if the reduction in gain is allowable.

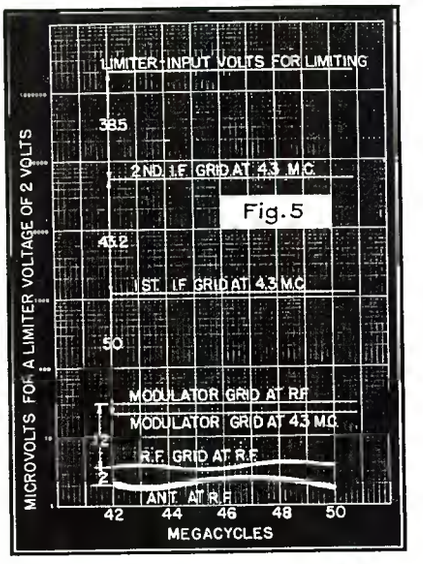
Fig. 6 shows the most universal set of curves for operation of an f-m receiver. These curves represent what happens with regard to signal-noise ratio at an infinite number of field strengths. The limiter characteristic is represented in this curve, the sensitivity of the receiver, the noise in the receiver itself, and the symmetry of the circuits. These curves were taken with no external noise added.

The signal was modulated 30% of maximum deviation. A frequency-modulated generator was used as the source and the signal-noise ratio was measured by means of A.V.T.V. If 100% of the maximum deviation was used, the signal-noise ratio would be increased by about 10 db. It is felt, however, that 30% of the maximum deviation is a more representative practical value, since that would more nearly duplicate the point of audio level where the receiver volume control would be set and also be nearer to an average modulation figure (no filters were used to reduce the hum and noises beyond 15000 cycles). These are comparative curves of a number of commercial receivers.

One of the important characteristics to know is the amount of harmonic distortion produced by an f-m system. Since the tubes in the r-f and i-f amplifiers do not contribute to distortion, the circuits must be designed very carefully and the final test of a system from the quality standpoint is its overall harmonic distortion. *Fig.* 7 tabulates the various results of harmonic distortion showing the amplitude of the 2nd and 3rd harmonics at various signal inputs. These are shown for a number of the commercial receivers. It will be noted that the second harmonic is usually excellent throughout, but at the 50 uv level and 100% of maximum deviation the 3rd harmonic is high in almost all cases. This is due, perhaps, because of the lack of solid limiting. The second harmonic is good probably because the discriminator was always tuned to 0 d-c volts. The audio amplifier distortion does not enter into these figures because the measurements were taken at a very low level.



Overall acaustical frequency characteristic of commercial receiver using speaker system flat within plus ar minus 2 db fram 50 ta 15,000 cycles.



Overall gain af the receiver.

Thus, we see some of the progress made in the past two years in f-m receiver design. This past year has seen the double limiter design along with better single limiters. The most impressive advance is probably the sensitivity which the f-m receiver is capable of producing with stability. A good deal of tube development for f-m amplifiers at both i-f and r-f is now in progress and we look forward in the future to simpler and even more sensitive receivers.

The audio quality of f-m receivers depends largely of course on the speaker developments of the future. Good speaker systems with flat response and extended range both high and low frequencies are costly, but we may rest assured that the radio industry will produce within a short time extended range speaker more reasonably priced to give the American public the fine quality that f-m is capable of delivering. Fig. 8 shows an overall acoustical frequency characteristic of a commercial f-m receiver using a speaker system which is flat within ±2 db from 50 to 15,000 cycles.

• • •

F-M STATION

The FCC has just granted a construction permit for a 50,000-watt F-M station to cover an area of 69,400 square miles. Issued to Gordon Gray, Winston-Salem, North Carolina, publisher, the top of the antenna will be 6,875 feet above sea level (atop Clingman's Peak). Some 4,346,000 people live within the coverage area which embraces portions of 7 states.

Tabulatian of harmanic distartian, shawing amplitude af 2nd and 3rd harmanics at variaus signal inputs far a number af cammercial receivers.

Overall Harmonic Distortion @ 400 Cycle 30% Mod.

Input uv		% Harmonics 30% Mod.					% Harmonics 60% Mod.					% Harmonics 100% Mod.				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
	II	.3	1.5	3.2	2.3	.3	.1	1.2	4.3	1.8	2.3	.3	1.0	7	2.2	7.1
50 uv	III	1.1	2.4	1.5	2.2	1.8	3.9	5.9	2.6	3.8	4.1	26.	12.5	17	50.	12.
5000 uv	II	.4	.8	2.6	1.55	2.7	.9	3.7	4.4	2.3	.5	.9	9.0	4.5	2.1	.7
	III	1.0	3.5	1.1	1.2	1.3	.2	19.5	.8	1.2	2.2	1.0	26.	.8	2.2	.47
	II	1.6	1.8	.2	.7	-	2.4	3.6	.1	1.25	1.2	1.2	2.3	.8	2.1	1.3
50000uv	III	1.3	2.5	1.1	1.6	1.4	1.5	6.0	.4	2.5	2.3	2.3	13.	1.5	4.8	4.5

Note II = Second Harmonic Fig.7 III = Third Harmonic

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FREQUENCY-MODULATION TRANSMITTERS

WITH frequency-modulation broadcasting now on a commercial basis, it is of interest to follow the developments in f-m transmitting equipment. Past issues have contained data on several lines[1] and it is the purpose of this article to briefly describe the RCA f-m transmitters.

This organization has made available f-m transmitters in various power ratings, including 250, 1,000, 10,000 and 50,000 watts units. Most of these transmitters are shown in accompanying illustrations. All of them employ the same basic modulation and frequency control unit with appropriate power amplifiers. Hence it will suffice to describe only one of these transmitters in detail, the FM-1B.

This transmitter may be considered in two parts, the Crosby exciter and the amplifier. We will first consider the exciter unit, which employs a stabilized circuit conceived by M. G. Crosby of RCA Communications. Advantages claimed for this circuit are simplicity, a relatively small amount of frequency multiplication, and high stability.

The Crosby Exciter

Referring to the simplified schematic diagram of the complete transmitter, it will be noted that an 807 tube is used as the electron-coupled oscillator. This oscillator is modulated by two 807 reactance tubes to provide the frequency modulation. These modulator tubes have their plates connected in parallel across the oscillator tank while their grids are supplied inductively with push-pull excitation from, but 90° out of phase with, the oscillator tank circuit.

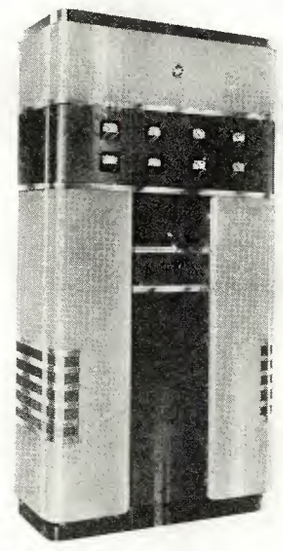
The audio-frequency modulating voltage is also introduced into the grid circuits in push-pull so that under quiescent conditions the modulator tubes draw equal and oppositely phased currents from the tank circuit. An audio signal disturbs this balance causing one tube to draw more current and the other to draw less to produce an effective positive or negative reactance across the oscillator tank circuit, thereby modulating the frequency in accordance with the amplitude of the audio frequency voltage impressed on the modulator grid.

To maintain the degree of frequency stability required by the regulations of the FCC, the Crosby automatic-frequency-control circuit is provided to hold the average carrier frequency within close limits. A separate quartz crystal-controlled oscillator is arranged so that its output excites one grid of a 1613 mixer tube. The other grid of this tube is supplied with energy from the 807 amplifier stage following the oscillator. The plate circuit of the mixer is tuned to the difference in frequency between these two signals, or one megacycle. The output of the mixer is coupled to a 6R6 rectifier tube through a discriminator circuit and the direct-current output of the rectifier is in turn connected into the grid circuit of the modulator tubes to provide differential correction bias.

The discriminator circuit is so set up and tuned that no control voltage is obtained on the grids of the modulating tubes as long as the mixer output frequency is one megacycle. If the oscillator frequency varies, the beat frequency fed to the discriminator will vary in the same way, thus setting up a differential voltage on the grids of the modulator tubes which tends to counteract this frequency change. The control ratio is such that the net frequency change is a very small fraction of the change which would have resulted had the oscillator been uncorrected.

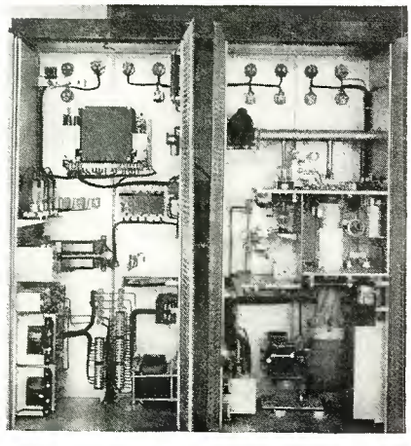
A 6J5 is used in an interlock circuit so arranged that failure of any component in the automatic frequency control circuit actuates a relay which is used to sound an alarm and/or take the transmitter off the air.

Provision is also made in the modu-

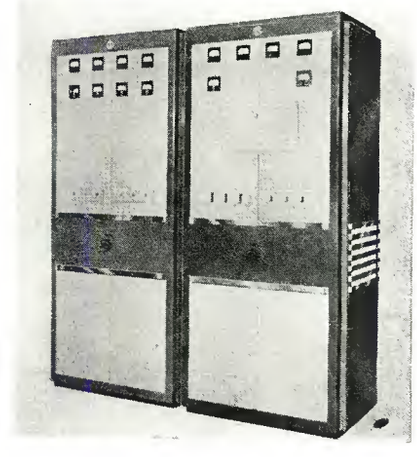


Front view of RCA 250-watt f-m transmitter.

Rear view of 1,000-watt f-m transmitter.



Front view of the 1,000-watt transmitter.



[1] "New U-H-F Transmitters," p. 10, Dec., 1939, COMMUNICATIONS.
"Notes on F-M Transmitters," by Frank A. Gunther, p. 11, April, 1940, COMMUNICATIONS.
"Synchronized Frequency Modulation," p. 12, August, 1940, COMMUNICATIONS.
"F-M Broadcast Transmitters," by W. R. David, p. 8, Oct., 1940, COMMUNICATIONS.

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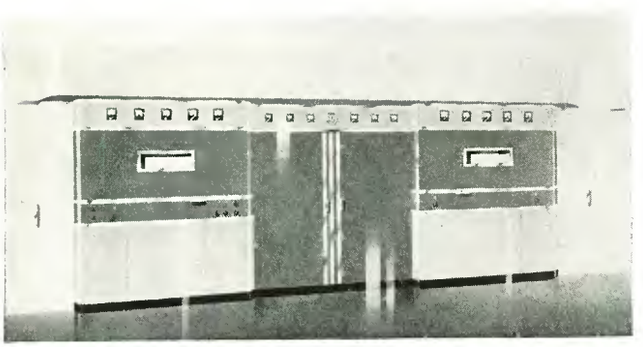
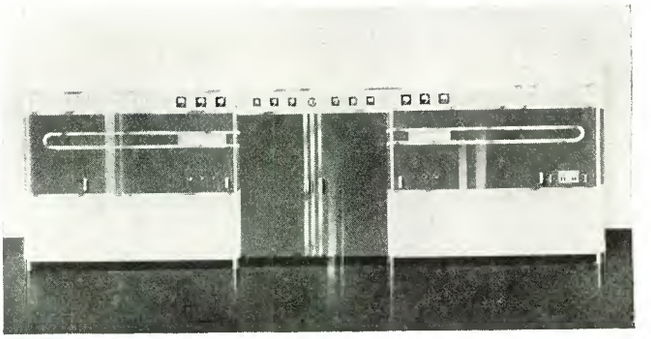
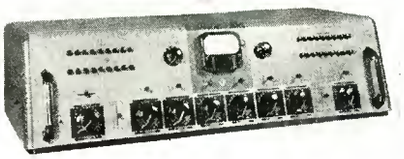




Above: Left, 10,000-watt, and, right, 50,000-watt f-m transmitters.
Below: Speech-input consolette suitable for f-m.



lator bias circuit to statically move the unmodulated carrier from side to side by the full deviation capability to aid in aligning succeeding amplifier stages for proper bandwidth.

Two audio-frequency input circuits are provided, one following the standard 100 microsecond RMA pre-emphasis curve from 30 to 15,000 cycles for high-fidelity audio transmission and the other flat from 30 to 25,000 cycles to provide for multiplex transmission of facsimile on a subcarrier frequency as well. Filter circuits are provided in the automatic frequency control circuit to give sufficient time lag so that fidelity will not be affected by the feedback modulation, nor will afc be affected by the modulating signal.

Since no audio-frequency amplifier tubes are used in the transmitter between the audio input terminals and the modulator grids, distortion is low and substantially independent of the modulating frequency.

The discriminator and modulated-oscillator tank circuits are equipped with negative temperature coefficient compensators and all frequency affecting circuits in the exciter are enclosed within a dual heat oven in order to further insure the frequency stability. The oven heater winding operates on a separate 115-volt a-c input, in series with two thermostats. One of these is for normal regulation of the oven temperature and the other for emergency cut-off in case of failure of the first.

The use of two tubes as a differential or push-pull modulator gives the circuit a compensating effect which tends to balance out circuit disturbances or irregularities which exist simultaneously in both modulator tubes. Thus, the variation in plate potential due to transients, line-voltage fluctuation or rectifier ripple is almost completely cancelled out. The effect is directly analogous to that existing in a push-pull audio system in which even harmonic distortion cancels and the fidelity of the system is greatly improved.

Although the distortion is low over the normal (± 100 kc) modulation range, the modulators are capable of swinging the frequency twice as far (± 200 kc) with virtually no increase in modulator distortion.

An automatic regulating transformer supplies all filament and plate voltages to the exciter so that line voltage fluctuations as high as ± 15% have substantially no effect on the output frequency. Overall exciter protection is provided by a circuit breaker switch ahead of the regulating transformer.

The exciter employs only eight tubes, exclusive of its power supply, thus avoiding the circuit adjustment complexity. Two meters are provided in conjunction with the exciter circuit. By means of a selector switch, a milliammeter allows checking of all cathode currents. The discriminator balance meter provides a continuous check of frequency stabilizing action and simplifies initial tuning.

In order to provide for rapid servicing of the heat oven and the components housed within it, the entire oven may be very quickly unplugged from the exciter chassis and slid out on its runners. Similar access may be had to the components within the heat oven.

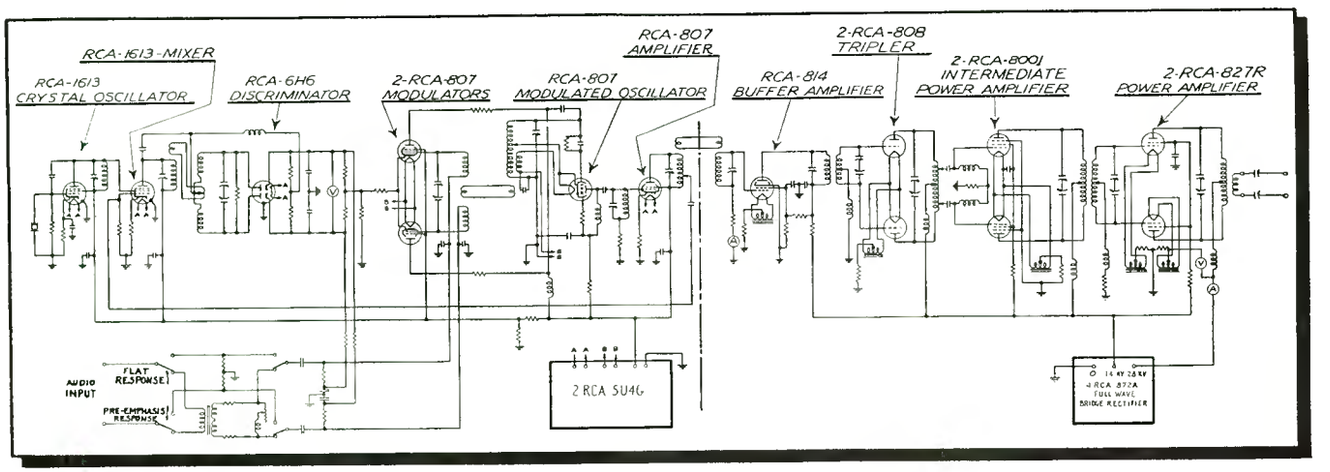
Front panel tuning controls are provided for the modulated oscillator, modulator grid, mixer plate, discriminator, buffer grid, and buffer plate. The modulator control switch (afc on-off), static deviation control, afc, alarm control, plate switch, and heater fuses are also located on the front panel.

The FM-1B Amplifier

This amplifier is composed of two cabinets, one housing the radio fre-

(*Continued on page 23*)

Simplified circuit of 1,000-watt transmitter.



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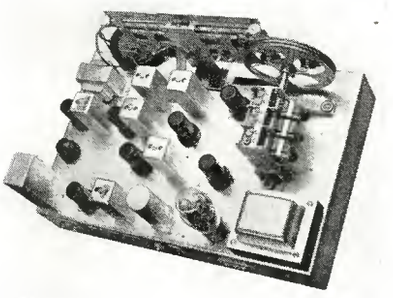
A-M/F-M Broadcast Tuner

By S. GORDON TAYLOR

IN THE development of a line of f-m receiver equipment by Hallicrafters stress has been laid throughout on its technical applications rather than home use. True, equipment which meets the higher technical standards for the various professional services necessarily provides features which suit it admirably to home service, at least so far as operating characteristics are concerned. Physical appearance is another matter and no attempt has been made to dress up these models for the living room.

The S-27 model described in some detail in the December issue of COMMUNICATIONS was designed to provide complete coverage of the ultra-high-frequency ranges from 27 to 145 mc. Including provision for both f-m and a-m reception throughout this range, it has found application in a wide variety of professional and experimental services including government, commercial and amateur. Because in many of these services compactness is desirable, with maximum convenience in arranging set-ups, this receiver was made entirely self-contained except for the loudspeaker.

It was realized that while this receiver serves substantially all services operating above 27 mc, it is unnecessarily "universal" for some specific types of service, particularly for fixed service in broadcast stations, studios, high-quality sound installations, etc. It therefore seemed desirable to provide somewhat simpler equipment to meet the individual requirements of these specific services. The result is the Model S-31 f-m/a-m tuner to be described here, designed especially for broadcast service.



Above: Top view of tuner with cover removed.

Below: Circuit diogrom of tuner.

As illustrated herewith, this is a rack-mounting unit with self-contained power supply but without audio power stage or loudspeaker. It provides output power of 130 milliwatts into loads of 500 or 5000 ohms, or headphones. It is therefore suitable for operation into any good standard amplifier system, or into the audio end of high-quality radio sets.

The tuner provides a-m coverage over the range of 545 to 1650 kc and f-m coverage from 40 to 51 mc. Selection is made by means of a "Broadcast-FM" switch on the front panel. Provision is also made for working a phono pick-up through the single audio stage so that, employed in sound systems and the like, the choice of radio inputs a-m or f-m and phono input is available from another switch on the tuner panel. In addition to these two controls the

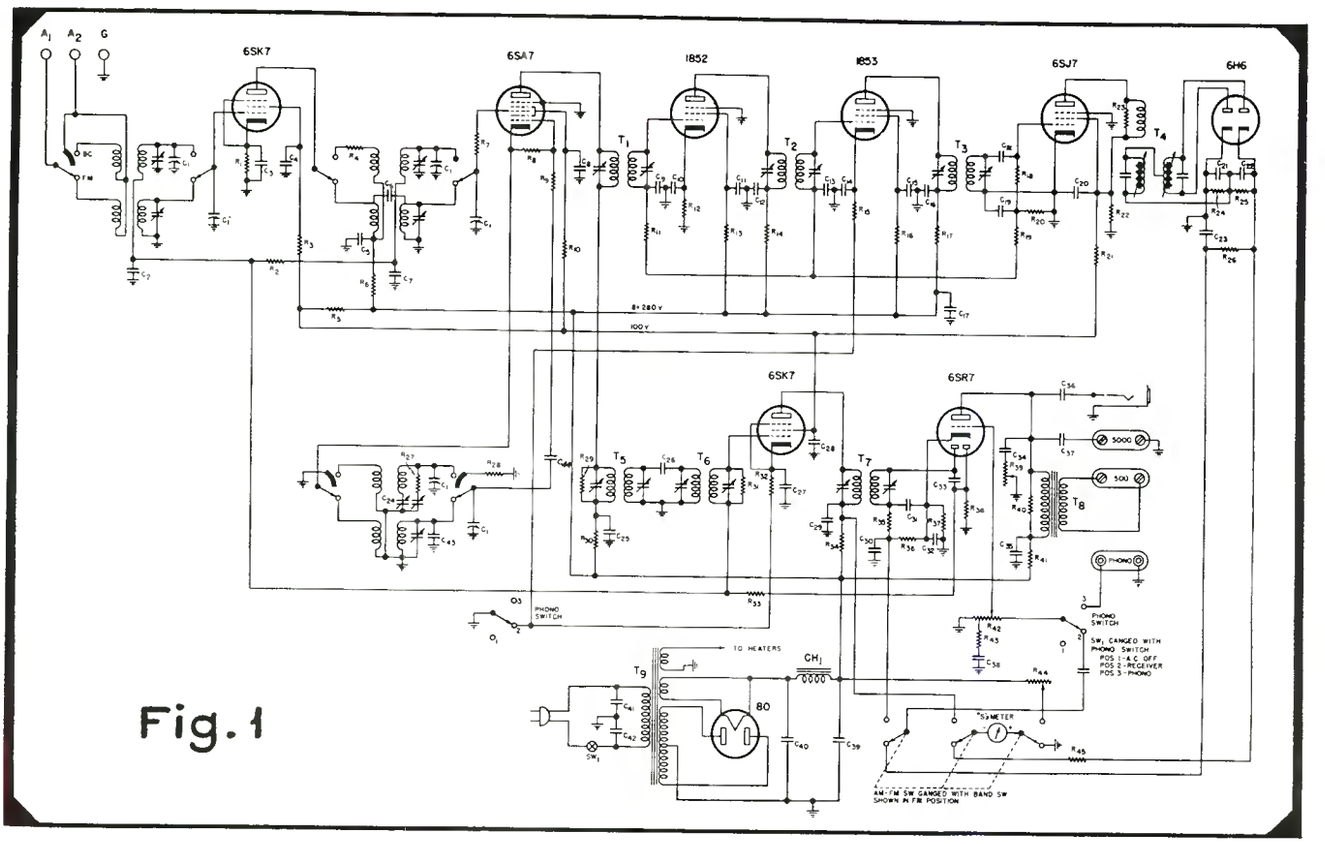


Fig. 1

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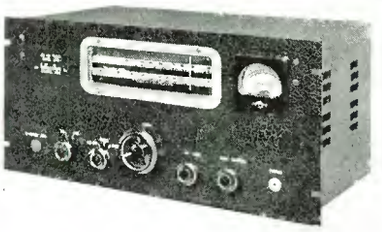
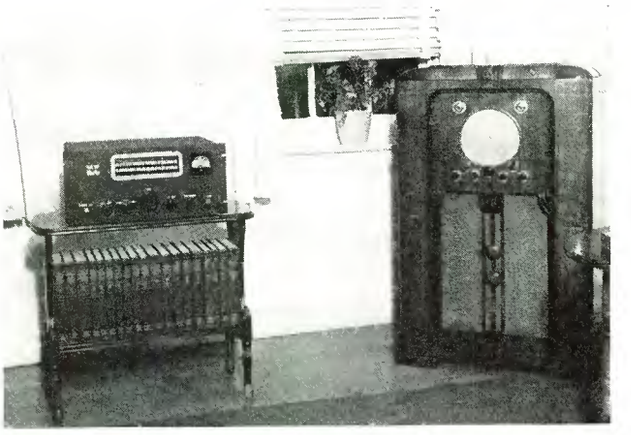


Left: Frant view of the a-m/f-m broadcast tuner.

• • •

Right: Showing the tuner in use with o cammercial hame receiver.

• • •



only others are the conventional audio gain and tone controls.

A single large tuning "wheel" serves for both bands, a pointer moving over a well illuminated "slide-rule" type dial which is fully calibrated for both tuning ranges. An important tuning accessory is the meter located beside this dial. When operating in the standard broadcast band this meter functions as a conventional "S" meter, for which purpose it is calibrated to "S-9", and in db above this level.

When the tuner is switched to the f-m position the meter is automatically changed over to serve as a voltmeter across the discriminator load where it functions as an accurate carrier centering indicator. Its zero position is now at a red line about three-quarters upscale. In tuning through an f-m signal the pointer will first move away from zero, will return to zero when the signal is exactly centered, and will again move away from zero, but in the opposite direction, as the receiver is tuned through the other side of resonance. It is therefore only necessary to tune for this zero point between excursions to insure maximum fidelity of reproduction and freedom from noise.

The complete schematic circuit of the S-31 tuner is shown in Fig. 1. Here it will be noted that the 6SK7 preselector stage and 6SA7 converter are common to both channels. The output of the converter is fed simultaneously to the two separate i-f systems. The 4.3 mc f-m i-f amplifier consists of two high-gain stages utilizing an 1852 (6AC7) and an 1853 (6AB7). These are followed by the 6SJ7 limiter and 6H6 discriminator.

The 455 kc broadcast i-f amplifier includes only a single 6SK7 tube, but has a total of 6 tuned circuits so designed as to combine sufficiently wide bandpass for good audio quality with the steep skirts necessary for good selectivity. The diode section of the 6SR7 serves as a-m detector and avc voltage source.

The triode section of the 6SR7 serves

(*Continued on page 24*)

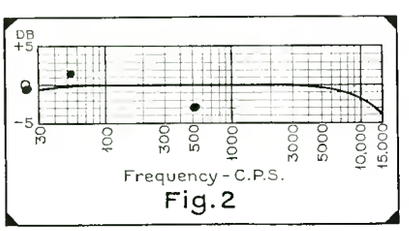


Fig. 2

Abave: Frequency respanse characteristic of tuner.

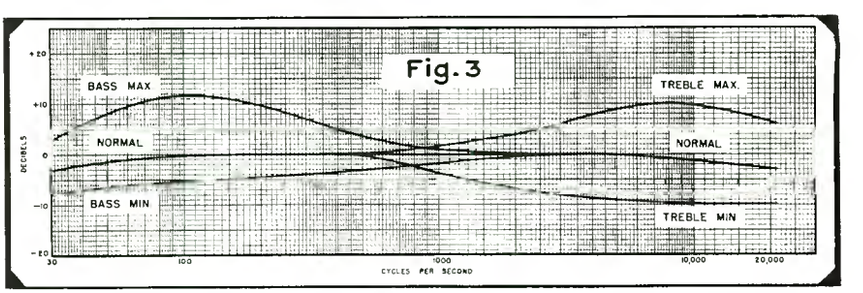


Fig. 3

Above: Response characteristic af amplifier for variaus positians af tane contral.
Left: Circuit af amplifier.
Below: Tuner and amplifier can be rock maunted.

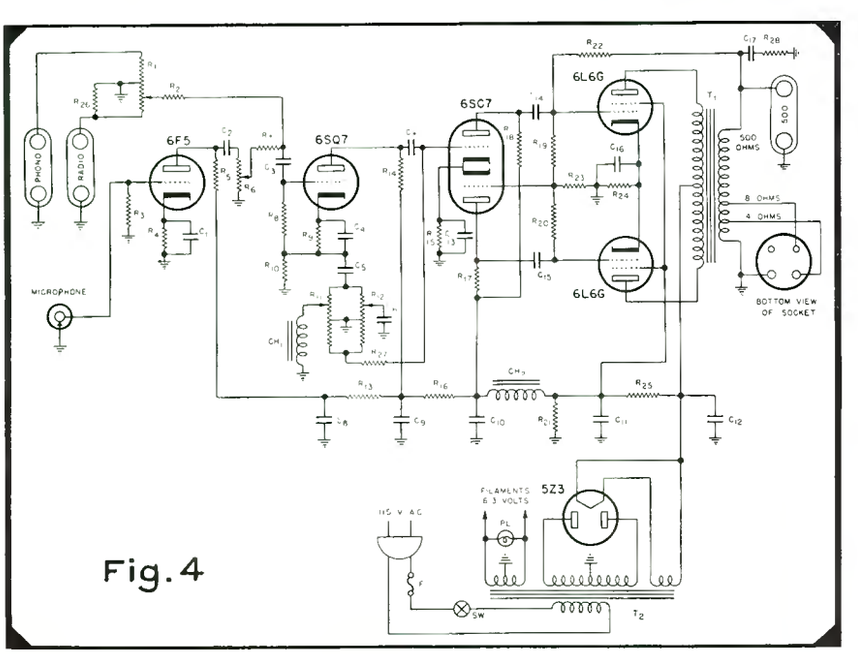
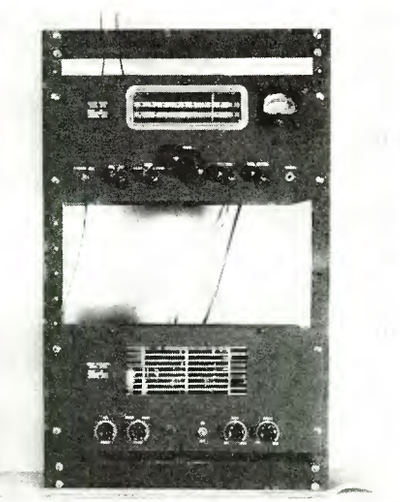


Fig. 4



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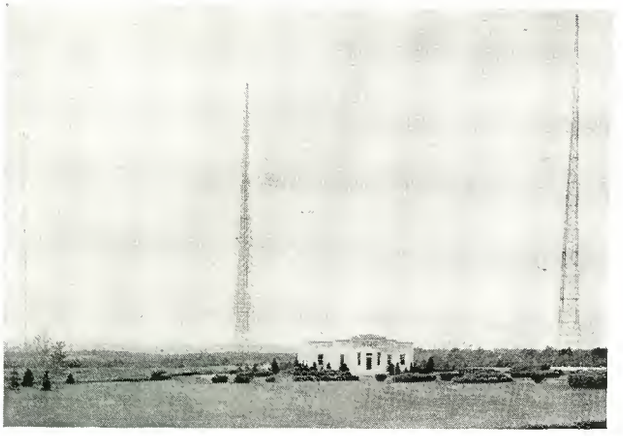
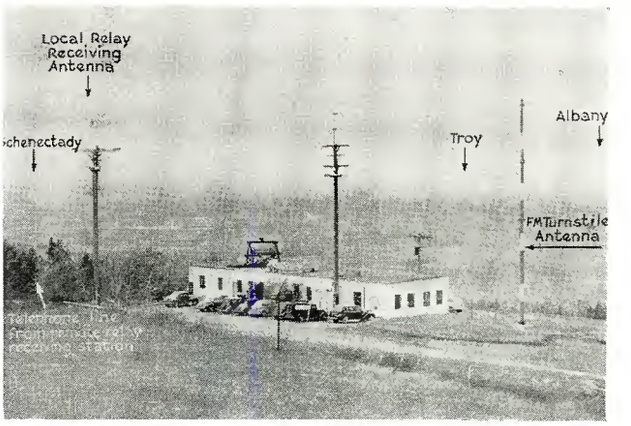


Transmitter building and antennas of WTAG, Worcester, Mass. Building hauses 1000-watt f-m transmitter. Phata caurtesy General Electric Ca.



General Electric frequency-modulatian and television statian in Helderberg Mauntains near Schenectady, N. Y. Nate f-m and relay antennas.

FREQUENCY-MODULATION BROADCASTING

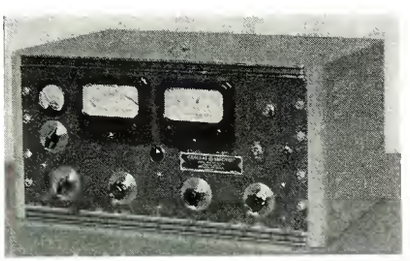
WITH frequency modulation playing an ever more important role in broadcasting, it seems well to pause and view the present status of the art. That, in a general way, is the purpose of this article.

F-m really began to show itself as a factor in the radio industry in the early part of 1940. Early in the year the F-M Broadcasters, Inc. (FMBI), was organized to coordinate the activities of the various parties interested in f-m broadcasting. The FMBI, incidentally, has done some excellent work in the interests of f-m broadcasting.

After hearings before the Federal Communications Commission, frequency-modulation broadcasting was placed on a commercial basis the first of this year. To date (March 15) the Commission has granted some 43 construction permits, while a total of 51 applications still await official action. Some idea of the scope and coverage of these stations may be gained from the accompanying table.

While several stations are operating with commercial transmitters, most f-m broadcasting is still confined to the use of low-powered experimental transmitters, most of which are 1000-watt units.

G-E manitar tar f-m station, measures center-frequency deviatian, percentage madulatian, and includes modulatian-limit flasher, high-fidelity a-f autput and temperature-cantrolled crystal.



State and City	Owner	Call Letters	Freq. Mc.	Coverage Sq. Mi.	Coverage Population
CALIFORNIA					
Los Angeles	Don Lee Broadcasting System	K45LA	44.5	6,944	2,600,000
CONNECTICUT					
Hartford	The Travelers Broadcasting Svc.,	W53H	45.3	6,100	1,036,400
	WDRC, Inc.	W65H	46.5	6,100	1,118,000
ILLINOIS					
Chicago	NBC	W63C	46.3	10,800	4,500,000
	WJJD, Inc.	W47C	44.7	10,800	4,500,000
	WGN, Inc.	W59C	45.9	10,800	4,500,000
	CBS	W67C	46.7	10,800	4,500,000
	Moody Bible Institute		47.5	10,800	4,500,000
	Zenith Radio Corp.	W51C	45.1	10,800	4,500,000
Rockford	Rockford Broadcasters Inc.	W71RF	47.1	3,900	270,000
INDIANA					
Evansville	Evansville on the Air	W45V	44.5	8,397	465,000
South Bend	South Bend Tribune	W71SB	47.1	4,300	448,000
Ft. Wayne	Westinghouse Radio Stations	W49FW	44.9	6,100	420,000
LOUISIANA					
Baton Rouge	Baton Rouge Broadcasting Co.	W45RG	44.5	8,100	361,400
MASSACHUSETTS					
Boston	Westinghouse Radio Stations	W67B	46.7	6,700	3,400,000
Springfield	Westinghouse Radio Stations	W81SP	48.1	2,500	500,000
MICHIGAN					
Detroit	Evening News Assoc.	W45D	44.5	6,820	2,498,000
	John Lord Booth	W49D	44.9	6,800	2,900,000
NEW HAMPSHIRE					
Mt. Washington	Yankee Network	W39B	43.9	31,000	2,000,000
NEW YORK					
New York City	CBS	W67NY	46.7	8,500	12,000,000
	Bamberger Broadcasting Svc.	W71NY	47.1	8,500	12,000,000
	W. G. H. Finch	W55NY	45.5	8,500	12,000,000
	NBC	W51NY	45.1	8,500	12,000,000
	Marcus Loew Booking Agency	W63NY	46.3	8,500	12,000,000
	Frequency Broadcasting Corp.	W59NY	45.9	8,500	12,000,000
	Metropolitan Television, Inc.	W75NY	47.5	8,500	12,000,000
	E. H. Armstrong		43.1	15,610	12,200,000
Schenectady	General Electric Co.	W57A	45.7	6,600	968,000
	Capitol Broadcasting Co.	W47A	44.7	6,589	967,000
Binghamton	Howitt-Wood Radio Co.	W49BN	44.9	6,500	256,300
Syracuse	Central New York Broadcasting	W63SY	46.3	6,800	600,000
Rochester	Stromberg-Carlson		45.1	3,200	585,000
NORTH CAROLINA					
Winston-Salem	Gordon Gray		44.1	69,400	4,346,000
OHIO					
Columbus	WBNS, Inc.	W45CM	44.5	12,400	1,100,000
PENNSYLVANIA					
Philadelphia	WCAU Broadcasting Co.	W69PH	46.9	9,300	3,846,000
	WFIL Broadcasting Corp.	W53PH	45.3	9,300	3,850,000
	Pennsylvania Broadcasting Co.	W47PH	44.7	9,300	4,500,000
	Westinghouse Radio Stations	W57PH	45.7	9,300	4,500,000
Pittsburgh	Walker-Downing Radio Corp.	W47P	44.7	8,400	2,100,000
	Westinghouse Radio Stations,	W75P	47.5	8,400	2,100,000
TENNESSEE					
Nashville	National Life & Accident	W47NV	44.7	16,000	819,000
UTAH					
Salt Lake City	Radio Service Corp. of Utah	K47SL	44.7	623	194,000
WISCONSIN					
Milwaukee	The Journal Co.	W55M	45.5	8,540	1,522,000

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Photos courtesy Western Electric Co.

Above: WOR's f-m transmitter. Left: J. R. Poppele, WOR's Chief Engineer, and Conductor Alfred Wallenstein examine f-m speech input equipment.

This condition exists mainly because of slow delivery of some transmitting equipments. Certain manufacturers are loaded with defense orders and have been unable to promise an early delivery date. While this condition may be improved shortly, the broadcasters must still undergo a period of transmitter building, field tests, organization forming, etc., so that full commercial operation is likely to take from 60 days to 6 or 8 months in some communities.

Recognizing the situation, the FCC will now permit experimental transmitters to switch over to commercial operation with commercial call letters pending complete installation of regular equipment.

The FCC has also made provisions for experimental stations whose applications are still awaiting official action. Theoretically, all experimental licenses expired December 31, 1940, but actually were extended 60 days to March 1, 1941. Now, upon request, there may be granted one or more extensions until action is taken on the f-m applications still pending. The stations will continue to use their experimental call letters and channel.

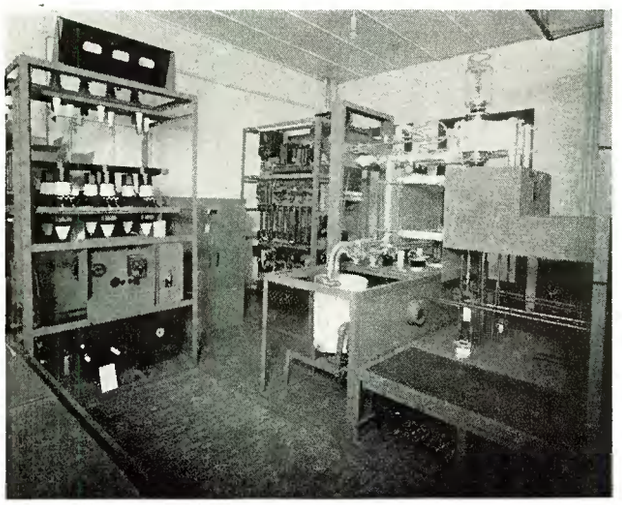
Another situation has been considered by the FCC. This comprises operators of experimental f-m transmitters who have not as yet filed application for commercial licenses. They will be permitted additional extensions only so long as no commercial service is being offered in their area.

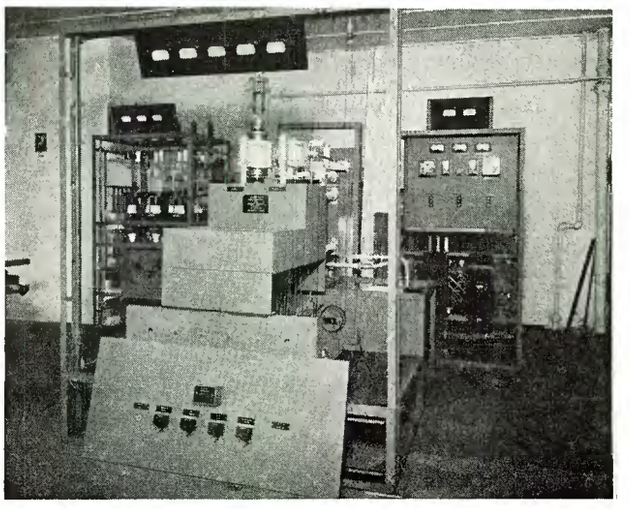
It is interesting to note the standard method that has been adopted for assigning call letters to f-m stations. The first letter is either a W or K, depending upon whether the station is east or west of the Mississippi. This is followed by two numbers indicating the frequency assignment in the 40-mc band. The final letter or letters are used to designate the city or general locality of the station. For example, W63NY is a New York station operating on 46.3 mc, while K47SL is a Salt Lake City station on 44.7 mc.

It is also interesting to note that f-m stations are assigned areas rather than

(*Continued on page* 15)

Two views of a 50-kw frequency-modulation transmitter under construction in the Radio Engineering Laboratories.





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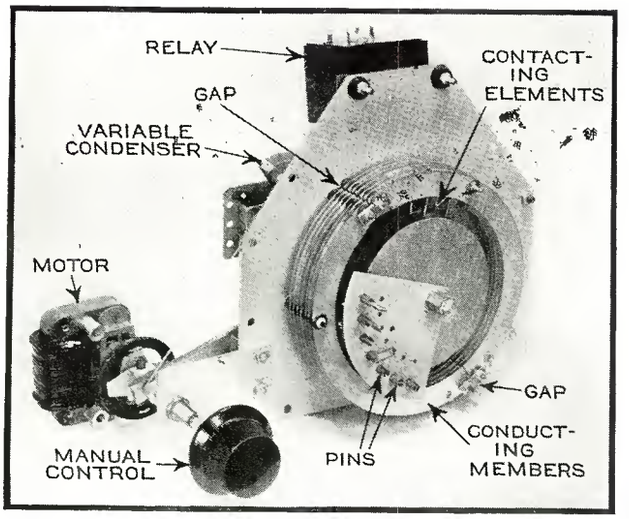

Fig. 1. Showing the vorious ports of the remote-control system.

A REMOTE CONTROL

A New Automatic System for Remote-Control Operation of Radio Receivers and Transmitters

By MICHEL YARDENY

THERE are many instances when it is desirable to operate special radio transmitters and receivers by remote control. Their use in boats, tanks, airplanes, etc., is increasing daily. Hence it is believed that the new system described here will be of interest.

This remote-control selector system (U. S. patents pending) has a high degree of accuracy and permits the user to pass directly from automatic to manual operation and vice versa. The selector of this system differs somewhat from the usual motor-driven type. The fundamental assembly* is shown in Fig. 1, while a cross section diagram of the unit is shown in Fig. 2. It comprises a demultiplication system for the manual control, the selector, variable condenser and a hunting means to absorb momentum of the motor. Referring to the above figures, it will be noted that pins are used to predetermine the desired points of contacting elements. Each of the circular outside conducting members consists of two separate semi-circular parts electrically separated by gaps. Referring to Fig. 3, it will be seen that the size of the actual contacting element is made larger than the gap, so that the contact will touch both of the conducting members at the same time and at the same points. When this condition is obtained opposing currents are set up in the windings of the reversible motor, resulting in an electric break in the motor. The delay relay switch mounted in the selector circuit automatically cuts off the current when the motor stops definitely.

Perhaps the best way to explain the operation of this unit is to describe its operation in several special circuits.

First let us consider the circuit shown in Fig. 4. This circuit is comprised of two elements of the selector, a relay, two push-button switches and a reversible motor. For purposes of simplification only two selector elements and two push buttons are shown. In general there would be as many selector elements as push buttons. It should also be noted here that only one reversible motor and one relay is required for any number of push buttons.

Let us refer again to Fig. 4. When push-button A is depressed the other push button B is automatically switched off. Contacts C and D provide momentary contact at the same time that contact is made between E and F. Contact between C and D is broken when the pressure is removed from the push button.

Above: Fig. 3. Note thot size of contocting element is lorger than the size of the gop.

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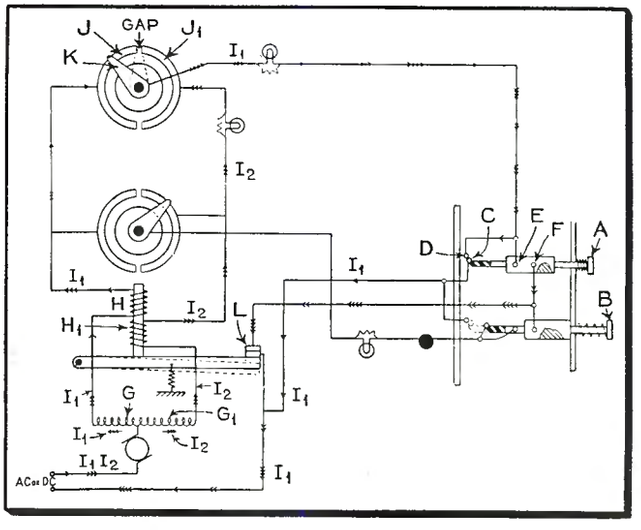
Right: Fig. 4. A tuning method using the remote-control selector system.

Now when button A is switched on, momentary contact is made between C and D and the current flows as indicated by I_1, i.e., from source through motor winding G, coil H to semi-circular conducting element J, contactor K, through contacts C and D and back to the source. As relay H is energized contacts L and M are made and contacts C and D broken. The motor now drives the contactor K to the gap and the current flows as indicated by I_1 and I_2—G, G_1; H, H_1; J, J_1 etc. Since the windings on the relays are opposing, the motor is electrically broken and the relay contacts L and M broken.

The lamps shown in Fig. 4 are given as an example, as they can often be used for signalling purposes. Naturally, the arrangement given above can also be operated by wireless . . . such as a transmitter operating a receiver which establishes the correct circuit connections.



*This particular unit was manufactured originally in the Yardeny laboratories in Paris.

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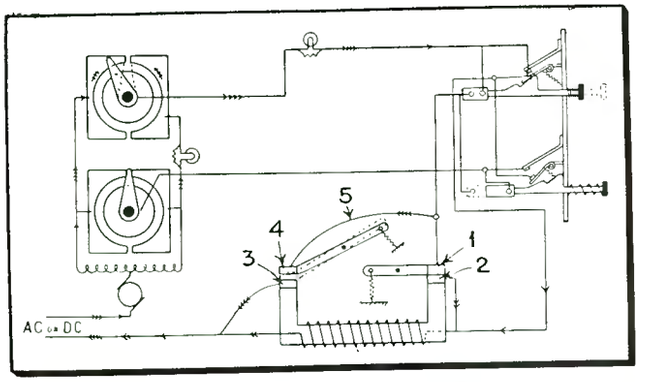
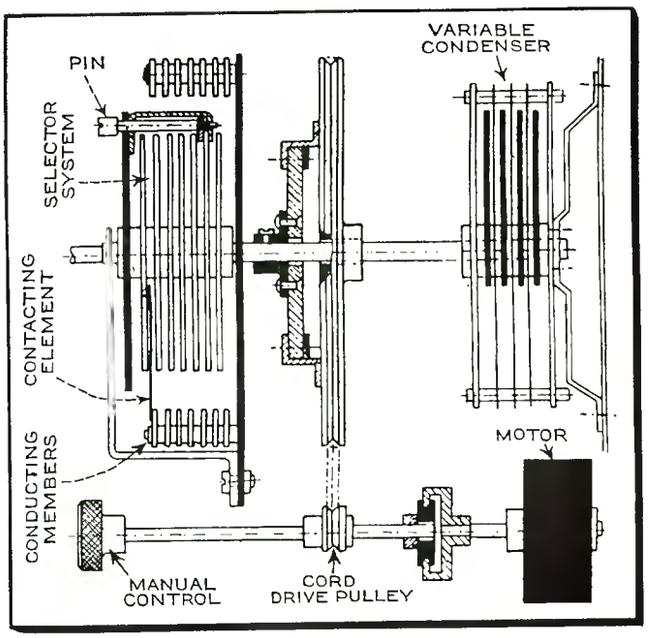
SYSTEM



Right: Fig. 2. Cross-section view of the control system.



Above: Fig. 5. Another method in which the tuner may be used.

Instead of having the currents in Fig. 4 operating in opposition, they can be used to boost the current in the common wire, as in Fig. 5. Here the normal current energizes the relay and contacts 1 and 2 are closed. When the current boost occurs, the e-m-f on the relay is increased and contact is established between 3 and 4. This latter action short-circuits the relay and permits current to pass through the wire 5. As the relay does not receive further energy the current is broken. Of course the relay switch must be of the time-delay type.

Fig. 6 shows another way in which the current in the common wire can be automatically cut. When the current passes through one of the windings of the motor, the shaft of the motor advances and closes contact AB. However, when the contactor reaches the gap, opposing currents flow through the motor windings, deenergizing the motor. The shaft of the motor then returns to its normal position and the current is cut.

Advantages claimed for this system are: (1) high accuracy; (2) low cost; (3) permits user to pass directly from automatic to manual operation or vice versa; (4) permits setting up any station with any push-button, setting up stations as near one another as desired, setting up all push-buttons to one station. In addition there can be considerable tolerance in manufacture, since the size of the gap is not critical . . . the only requirement in this connection being that the size of the contact is larger than the size of the gap. Also there is little alteration in the size of the selector contacts, for the current is broken by a relay eliminating sparking at gap.

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F-M BROADCASTING

(*Continued from page* 13)

power. In other words, a station will use whatever power is necessary, depending upon antenna height and other limiting factors, to cover a certain specific area. However, stations operating in the same community are in general required to cover the same area.

So far standards have not been set up as to the type of polarization to be used, although it is believed that horizontal polarization is favored. Vertical polarization, however, has an advantage which should not be overlooked, in that a vertical antenna or rod may be used in place of the directive dipole.

Broadcast transmitting equipments are available in 250, 1000, 3000, 10,000 and 50,000 watt ratings. At least five manufacturers have announced commercial units, the transmitters varying, of course, in circuit details.

Those interested in securing more information on the transmitting equipments available from the various manufacturers should refer to the bibliography at the end of the article.

The FCC, in response to several applications and a number of inquiries regarding radio relay links between studio and transmitter (instead of telephone lines), have paved the way for such short haul relay service using f-m on frequencies above 330 megacycles. Suitable rules and definite channel assignments will be drawn up shortly to establish such service on an experimental basis.

These link stations will operate with highly directive antennas that can beam their signal, along a narrow point-to-point path. Many stations of this nature use the same channel without interference. In many cases the use of radio relay will, at the present time, greatly decrease the cost of station operation, particularly when the f-m transmitter is on a high hilltop where suitable telephone facilities are not available.

Since f-m broadcasting is assigned to fairly high frequencies the location of

(*Continued on page* 26)

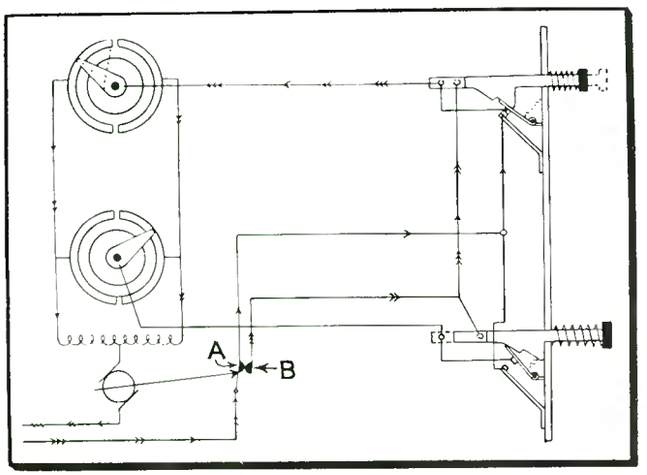

Fig. 6. A third method of employing the remote-control system described in the accomponying text.

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DETECTION IN F-M RECEIVERS

By W. WEISS

The Hickok Electrical Instrument Co.

THE fundamental difference in frequency-modulated and amplitude-modulated receivers lies in the method of converting the variations in the r-f carrier back to audio frequency and reproducing the program in its correct frequency and amplitude. A complete understanding of the principles involved in f-m detection is essential to engineers and men working with f-m equipment. While most engineers understand this principle to their own satisfaction, its explanation to others, especially those not familiar with vector analysis, has often proven difficult. It is with this in mind that the following analysis of this system is outlined.

With reference to Fig. 1 there is developed at the primary of the discriminator transformer an i-f voltage E_1, the frequency of which is presumably the frequency of the intermediate-frequency amplifiers of a frequency-modulated receiver. It can be seen that this voltage, E_1, is impressed across a network consisting of condenser C_1, r-f choke and condenser C_3 in series to ground. If the reactance of condenser C_1 and C_3 are relatively low, we can assume that voltage E_1 is essentially impressed across the r-f choke. This voltage is shown in Fig. 2 plotted as the solid line labeled E_1. It will be noted that this voltage does not change in phase relationship through the entire length of this curve.

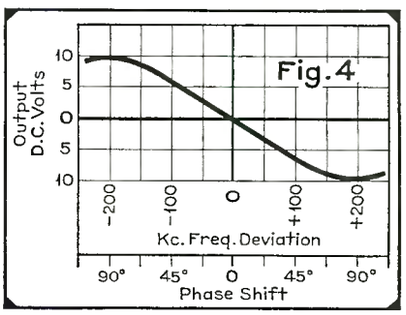
There is, in addition to voltage E_1, voltages E_2 and E_3 induced in the secondary of the discriminator transformer. These two voltages are effectively in series and applied across the plates of the discriminator tubes T_1 and T_2. For the purpose of discussion, however, we will consider these voltages independently, and looking at them as such, E_2 could be considered to be in series with E_1, both voltages using as their load the discriminator tube T_1 in series with the parallel combination of condenser C_2 and resistance R_1. The phase relation of E_2 with respect to E_1 can be seen in Fig 2 in which E_2 is shown as the sine wave drawn with the dotted line. It will be noted that E_2 leads E_1 by 90 degrees. The a-c voltage then applied to the rectifier tube T_1 is the sum of these two voltages and is indicated as the heavy black line labeled "E_1 plus E_2."

The rectifier tube "T_1" will only pass current in one direction which would neglect the summation of these two voltages when this sum is below the center line, as a result, a d-c voltage labeled E_{dc_1} is developed across R_1 which would be equal to the peaks of "E_1 plus E_2" if we considered R_1 as being of sufficiently high resistance that it would not appreciably discharge condenser C_2 between peaks of a-c voltages "E_1 plus E_2." Actually, of course, the d-c voltage will be somewhat less than this shown, due to this action of resistance R_1.

There is also a similar condition of voltage E_3 plus E_1 being added together as indicated and applied to rectifier tube T_2 which has a similar load resistance in capacity C_3 and resistance R_2. In this case, however, the voltage developed across R_2 will be in an opposite direction with respect to ground to the voltage developed across R_1. If the transformer secondary is so designed and center tapped that voltage E_2 will be exactly equal to voltage E_3, then the d-c voltage developed across R_1 will be exactly equal to that developed across R_2 and being in opposite polarity, the total d-c voltage labeled E_{dc_3} will be zero. This condition exists only when the discriminator transformer secondary is tuned to the exact intermediate frequency being developed across the primary of discriminator transformer.

For the sake of explanation, let us assume that the intermediate frequency in this case is 5 megacycles.

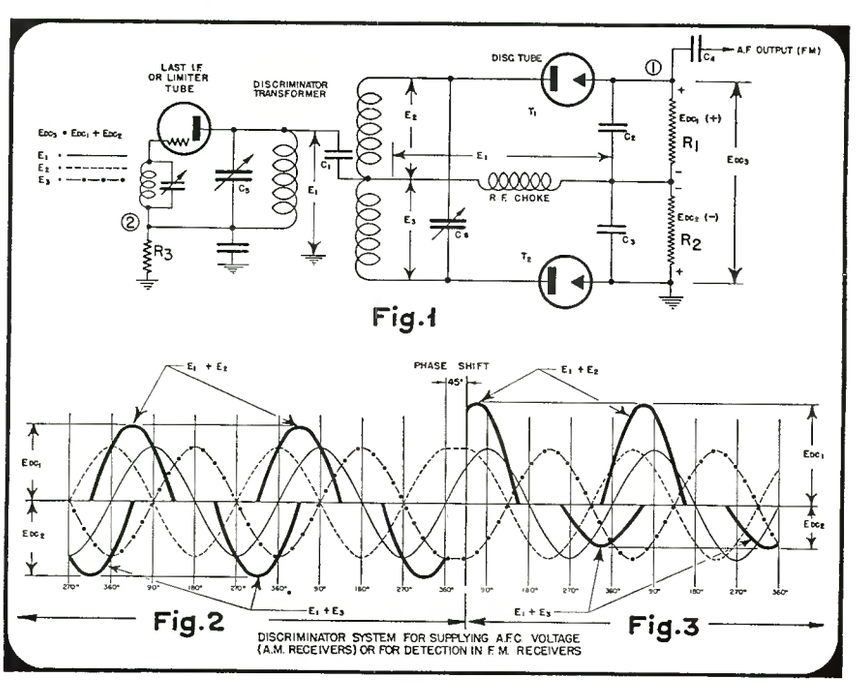
The secondary of this transformer when tuned to the proper frequency of 5 mega-



cycles acts as a pure resistance load on the primary of this transformer. In a pure resistance the current is in phase with the voltage. If the load were a pure capacity the current would lead the voltage by 90 degrees, or if the load were purely inductive the current would lag the voltage by 90 degrees.

In this secondary is an inductance shunted by a condenser. From the formula for inductive reactance $X_L = 2\pi FL$ it is evident that as the frequency increases the inductive reactance also increases. It is also known from the formula $X_c = \frac{1}{2\pi FC}$ that the reactance of a capacitor works just the opposite of this. That is, if it has a reactance of 100 ohms at 60 cycles, as the frequency goes up the effective reactance or resistance goes down.

So far the assumption has been that the secondary has been tuned to resonance at 5000 kc and therefore presents a resistive load. Taking an extreme hypothetical case where the frequency developed at the primary of a transformer goes from 5000 kc down to 50 kc, the reactance of condenser C_6 may then be considered infinitely high or completely neglected, for the sake of discussion. Whereas the inductive reactance of the secondary winding of this transformer becomes extremely low and so far as the nature of the load is concerned it may be considered purely inductive, which results in a lagging current in the load. Conversely, of course, at the other extreme where the primary frequency changes from 5000 kc to, for example, 50 megacycles, in which case the inductive reactance of the secondary would become extremely high and the capacity reactance extremely low and therefore the load would draw a leading current.



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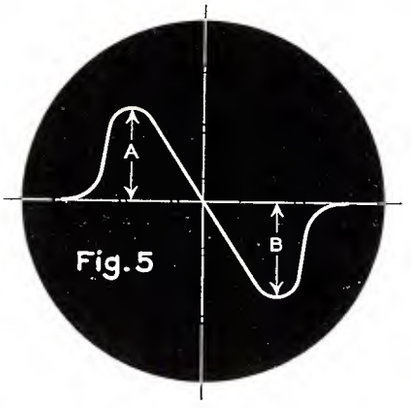
In the case illustrated by Fig. 3 there is an assumed frequency change in the primary, such that voltages E_2 and E_3 which were respectively leading and lagging voltage E_1 by 90 degrees will both change simultaneously 45 degrees. As a result of this, voltage E_2 is now leading voltage E_1 by only 45 degrees whereas voltage E_3 is now



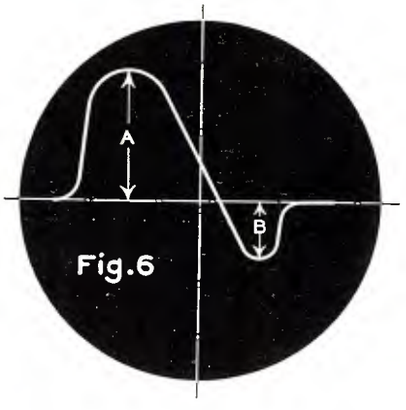
lagging voltage E_1 by 90 plus 45, or 135 degrees.

In referring to the curves of Fig. 3 it will be noted that summation of voltage E_1 plus E_2 due to the fact that these two are more nearly in the same phase relationship is now greater. This is as shown by the heavy line labeled "E_1 plus E_2".

As a result of voltage E_3 now being 135 degrees away from voltage E_1 the summation of these two voltages is less than it was before and is designated by the heavy line labeled "E_1 plus E_3".

As a result of this increased a-c voltage "E_1 plus E_2" being applied to the rectifier tube T_1 it is natural to expect an increased d-c voltage across R_1 which is shown as E_{dc_1} in Fig. 3. Likewise, as a result of the decrease in a-c voltage applied to rectifier T_2 we naturally expect a decrease in the d-c voltage developed across R_2 which is shown as E_{dc_2}.

The total d-c voltage developed across the entire network is then the sum of these two d-c voltages, taking into consideration their proper polarity. This now is no

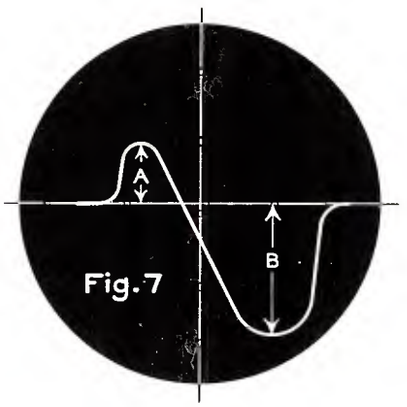


longer zero, since the two voltages are not equal, but would represent a positive voltage with respect to ground from the high end of these two load resistances in series.

Likewise, if the frequency shift has been in the opposite direction it would have tended to reduce the value of "E_1 plus E_2" and increase the value of "E_1 plus E_3" consequently giving a total d-c voltage at point 1 which would be negative with respect to ground.

Since condenser C_2 and C_3 only have to present a relative low reactance to the intermediate frequency, 5000 kc, they can be chosen of such a value that their reactance will be relatively high to the audio frequency which is taken off through condenser C_4.

It is obvious that the limit to which a frequency or phase shift will continue to produce changes and develop d-c voltage is when there is a phase shift of 90 degrees. At this point E_1 and E_2 would be in exact phase relationship with each and E_1 and E_3 would be 180 degrees out of phase. Any increase in phase shift beyond this would result in an increase in phase angle between E_1 and E_2 with the consequent reduction in the summation of these two voltages and also a decrease in the phase angle between voltages E_1 and E_2 with a consequent increase in the summation of these two voltages. This is illustrated in Fig. 4. In practice, a 90-degree phase shift would not be considered 100% modulation, but over modulation, since at this point is approached the developed d-c voltage is



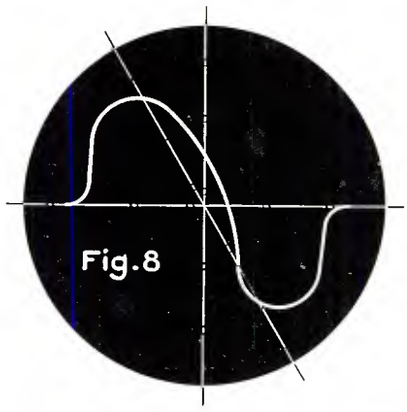
no longer a linear function of the frequency deviation.

In frequency-modulated transmission the deviation in frequency is proportional to the amplitude of the modulating voltage and the rate of frequency change proportional to the frequency of the modulating voltage. This system of detection produces a voltage which is in proportion to the extent of frequency deviation and which will correspond in frequency to the rate of deviation. It will then, when properly adjusted, give a faithful reproduction of the broadcast program both with respect to amplitude and frequency.

The proper alignment of discriminator transformer can best be effected by means of a wide-band frequency-modulated signal generators and an oscillograph. If the oscillograph has a self-contained wide-band f-m oscillator—a conventional signal generator can then be used. The vertical input to the oscillograph can be connected across the discriminator load from point 1 to ground and the signal generator so adjusted to deliver a wide-band frequency modulated signal, preferably of at least 300 or 400 kc sweep and at the proper i-f.

When primary condenser C_1 and secondary condenser C_2 are properly adjusted, a curve similar to that illustrated in Fig. 5 should be obtained. In this figure it will be noted that the height represented by "A" and "B" above and below the line respectively are equal and that the central portion of this curve is a st.aight line indicating linearity of voltage developed with frequency variation.

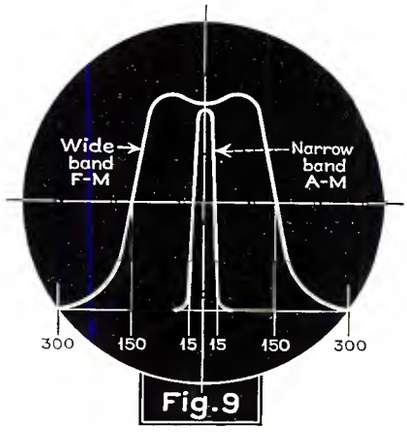
If the secondary condenser C_2 is adjusted above or below the proper capacity the entire curve will shift as illustrated in Fig. 6 or 7. As the primary condenser is



adjusted, it will be noted that true linearity no longer exists on the straight portion of the curve (Fig. 8) Sometimes it is necessary to adjust first C_2 and then adjust C_1 and come back and adjust C_2 for proper response, but this can be effected very readily in actual alignment.

Proper adjustment of the intermediate-frequency transformers is also best effected by means of the wide-band signal generator and the oscillograph; however, in this case the oscillograph should be connected across the discriminator load resistance R_3 from point 2 to ground. The intermediate-frequency transformer should then be adjusted until a symmetrical flat top curve is obtained similar to Fig. 9.

An alternate method of alignment in the absence of an oscillograph and wide-band f-m signal generator can sometimes be used by inserting a microammeter between resistance R_3 and ground and adjusting the intermediate-frequency transformers one at a time starting with the last and proceeding backward towards the first detector for maximum deflection of the microammeter.



The alignment of the discriminator transformer could also be effected by inserting the microammeter between resistance R_2 and ground and adjusting the primary trimmer condenser C_1 for maximum deflection of this microammeter and then readjusting secondary condenser C_2 for zero deflection of the microammeter.

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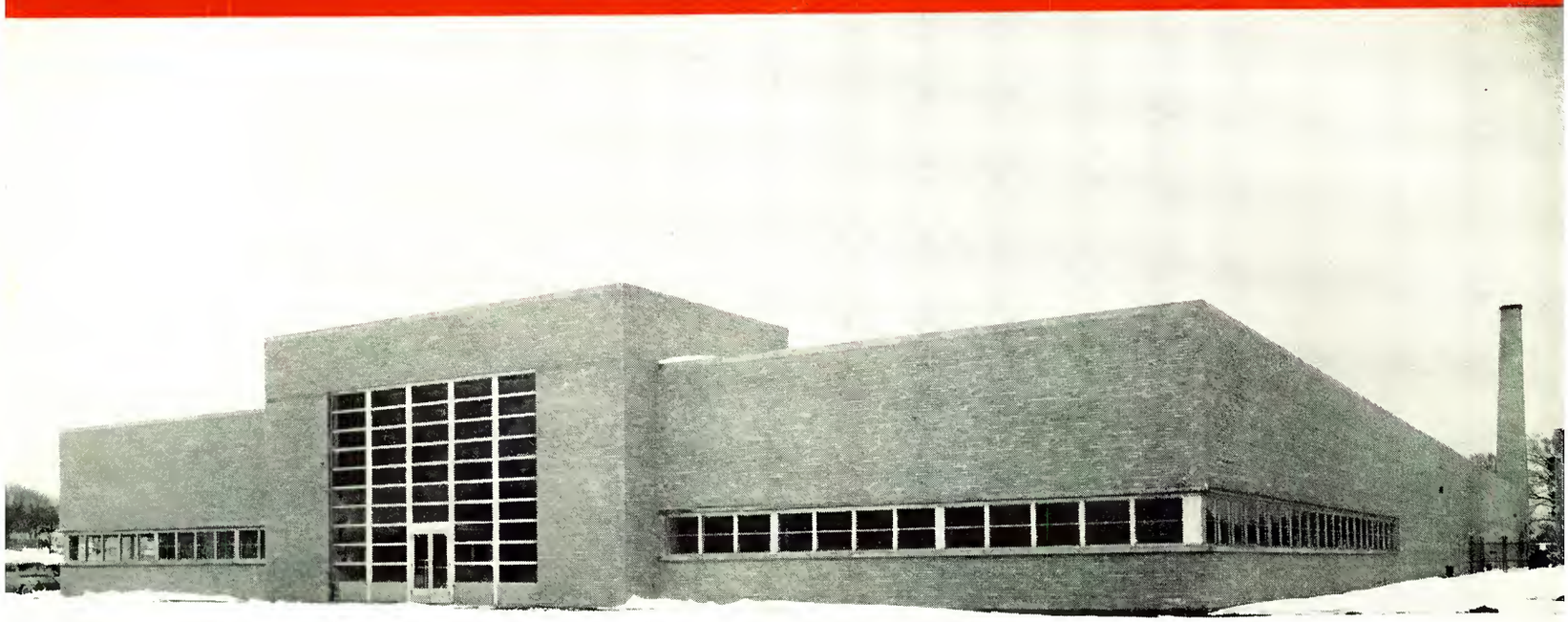
At Home after January 21st



By the time you read this we will be installed and working in our new factory and office building. Used in conjunction with our other plant, we now have over 50,000 additional square feet of floor space in which to expand. Several novel features of the place may be of interest to you. Of the wide-span truss construction, floor space is practically unobstructed and there is plenty of flexibility to enlarge certain departments

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Book Reviews

UNDERSTANDING RADIO—A Guide to Practical Operation and Theory, by Herbert M. Watson, Herbert E. Welch and George S. Eby, published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York City, 603 pages, price $2.80.

This is an excellent non-mathematical text on the fundamentals of radio. Written in an interesting, simple and exceptionally clear manner, this book is, of course, intended for the beginner in radio. In addition to the explanations each chapter suggests and outlines practical methods for building, operating and studying simple but practical equipment. It also contains numerous questions to be answered by the reader . . . a valuable aid in determining one's understanding of a particular topic.

The authors' explanation of radio waves and wave travel is especially good. This is followed by chapters on wave-form pictures, principles of the vacuum tube, tuning, receiving sets using d-c tubes, phones and speakers, power supply, a-c tubes and receiving sets, short-wave sets, oscillators and transmitters, radiotelephone transmitters, aerials, and ultra-short-wave sets. The final chapter in the book is appropriately titled "Looking Ahead in Radio". Additional data found in the book is a glossary of radio terms and a suggested reading list.

This book is highly recommended as a text for those interested in securing a non-mathematical understanding of the fundamentals of radio. R. D. R.

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HOW TO MAKE GOOD RECORDINGS, published by Audio Devices, Inc., 1600 Broadway, New York City, N. Y., 128 pages, price $1.25.

This excellent little book is written in simple non-technical terms. While it is obvious that a complete treatise on "how to make good recordings" could not be given in 128 pages, nevertheless this book does give a clear and practical picture of the fundamentals of sound recording. Although written primarily for non-technical consumption, this publication also contains many practical tips for the engineer.

The book begins by describing how a recorder works and then proceeds to give practical data on the method of choosing a good recorder. Considerable space is devoted to the discussion of discs, and cutting and playback needles. The next portion of the book is given over to the various steps in preparing the recorder for use, i.e., adjusting the turntable drive, setting the cutting angle, adjusting the depth of cut, determining the correct recording volume, and controlling the thread. Considerable data is also given on the method of making recordings from the radio, direct from a microphone, etc. Other chapters are devoted to microphone placement, sound effects, acoustically treating the studio, 33-1/3 r-p-m recording considerations, making copies, preserving the record, putting together a show, common recording difficulties and their remedies, and a glossary of technical terms.

This book is recommended to those seeking non-technical data on the fundamentals of sound recording. R.D.R.

Over the Tape

CONDENSER CATALOG

Bearing the busy radio man in mind, Aerovox has compiled its new 1941 general catalog in concentrated or tabloid form. Illustrations, descriptions and listings are reduced to the absolute minimum consistent with providing all essential data, so as to save time, effort and patience of the practical reader. The new catalog covers the general line of electrolytic, paper, oil, exact-duplicate replacements, transmitting and other condensers, together with such Aerovox instruments as the L-C checker, capacity-resistance bridge, and motor-starting capacitor selector. Copy may be had on request from local jobber or by writing Aerovox Corporation, New Bedford, Mass.

TRANSMISSION LINES CARRY SPEECH AND POWER

A "wired" radio technique to transmit speech by power lines was described at the 1941 AIEE convention by J. D. Booth and A. P. Bock, radio engineers of the Westinghouse Electric & Manufacturing Company.

Vacuum tubes giving automatic voice control are used in the new system to perform sending and receiving functions. Speech into the transmitter causes the tubes to start the carrier current and connect the transmitter and listener's receiver into the line. This switching is done within nine thousandths of a second after the first sound is uttered.

This automatic exchange is designed to select any one of ten stations along the power line and any one of ten extension dial phones at each station. By this method 100 telephones using the dial system are all connected to a single pair of wires over which conversation can be carried without interruption or disturbance from the high-voltage power carried on the same wires. The power lines act as guiding channels to prevent the high-frequency radio waves from escaping into space and interfering with regular radio broadcasts.

The system provides reliable communication service when wire line telephones become inoperative due to severe storms or other forces of nature.

MITCHELL-RAND BOOKLET

Mitchell-Rand Insulation Co., 51 Murray St., New York City, have recently issued a guide book on electrical insulating materials. This 42-page booklet contains data on Fiberglass, insulating papers, twines, cotton and asbestos sleevings, tapes and webbings, armature wedges, varnished tubing and the like. Copies are available on request.

GARRARD CATALOG

The Garrard Sales Corp., American representatives for the Garrard Engineering and Mfg. Co., Ltd., Swindon, England, manufacturers of record changer, announce the release of their new 1941 Catalog No. 41. The new catalog describes and illustrates the complete Garrard line of automatic record changers, phonograph turntables, motors, pick-ups and accessories. Copies may be obtained free by addressing Garrard Sales Corp., 296 Broadway, New York City.

N. U. TO DISTRIBUTE ERWOOD EQUIPMENT

National Union Radio Corp. announces that effective March 1, 1941, the Erwood Sound Equipment Co. have appointed National Union as their exclusive distributor of all their sound equipment and accessories for the entire world. Both John and Joe Erwood of the Erwood Sound Equipment Co. have been in the sound business for the past twenty years.

INT'L TELE. DEVELOPMENT EXPANDS

International Telephone Development Co., Inc., subsidiary of the International Telephone and Telegraph Corp., announces that it is more than doubling the space at its factory at 137 Varick Street, New York City. This expansion, according to Mr. George Lewis, vice-president of the company, is to meet an urgent demand for Selenium Rectifiers, of which International Telephone Development Co. is the sole manufacturer in the United States.

EXPERIMENTAL FACSIMILE STATION

The FCC today granted a license to W. G. H. Finch, President of Finch Telecommunications, Inc., of Passaic, N. J., manufacturers of facsimile and radio apparatus, to operate a facsimile experimental station at the company's Bendix Airport laboratory, at Bendix, New Jersey. The station W2XAH is authorized to use frequencies between 30 and 40 megacycles, which are adjacent to f-m channels with 1-kw.

H-F ELECTRIC TOOL CATALOG

Nineteen new models of high-frequency electric tools are shown in the new Thor High-Frequency Electric Tool Catalog, 1941 edition, now ready for distribution, announces the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago. These new models consist of: balancers, drills, grinders, nut setters, the "Pix-Up" finder, polishers, rubbers, sanders and screw drivers. The No. 61 High Frequency Electric Tool Catalog is available upon request to the above company.

NATIONAL RECORDING CATALOG

National Recording Supply Co., Hollywood, Cal., in Feb. issued its 1941 catalog of recording machines and its complete line of recording accessories. The firm has just announced a line of four types of recording blanks, coated on paper, bond base, aluminum and heavy alloy base in various sizes. The discs are manufactured for professional or home use. Newest single item in the National catalog is a small coated blank made especially for amateurs in the form of a patented National QSL disc.

SOLAR APPOINTMENT

Mr. J. I. Cornell, Chief Engineer of the Solar Manufacturing Corporation, Bayonne, N. J., makers of capacitors, has been elected a Director of that company.

(*Continued on page* 28)

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VWOA NEWS

Veteran Wireless Operators Association

RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y.

W. J. McGONIGLE, President — GEORGE H. CLARK, Secretary

Sixteenth Annual

ON February 11 our Association held their Sixteenth Annual Dinner-Cruise at the Hotel Astor. Referring to the accompanying photo seated at the Speakers Table from left to right were: David Karp, Marconi Memorial Scroll of Honor recipient; J. R. Poppele, Chief Engineer of WOR and Chairman of our Scholarship Committee; George W. Bailey, President, American Radio Relay League and Chairman of Amateur Committee, Defense Communications Board—Honorary Member VWOA; Commander Starkey, District Communications Officer, United States Navy, representing Admiral Noyes at the Dinner; James Lawrence Fly, Chairman, Defense Communications Board and Federal Communications Commission, who received the Marconi Memorial Service Award on behalf of the DCB; William J. McGonigle, President, VWOA, and Toastmaster of the evening; Colonel John C. Moore, Signal Officer of the First Army, representing General Mauborgne at the Dinner; Lt. Col. Clyde V. Simpson, Signal Officer of the Second Corps Area; Richard E. Nebel, Radio Aide to Signal Officer of the Second Corps Area, a paralysis victim since the age of three, awarded a Marconi Memorial Scroll of Honor for his outstanding work in defense—though physically handicapped; "Dick" Nebel's brother; E. H. Rietzke, President, Capitol Radio Engineering Institute; Frank Butler, one of Dr. de Forest's first assistants; Abraham White, first president of the De Forest Wireless Telegraph Company back in 1902.

Among those present were: Mr. and Mrs. Ray Rettenmeyer—Ray is Editor of *Communications;* Mr. and Mrs. James Walker—Jim is Secretary of Bryan Davis Publishing Company; Lewis MacConnach, Secretary of RCA; George Shecklen, Commercial Manager, R. C. A. Communications; A. J. Costigan, Association Director and Traffic Manager, Radiomarine Corporation; Mr. Russ, John Bossen and Bill Gillule of Mackay Radio; C. D. Guthrie, Radio Supervisor for Maritime Commission; Peter Podell and Fred Klingenschmitt, two of our earliest members; Charles Horn, Director of Development and Research of NBC; Fred Muller, past President, Lt. Commander, U. S. Navy; George Clark, our hard working Secretary; R. H. Frey, Chairman of our Reception Committee; Bruce Robertson, Associate Editor of *Broadcasting;* Major Milleken of RCA; H. H. Beverage, Vice-President of RCA Communications; Walter Jabolin, Sales Engineer of Hammarlund; C. B. Jolliffe, formerly Chief Engineer, Federal Communications Commission, Manager of RCA Frequency Bureau; Commander Webster, Assistant Chief Engineer, Federal Communications Commission; R. V. Howley, Vice-President, Tropical Radio Telegraph Company; E. T. Jones, Advertising Executive, RCA Manufacturing Co.; Arthur F. Van Dyck, Executive Engineer, RCA License Laboratory; Charles Singer, Chief Transmitter Engineer of WOR and Mrs. Singer; Charles Hahne; F. P. Guthrie, our Washington Chairman, who did such a splendid job of arranging details of Washington activities; Harvey Butt of the Washington staff of Radiomarine; George Maedel, Chief Instructor, RCA Institutes; William Priess, well known pioneer inventor in radio and television; Lt. W. A. Eaton, Navy pioneer in wireless; W. S. Fitzpatrick, who gave our prexy his first assignment; H. Coulter, Comptroller of Radiomarine; Mr. and Mrs. M. Raber; Captain R. H. Ranger, pioneer in facsimile; E. J. Quinby and Mrs. Quinby with Pierre Boucheron, Sales Manager of Farnsworth Television and Radio Corporation and J. A. Hopfenberg; A. Barbalate, always present at our Cruises; Ralph Venegas of South-

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ampton, L. I.; P. K. Trautwein, a Director of our Association; Gus Ericson, Warrant Officer in the Navy; Mrs. Poppele and Miss Poppele; Miss Wishard and Miss Blocker; Mrs. McGonigle; John Varian, Purchasing Agent of Radiomarine; V. P. Villandre, Chairman of our Ticket Committee; James Rigby, Personnel Director of RCA Communications; Mr. and Mrs. Arnulf Olson and Mrs. Carl Peterson; Mr. McGrady, Vice-President of RCA; Frank Orth, pioneer in wireless and broadcasting; and a good many others.

VWOA Broadcast

Announcer: "We are speaking to you from the East Ballroom of the Hotel Astor in New York City where the Veteran Wireless Operators Association is at present holding its sixteenth annual meeting, the keynote of which is National Defense. Later during this program, the Association's coveted annual awards will be presented, and the men who receive them will speak. But first, here is Mr. William J. McGonigle, President of the Association, who will act as master of ceremonies for the evening and tell you briefly of the Veteran Wireless Operators.

"Mr. McGonigle."

McGonigle: Ladies and Gentlemen—A toast to the President of the United States—the Commander-in-Chief of our Army and our Navy.

"Tonight, at this National Defense dinner cruise, the Veteran Wireless Operators Association, a nationwide fraternal organization of veteran wirelessmen, celebrates its sixteenth anniversary, in this and other cities of the United States and in the Territory of Hawaii.

"Our Association is dedicated to fostering and extending an *esprit de corps* among wireless operators; affording opportunity for social intercourse; promoting a fraternal and comradely sentiment between and among our members; recognizing meritorious service rendered by wireless men on land, at sea, and in the air, by the erection of memorials and by the bestowal of testimonials, medals, scholarships, or other awards; and acquainting the public with the work, traditions and ideals of wireless operators.

"Tonight we take this opportunity of recognizing the magnificent achievements of the Defense Communications Board in promoting the best possible National Defense. We are honored by the presence of the Chairman of the Defense Communications Board. He has successively held positions of increasing responsibility in the service of our government, and was appointed Chairman of the Federal Communications Commission, on Sept. 1, 1939, and subsequently, on the creation of the Defense Communications Board, he was appointed its Chairman, in September, 1940.

"As our Association's tribute to National Defense and our recognition of the splendid efforts of the members of the Board in assuring that communication will be the nation's first line of defense, we take pleasure in presenting our Marconi Memorial Service Award, a plaque depicting the spirit of wireless, to Mr. James Lawrence Fly, chairman of the Defense Communications Board and the Federal Communications Commission. Mr. Fly":

Mr. Fly accepts Award.

McGonigle: "A radio amateur in 1898, experimenting with the elementary wireless equipment of that time, our next award recipient was the first to make use of airplane radio communication in Army artillery spotting. This was a milestone in

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Major General J. O. Mauborgne, Chief Signal Officer U. S. Army, recipient of VWOA's Marconi Memorial Medal of Service.

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Rear Admiral Leigh R. Noyes, Director of Naval Communications, another recipient of the Marconi Memorial Medal of Service.

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Army radio history. A pioneer of wireless in the Army, he has progressively occupied positions of increasing responsibility, and today is Chief Signal Officer of the United States Army.

"We award tonight a Marconi Memorial Medal of Service to Major General J. O. Mauborgne, who, because of the pressure of Governmental duties, has been obliged to cancel his meeting with us tonight. He has designated Colonel J. C. Moore, Signal Officer of the First Army, to represent him here. Colonel Moore, will you please con-

James Lawrence Fly, Chairman of Federal Communications Commission and Defense Communications Board.

vey this medal to General Mauborgne with our sincere admiration?"

Col. Moore: "I shall be glad indeed to do so. . . . "

McGonigle: "George Mauborgne will now address us from the Washington studios of the National Broadcasting Company, General Mauborgne:"

After address by General Mauborgne, from Washington, Mr. McGonigle continued:

"As wireless communication is important to the Army on land, even more vital is it to our Navy's ships at sea, for to them no other method of communication is possible over long distances. Our third award, recipient is an officer of the Navy, who during his long and creditable career has served in all important branches of Navy wireless operation, and now occupies the office of Director of Naval Communications.

"First communication officer of the Navy in 1915, he was first Fleet Communication Officer of the Navy in 1916, and during the World War inspected all facilities of the U. S. Naval forces in Europe. Rear Admiral Leigh R. Noyes, we are proud to award to you our Marconi Memorial Medal of Service, through Commander Starkey, whom you have designated to represent you. Commander Starkey, please convey this medal to Admiral Noyes with the best wishes of our Association."

Commander Starkey: "I shall carry out my orders with great pleasure."

McGonigle: "Admiral Noyes will now address us from Washington. Admiral Noyes":

Admiral Noyes addressed the Dinner from Washington, after which—

McGonigle: "The V. W. O. A. is proud of the opportunity of honoring a young man who, although never professionally engaged in wireless communication, is today a splendid example of how those unable to enter the active forces may yet serve their country in National Defense.

"But let his commanding officer Colonel Clyde V. Simpson, Signal Officer of the Second Corps Area tell us about him."

Colonel Simpson: "A victim of paralysis since the age of three, unable to walk alone, he never attended formal school. Despite this handicap, which to many of us would have been insurmountable, he received a diploma from New Utrecht High School on completion of home studies.

"He became interested in radio in 1926, and has since that time progressed through various offices of the American Radio Relay League and the Army Amateur Radio System, until today he occupies the position of Radio Aide to the Signal Officer of the Second Corps Area, a position formerly occupied by a Major in the Signal Corps Reserve.

"The VWOA awards a Marconi Memorial Scroll of Honor to Richard Nebel, who despite his handicap is contributing bravely his share to the best possible national defense. Richard, it is a distinct pleasure to present this scroll to you on behalf of the Veteran Wireless Operators Association."

Dick Nebel accepted.

Announcer: "You have been listening to the presentation of awards by the Veteran Wireless Operators Association, at its sixteenth annual meeting at the Hotel Astor, New York.

"These awards have been made in recognition of the distinguished contributions to National Defense, and were presented to Chairman Fly, head of the Defense Communications Board and of the Federal Communications Commission; to

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General J. O. Mauborgne, Chief Signal Officer of the U. S. Army; Admiral Leigh Noyes, U. S. Navy and Radio Aide Richard Nebel, radio aide to the Signal Officer, Second Corps Area.

"This program has been presented as a public service by the National Broadcasting Company and the independent radio stations associated with the NBC networks."

In addition to the awards mentioned in the broadcast a Marconi Memorial Medal of History was awarded to George H. Clark, the Historian of Radio for his outstanding efforts in keeping alive the memory of the history of Wireless; a Wireless Pioneer Medal was awarded to Arthur A. Isbell at the San Francisco Dinner held at the Vallejo Country Club at Vallejo, Calif.; a Life Membership certificate was presented to "Bill" Halligan, Chairman of our Chicago Chapter by George Martin, former Chairman; Dr. Lee de Forest, our Honorary President addressed the Dinner by transcontinental telephone as did Arthur Isbell, Ray Meyers, Gilson Willets and others from the San Francisco Cruise and Bill Halligan and George Martin from the Chicago Cruise.

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F-M TRANSMITTERS

(*Continued from page 9*)

quency buffer, triplers and amplifiers together with the 827-R output tubes and their associated blower and the f-m monitor. The other cabinet houses the filament, grid, and plate voltage supplies together with the control circuits and Crosby exciter unit.

The output of the Crosby exciter 807 amplifier tube feeds an 814 buffer which in turn drives the pull-pull 808 tripler stage. These feed the 8001 intermediate power amplifier push-pull stage which in turn drives the 827-R push-pull power amplifier.

The construction of the 827-R tube is such that use is made of an external anode structure equipped with a fin assembly for forced air cooling, minimizing plate lead inductance. Forced air cooling with a suitably interlocked blower allows high anode dissipations as compared with conventional air-cooled designs and also allows the glass envelope to be made smaller than would otherwise be possible. A compact tube for high-frequency operation results.

All electrodes are supported by the header of the tube alone, no solid insulation being used between the elements in the tube. Dielectric losses which would impair the performance of the tube at these frequencies are therefore eliminated. Control grid and screen grid wires are vertical and oriented so that the screen grid wires are located in the shadow of the control grid wires, thus forming electron beams which considerably reduce the current collected by the screen grid as compared with a structure having random alignment. Because a ring seal is used as a screen grid connection, it has been possible to build the tubes into the circuits with such good isolation between grid

MODEL WR-20

Utilizing two dual-diaphragm crystal cartridges with four diaphragms. Permits cable lengths approximately double that of conventional crystal microphones.

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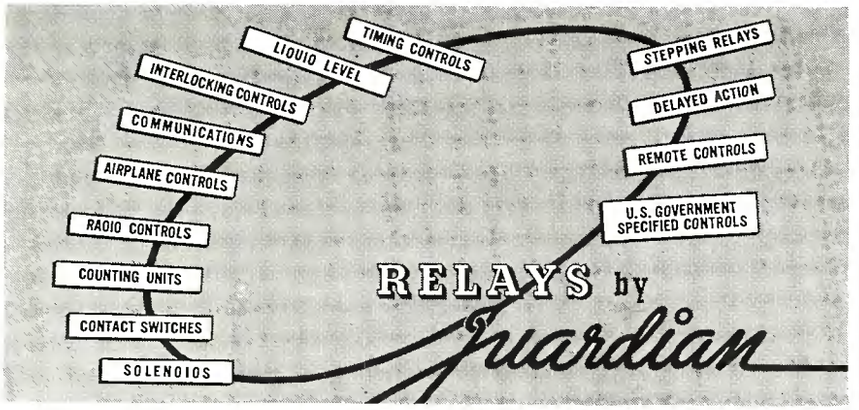

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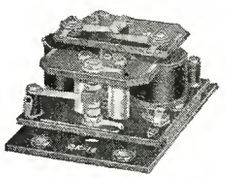

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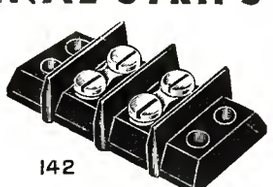

142
1-5/16" wide by ⅝" high.
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Barrier strip not only makes long leakage path but prevents direct shorts from frayed wires at terminals. Molded bakelite insulation. Ample space on sides for engraving numbers or designations in white. Three sizes as shown. A handy terminal with many applications. Write for prices.

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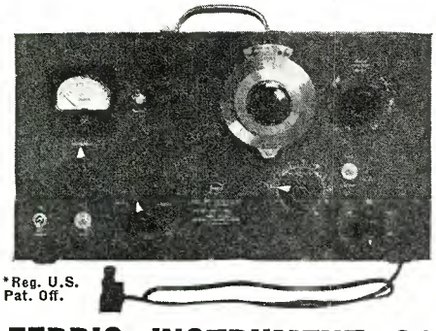

- Frequency range 5 to 175 megacycles
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- Output .2 to 100,000 microvolts
- Panel Jack for 2 volts output
- 400-1000 cycles and External Modulation

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and plate circuits that perfect stability is obtained with only slight neutralization at very high frequencies.

By careful positioning of the circuit elements, it was found convenient to use conventional lumped constants and circuits over the entire FM-1B output frequency range of 26 to 108 megacycles.* Plate tank tuning of the power amplifier is accomplished from the front panel by varying the capacitance between the metal shells into which the tube anodes are mounted. The load circuit is inductively coupled to the power amplifier tank and will operate into a transmission line of any impedance between 70 and 600 ohms.

FM-10A Amplifier

This amplifier when used with the Type FM-1B frequency-modulated transmitter constitutes a complete 10-kilowatt transmitter. The FM-1B amplifier output from the 827-R tube drives two 889-R tubes connected in push-pull to generate the 10-kilowatt carrier. Four 845 amplitude-modulator tubes are used in conjunction with the 5U4G rectifier and 1620 and 870 audio feedback amplifiers to reduce amplitude modulation due to hum to better than 50 db below 100% amplitude modulation. The four 845's modulate the plate supply to the power amplifiers. All tubes are air-cooled. The blower for the two RCA-889R tubes also cools the 827-R tubes through an inter-unit duct.

The FM-10A is designed to work into a 72-ohm 1⅜-inch concentric transmission line.

FM-50A Amplifier

This amplifier and associated power, control, and water-cooling equipment, when used with the Type FM-3A frequency-modulated transmitter** constitutes a complete 50-kilowatt f-m transmitter. The FM-3A amplifier output from the 827-R tube drives two 894 tubes connected in push-pull to generate the 50-kilowatt carrier. Provision is made for cut-back to 3 kilowatts in case of failure of the high-power amplifier.

The FM-50A is designed to work into a 72-ohm concentric transmission line. Power output is controlled from the front panel by means of a variable coupling link.

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A-M/F-M TUNER

(*Continued from page* 11)

as the single audio stage for both the a-m and f-m outputs, and likewise for the phone input. To compensate for the greater modulation of the higher audio frequencies inherent in f-m transmis-

*Coils for 35-50 mc are supplied in FM-1B when used to excite the 10-kw amplifier of FM-10A, and with FM-3A used to excite 50-kw amplifier of FM-50A.

**FM-3A amplifier similar in most essentials to FM-1B.

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sions, a de-emphasis network consisting of R_{20} and C_{23} is included in the discriminator output circuit.

The f-m channel provides band-width of 150 kc at 6 db down from resonance. Overall sensitivity is such that full limiter action is obtained on signal inputs of 35 to 45 microvolts. Frequency response of the audio system of the tuner varies only 1 db from 30 to approximately 7000 cycles, at 10,000 cycles is down only 1.8 db and 4 db at 15,000 cycles. The curve is shown in Fig. 2. The image ratio in the f-m range is 140 at 49 mc and 90 at 43 mc.

In the a-m broadcast band the i-f band-width is 14 kc at 6 db down and 25 kc at 1000 times down. Sensitivity averages 20 microvolts for 6 milliwatts output. Overall frequency response (antenna to output terminals) is 1.3 db down at 30 cycles, 2 db down at 3000 cycles and 7 db down to 5000 cycles (with output at 400 cycles used as zero reference level).

The Model S-31A amplifier available for use with this tuner provides response flat within 1½ db from 30 to 20,000 cycles. Its normal response, plus variations made possible by the separate bass and treble boost controls, is shown in Fig. 3, while the circuit appears in Fig. 4. High-gain triodes are used throughout the voltage amplifier section with resulting overall gain of 90 db from the microphone input and 50 db from phono or radio inputs. The push-pull 6L6 power stage provides 25 watts undistorted output. This is available at the output transformer, with terminals for matching a 500-ohm line and plug-connections for 4-ohm and 8-ohm speaker lines.

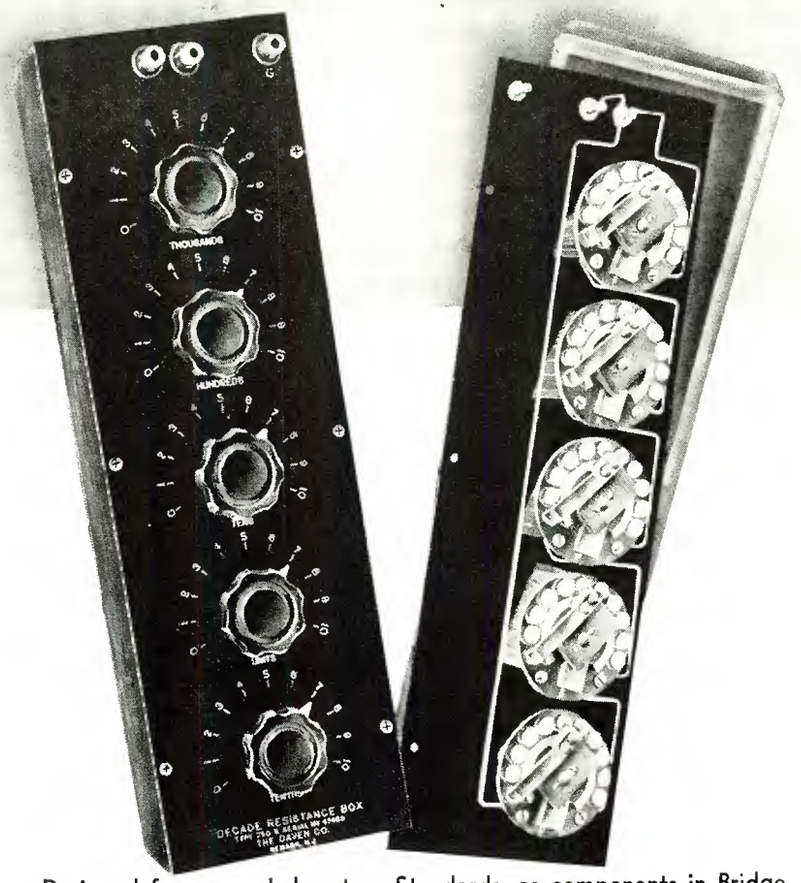
Operating controls on the front panel include microphone gain, phono-radio gain and fader, bass boost, treble boost, and line switch. The pilot light and line fuse are both accessible for replacement without removing the amplifier case.

The S-31 tuner provides an ideal unit for use with high-quality sound systems where broadcast (f-m or a-m) pick-up is utilized as one of the input sources. It is equally well suited to studio use, and to use in the home provided a suitable amplifier is available. Where it is to be worked into the audio system of an existing radio set it will usually be found most practical to feed its 5000-ohm output directly into the phono input terminals of the radio. Even where the tuner is located some distance from the radio set this arrangement is still workable by virtue of the fact that the tuner output is at sufficiently high level to avoid trouble from hum or other noise pick-up in the relatively high-impedance line.

For such home service the professional appearance of the tuner is some-

POPULAR DAVEN SERIES 750

DECADE RESISTANCE BOX



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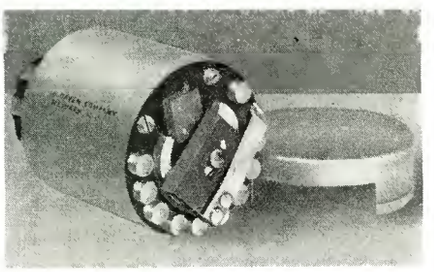

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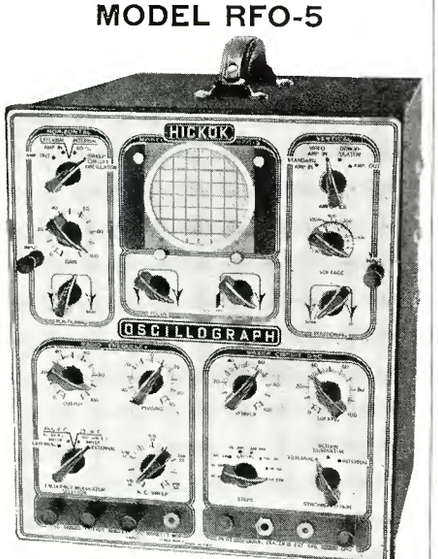

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times minimized by setting it into a bookcase, an existing cabinet or even into the side wall of an existing radio console. Where this can be done the tuner provides a highly effective as well as economical solution of the f-m problem.

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F-M BROADCASTING

(*Continued from page* 15)

the transmitting antenna becomes an important factor. In most large cities there will be a sufficient number of tall buildings on which to erect the radiator. Other localities will utilize hills or mountains to gain the necessary height. In some cases it may be found expedient to locate the f-m antenna on top of the towers of the regular broadcast station . . . or construct special towers for the purpose. In general, each locality will present special problems which must be solved in the field.

In regards to receivers, some 16 or more manufacturers are authorized to make sets under Armstrong patents, eight or ten of which have launched production. In general these sets may be placed in three classifications: (1) a-m/f-m combination sets, (2) f-m tuners to be used with the audio portion of conventional receivers, and (3) straight f-m receivers. In many cases the tuners will cover both the f-m and regular broadcast band.

No data has been made available as to the number of f-m receivers in use. However, sets will be available to the public in most locations served by f-m stations. It is difficult to estimate how fast receiver sales will advance, but it seems probable that sales will grow slowly at first, until the public becomes more familiar with their advantages, and then increase quite rapidly.

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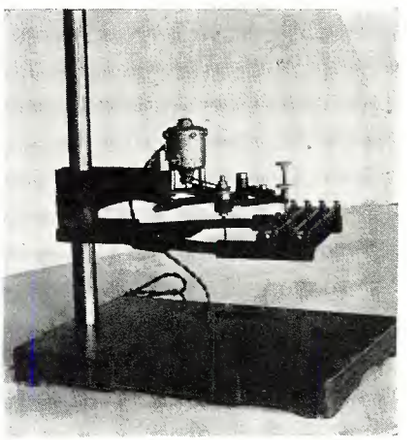

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"A Method of Measuring Frequency Deviation," by M. G. Crosby, p. 473, April, 1940, *RCA Review*.

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"Notes on F-M Transmitters," by Frank A. Gunther, p. 11, April, 1940, COMMUNICATIONS.

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"Reactance Tube Frequency Modulator," M. G. Crosby, p. 46, June, 1940, *QST*.

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"A Frequency Modulation Monitoring System," by R. J. Pieracci, Aug., 1940, *Proc. IRE*.

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"A Transmitter for Frequency-Modulated Broadcast Service Using a New Ultra-High-Frequency Tetrode," by A. K. Wing and J. E. Young, p. 327, Jan., 1941, *RCA Review.*
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"A Demonstration System for Frequency Modulation," by Marvin Hobbs, p. 20, Jan., 1941, *Electronics.*
"Practical Ideas for FM Antennas," by Tore Lundahl, p. 16, Feb., 1941, *FM.*
"Planning an FM Station," by W. R. David, p. 20, Feb., 1941, *FM.*
"Special Parts for FM Circuits," by Calvin F. Hadlock, p. 33, Feb., 1941, *FM.*
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"A-M/F-M Broadcast Tuner," by S. Gordon Taylor, p. 10, March, 1941, COMMUNICATIONS.
"Frequency Modulation" (bibliography), *AIEE.*
"F-M Receivers," by M. L. Levy, p. 5, March, 1941, COMMUNICATIONS.
"Detection in F-M Receivers," by W. Weiss, p. 16, March, 1941, COMMUNICATIONS.

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OVER THE TAPE

(*Continued from page 20*)

ARMSTRONG LICENSES FINCH

Announcement was made today that W. G. H. Finch, President of Finch Telecommunications, Inc., of Passaic, New Jersey, has been licensed by Major Edwin H. Armstrong, inventor of frequency modulation, to manufacture f-m mobile communication and miscellaneous apparatus.

HEINTZ & KAUFMAN BULLETINS

Heintz & Kaufman, S. San Francisco, Calif., have made available data sheets on their Types 54, 254 and 257 Gammatrons. These tubes are suitable for ultra-high-frequency use, particularly for frequency modulation services. The data sheets may be secured from the above organization on request.

RCA RESEARCH LABS.

The world's largest radio research laboratories will be built by the Radio Corporation of America, at Princeton, N. J., according to David Sarnoff, president of RCA. It will be known as "RCA Laboratories," and will be the headquarters for all research and original development work of RCA, and for its patent and licensing activities. The new organization is planned to promote the growth of radio as an art and industry, and to meet the expanding demands of national defense.

A further purpose, Mr. Sarnoff said, will be to facilitate the creation and development of new radio products and services which will provide new business and new employment for the post-war period. Under the impetus of emergencies intensive research creates new instrumentalities, and further research and development are necessary to adapt them to use by the public.

More than 130 manufacturers in radio and other fields, Mr. Sarnoff pointed out, are now licensed under the patents of RCA. He said that the new Laboratories will continue to make inventions available to competitors and others, and to cooperate with them in the fullest development of the radio art.

Otto S. Schairer, heretofore Vice-President in Charge of the Patent Department, will be Vice President in Charge of RCA Laboratories, which will include the Patent Department.

Ralph R. Beal, Research Director, will have general direction of all research and original development.

Dr. C. B. Jolliffe, who has been in charge of the RCA Frequency Bureau, has been made Chief Engineer, and will direct and coordinate the broad engineering policies.

E. W. Engstrom will be Director of the Princeton Laboratories, with Dr. V. K. Zworykin and B. J. Thompson as Associate Directors.

Dr. Harold H. Beverage will be Director of Communications Research in charge of the Long Island Laboratories at Riverhead and Rocky Point, which will be continued at those locations.

Arthur Van Dyck will be Manager of the Industry Service Section of the new organization and will continue in charge of service to licensees of RCA.

The chief engineers of the RCA companies—O. B. Hanson, National Broadcasting Company; E. W. Ritter, RCA Manufacturing Company; C. W. Latimer, RCA Communications, Inc., and I. F. Byrnes, Radiomarine Corporation of America—will be members of a Research Consulting Board.

General supervision over the research activities will also be exercised by an Executive Board consisting of Messrs. Sarnoff, Chairman; Schairer, Beal and Jolliffe, and the executive heads of the RCA companies, G. K. Throckmorton, RCA Manufacturing Company, Inc.; Niles Trammell, National Broadcasting Company; W. A. Winterbottom, RCA Communications, Inc., and Charles J. Pannill, Radiomarine Corporation of America.

FEDERAL TELEGRAPH BULLETINS

The Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J., have available data sheets on their types F-129-B and F-129-R transmitting tubes. These tubes are particularly suitable for frequency modulation services. Write to the above organization for copies.

• • •

NEW PRODUCTS

SPEAKER SYSTEM

Cinaudagraph Speakers, Inc., 2 Selleck St., Stamford, Conn., are now in full production on their latest development, a Cinaxial dual speaker system, incorporating a 12-inch woofer, a 5-inch tweeter, and com-

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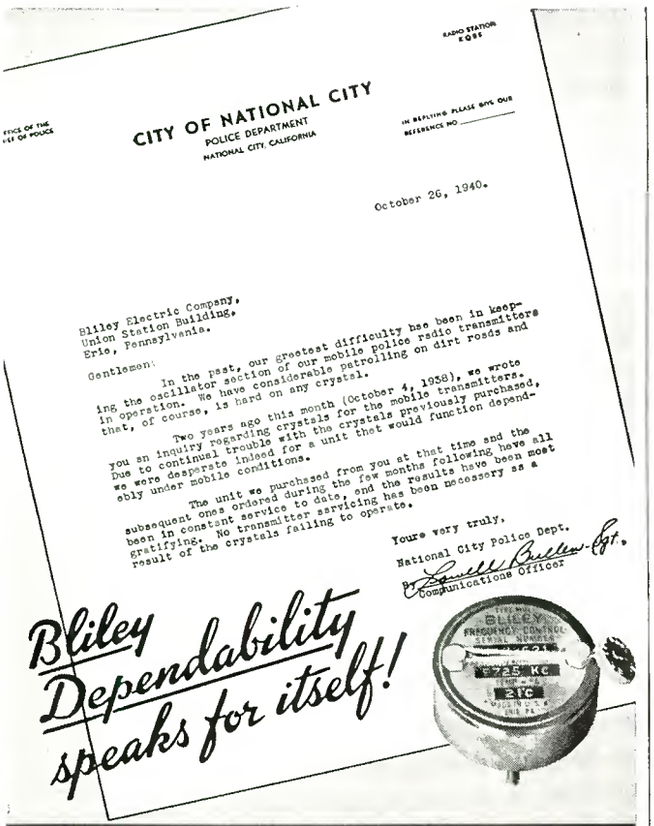
CITY OF NATIONAL CITY
POLICE DEPARTMENT
NATIONAL CITY, CALIFORNIA

October 26, 1940.

Bliley Electric Company,
Union Station Building,
Erie, Pennsylvania.

Gentlemen:

In the past, our greatest difficulty has been in keeping the oscillator section of our mobile police radio transmitters in operation. We have considerable patrolling on dirt roads and that, of course, is hard on any crystal.

Two years ago this month (October 4, 1938), we wrote you an inquiry regarding crystals for the mobile transmitters. Due to continual trouble with the crystals previously purchased, we were desperate indeed for a unit that would function dependably under mobile conditions.

The unit we purchased from you at that time and the subsequent ones ordered during the few months following have all been in constant service to date, and the results have been most gratifying. No transmitter servicing has been necessary as a result of the crystals failing to operate.

Yours very truly,
National City Police Dept.
By Lt. Communications Officer

Bliley Dependability speaks for itself!

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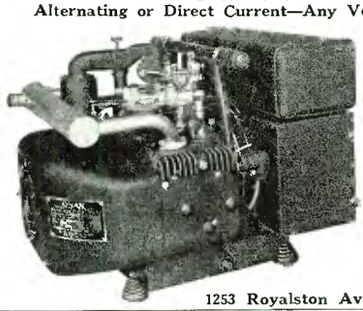

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New High Fidelity FM/AM

FM/AM Reception by a Turn of the Bandswitch with Hallicrafters Model S-31

A new 1941 Hallicrafters designed FM/AM Tuner with the No. 1 band covering all frequencies used by amplitude modulated broadcast stations and the No. 2 band covering frequencies used by high fidelity modulated broadcast stations. The Model S-31 Tuner combines both circuits and changes from FM to AM with the bandswitch. 8 tubes, power output 130 milliwatts undistorted, power consumption 120 watts, operates on 1150124 volt, 60 cycle AC. Model S-31 Tuner complete with 19″ x 8¾″ rack panel, metal cabinet and tubes, $69.50.

AMPLIFIER For Model S-31 Tuner

Designed for use as a companion to the FM/AM Model S-31 Tuner. Delivers 25 watts of high fidelity audio power to either speaker or 500 ohm load. 6 tubes, fidelity 2 DB from 50 to 15,000 cycles gain, channel No. 1, microphone (high impedance) 96 DB, channel No. 2, phone (low impedance) 60 DB, power output 25 watts, power consumption 120 watts, output impedance No. 1, 500 ohms; No. 2, 8 ohms; No. 3, 4 ohms. Dimensions: panel 19″ x 8¾″ x 10″. Complete with cabinet and tubes, $49.50.

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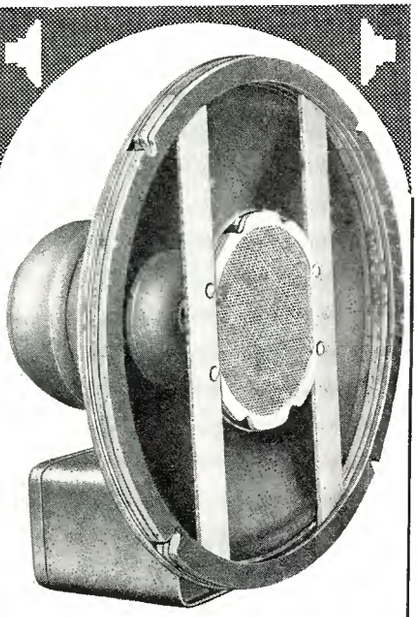

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CINAUDAGRAPH SPEAKERS present Model FM-12, designed to fit any standard 12-inch baffle mounting, and can, therefore, readily replace older equipment.

Woofer and Tweeter units are definitely controlled by an accurately calibrated network. All transformers and condensers are neatly contained within a single unit, compactly mounted on the speaker . . . the list, only $42.50

A special bulletin in preparation . . . write, mentioning this advertisement.

CINAUDAGRAPH SPEAKERS

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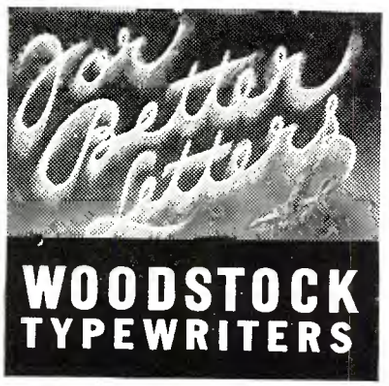
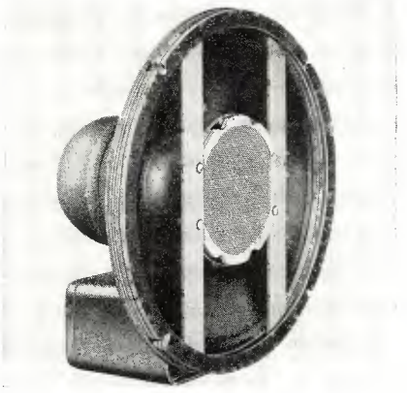


WOODSTOCK TYPEWRITERS



plete cross-over network. The system is expressly designed for use in high-fidelity phonograph equipment for commercial, professional, and home use; also for f-m receivers. Frequency response is substantially flat from 30 to 12,000 c-p-s. Its useful range is said to be considerably in excess of 12,000 c-p-s.

RCA TUBES

The RCA Manufacturing Co., Inc., Harrison, N. J., are making available the following new tubes: RCA-6SG7 triple-grid super-control amplifier; RCA-12SG7 triple-grid super-control amplifier; and the RCA-930 gas phototube.

The 6SG7 and 12SG7 are r-f amplifier pentodes of the metal type recommended for use in high-frequency receivers. They feature high transconductance, very low grid-plate capacitance, and two separate cathode terminals. Because of these features, the 6SG7 and 12SG7 offer receiver engineers new facilities for improving the stage gain of receivers, particularly those designed for high-frequency and/or wide-band operation. At higher frequencies, the use of two cathode terminals permits of greater isolation of input and output circuits through elimination of the coupling inductance of a common cathode return. As a result, the input conductance can be maintained at a high value at high frequencies. The low value of grid-plate capacitance minimizes regenerative effects, while the high trans-conductive makes possible a high signal-to-noise ratio. Furthermore, the single-ended metal construction with its self-shielding shell and short internal leads is a practical consideration in obtaining high gain with stability.

The 6SG7 and 12SG7 are alike except for heater rating. The heater of the 6SG7 is designed so that it can be operated in series with other 6.3-volt, 0.3-ampere types; likewise, the heater of the 12SG7 can be operated in series with other 12.6-volt, 0.15-ampere types.

The new gas phototube RCA-930 is recommended for use in sound reproduction and relay applications. Electrically, the 930 is like the type 923 with its high sensitivity and large response to red and near infra-red radiation. Physically, the 930 is like the type 929 with its simple, rugged, short construction and octal base. This combination makes the RCA-930 a phototube of particular interest to designers of new equipment utilizing phototubes.

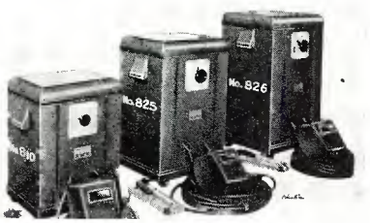
TRANSPARENT ACETATE TUBE

The Precision Paper Tube Co., 2033 Charleston St., Chicago, announces a new self-supporting spirally wound transparent acetate tube. This new transparent tube is made by spirally wrapping acetate tape over a steel form of the required I.D., and using a new acetate cement for the adhesive to insure a solid non-separating wall. Being pre-formed, the tube will not shrink, it is said. This new product is supplied in continuous lengths of any wall thickness with any i.d. and o.d.

Due to its dielectric properties, it is recommended for many high-frequency and electronic applications found in various branches of the radio and electrical industry, and for certain types and applications of low-amperage cartridge fuses. Further information may be had by writing direct to the manufacturer.

ARC WELDER

The Eisler Engineering Co., 740-770 South 13th St., Newark, N. J., has recently placed a new model a-c transformer type arc welder on the market. This ma-



chine is available from 100 to 400 ampere capacity. They are made standard to operate on 220 volts, 60 cycles, a-c, single phase, or any single phase of a polyphase circuit. Can be supplied for 440 or 550 volts at no extra cost.

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For Output Transformers of highest permeability

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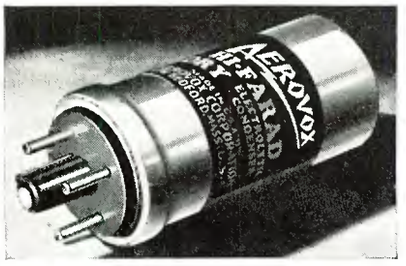
PLUG-IN ELECTROLYTICS

Originally made to order for military, aircraft, police radio, sound system, and other users of continuous-service equipment, the Aerovox plug-in electrolytics are now listed in the latest catalog and made available as standard jobber items. These plug-in condensers, developed and manufactured by Aerovox Corporation of New Bedford, Mass., are provided with a specially-con-

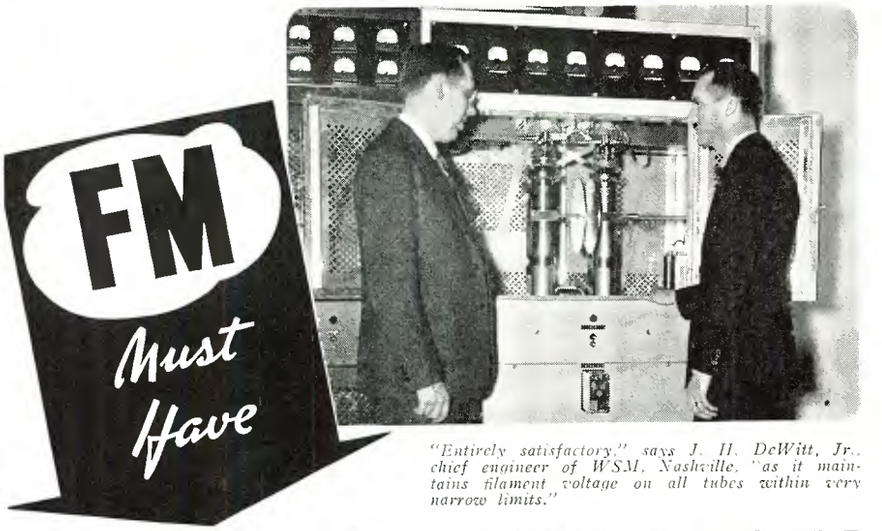


structed octal base which fits into the standard octal socket. Such units are readily removable for substitution testing and checking and replacement, in much the same manner and ease as regular radio tubes. This feature is important in continuous-service equipment, wherein electrolytic condensers must be instantly replaceable when necessary. Aerovox plug-in electrolytics are now available in the 525 v surge 450 v d.c.w. rating, and in 10 to 80 mfd single-section, 10-10 and 20-20 double-section, 10-10-10 triple-section, and the 10 x 10 x 450 + 20 x 25 combination.

RECORDIO PRO

In the accompanying illustration is shown a portable radio, recorder and phonograph for professional use. Known as the Recordio Pro, it is a product of Wilcox-Gay Corp., Charlotte, Mich. The master unit may be used with either one or two turn-

tables . . . the latter combination, of course, permitting continuous recording. Recording speeds are 78 and 33⅓ r-p-m. Recordings can be made from live talent or radio, and the master unit may be used separately from the turntables as a radio or for public-address purposes. Literature available from the manufacturer.



"Entirely satisfactory," says J. H. DeWitt, Jr., chief engineer of WSM, Nashville, "as it maintains filament voltage on all tubes within very narrow limits."

CONSTANT VOLTAGE!

The success of FM broadcasting depends heavily on the delivery of a **constant, unvarying voltage** for filament control, oscillator circuits and plate supply—and the most dependable source of that stabilized voltage is a SOLA CONSTANT VOLTAGE TRANSFORMER.

Sola Constant Voltage Transformers have been specifically designed for use with such exacting equipment as FM broadcasting transmitters. Their use will eliminate undependable manual controls, protect tube filaments against damage from surge or "off voltage" operation and greatly improve transmitter performance.

Fully automatic, instantaneous in operation. SOLA CONSTANT VOLTAGE TRANSFORMERS have no moving parts and require no maintenance. They are self-protecting and cannot be damaged by short circuit. AND—they will maintain their output voltage to within a fraction of a per cent of the specified value, **even though the line voltage varies as much as 30 per cent.**

You'll find these SOLA CONSTANT VOLTAGE TRANSFORMERS surprisingly compact—and economical, too. Available in capacities up to 10 KVA for single or polyphase operation.

SOLA ELECTRIC COMPANY
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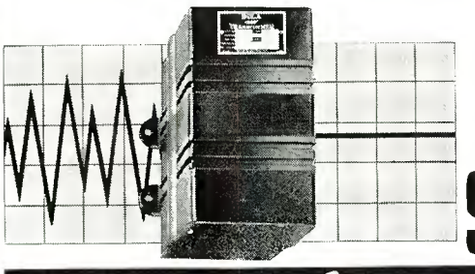

ASK FOR BULLETIN ECV-74

SOLA

Constant Voltage TRANSFORMERS

CATHODE-RAY TUBE

A new type high-vacuum cathode-ray tube designed for oscillographic applications where low deflection-plate capacitances are essential is announced by Allen B. Du Mont Labs., Inc., 2 Main Ave., Passaic, N. J. This group of teletrons, having four different screen phosphors with identical electrical characteristics, is designated as the Type 2529 series. The deflection-plate leads are short and direct, terminating in caps on the glass walls of the tube rather than in the tube base. The intensifier electrode featured in this tube makes use of the principle of acceleration of the electron beam after deflection in order to increase deflection sensitivity. The tube is available with the Du Mont types A, B, C and D screens; namely, medium-persistence green (Type 2529A5), long-persistence green (Type 2529B5), highly-actinic short-persistence blue Type2529C5), and medium-persistence white (Type 2529D5).

ELECTRONIC VOLT-OHM-MFD METER

A new electronic tube volt-ohmmeter, Model 661, has been introduced by the Radio City Products Co., 88 Park Place, New York City. This is the first of a new group of test instruments to be offered the radio and electric fields by the company. The Model 661 has the following features: input resistance—16 megohms (low) to 160 megohms; a-c/d-c voltage range—0.1 to 6,000 volts; resistance range—0.1 ohm to 1,000 megohms; capacity test range—.00005 to 600 microfarads. The instrument is inclosed in an all-metal case on the etched panel of which is mounted the 4½-inch rectangular meter.

LAFAYETTE AMPLIFIER

Designed for low-power installations of the better class, the Model 406T amplifier offered by Lafayette Radio Corp., 100 Sixth Ave., New York City, has an output of 6-watts. One microphone and one phono input are provided with a frequency response from 50 to 8,000 cycles. Parts and construction are husky to insure long dependable service, it is said.

TUBE PRICES UP

Several tube manufacturers have an-

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FREE TRIAL

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Hundreds of broadcasting and communication stations have standardized on IDEAL Cleaners *Because*

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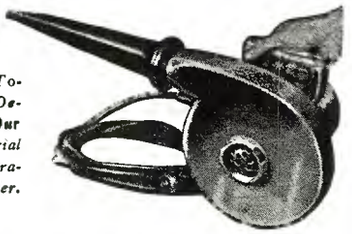

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IDEAL COMMUTATOR DRESSER CO.
1062 Park Avenue Sycamore, Illinois
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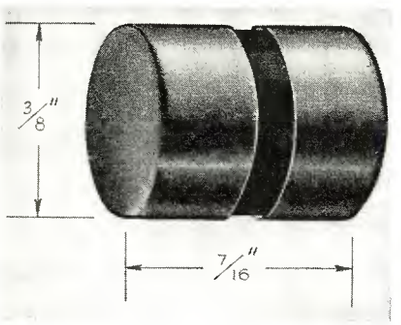
nounced that list prices of tubes have been increased an average of 5c per tube because of increased raw material costs.

PLUG-IN TUBE-TYPE RESISTORS

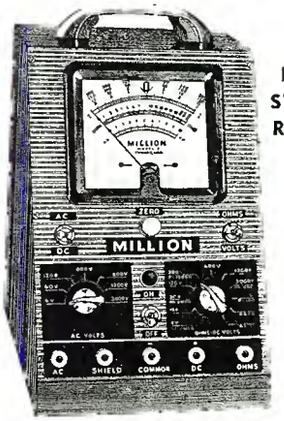
For heavy-duty service such as in sets employing both 300 and 150 milliampere tubes served by a single voltage-dropping resistor, a new glass-insulated-element plug-in tube-type resistor, Type MTG is announced by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y. Instead of the usual bare helical wire winding supported directly on the mica "card" or form, the new type employs a fibre-glass core for the winding which may also be covered with a fibre-glass braiding, supported on the mica. The glass-insulated element handles over three times the wattage of the usual bare winding. Some units are made with a combination of bare winding and glass-insulated winding, supported on the same mica form.

MERCURY MIDGET SWITCH

An extremely small mercury switch measuring only 7/16 inch long by 3/8 inch diameter has recently been announced by Littelfuse, Inc., 4748 N. Ravenswood Ave., Chicago. This switch is designed for use in low-voltage circuits up to 25 volts a-c or d-c, and currents up to 10 amperes at 6 volts and 3 amperes at 25 volts. There is no friction or wear in operation, and no maintenance or attention is required. The durable metal and bakelite body contains the mercury. A newly designed baffle device assures positive "make or break" operation, with no opportunity for a flickering action when equipment is jolted, it is said. Further information and specific recommendations can be obtained by writing the manufacturer direct.



MILLION ZERO CENTER



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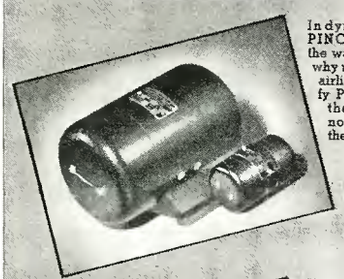
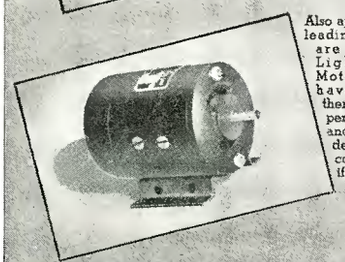


In dynamotors, PINCOR leads the way. That is why most major airlines specify PINCOR—they accept nothing but the best!



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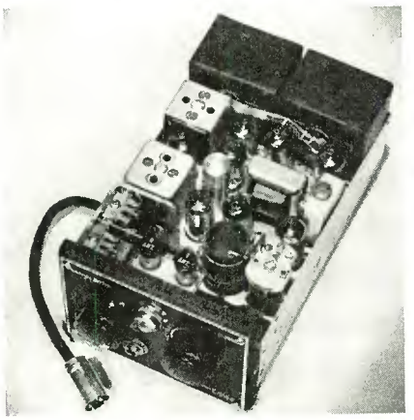
TWO-WAY AIRCRAFT RADIO

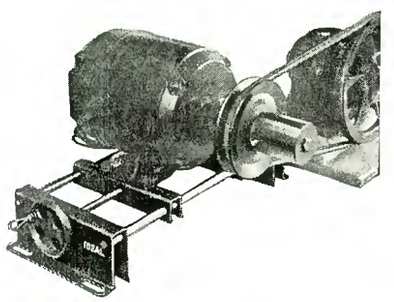
A transmitter-receiver for small aircraft is now being manufactured as one unit of a complete line of light plane, medium power, and ultra-high-frequency radio equipment by Air Associates, Inc., Bendix, N. J. Designed for light planes, the BR-



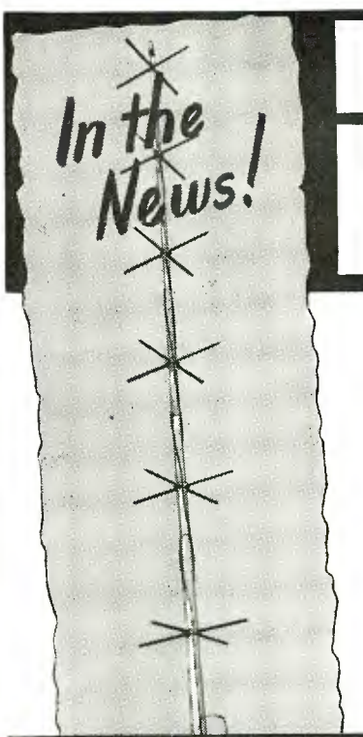
3T transmitter-receiver weighs only 10½ pounds with dry batteries, headphones, microphone, cables and shock mountings. Operation is reduced to its simplest form, for the pilot has only two receiver controls —the tuning knob and volume controls; and one transmitter control—a microphone push botton. The receiver, tunable over the range of 200 to 400 kilocycles, provides reception from radio beacon and weather stations up to distances of 150 miles. Receiver is so shielded that shielding of airplane and engine is not necessary. Transmitter is crystal controlled on a frequency of 3105 kilocycles and is capable of a power output of better than two and a half watts. Range of broadcast is 35 to 50 miles under normal conditions. A whip antenna is used for reception and a specially designed end loading antenna unit is said to give excellent transmitting performance.

MOTOR PULLEY

The Ideal Commutator Dresser Co., 4025 Park Ave., Sycamore, Ill., announces a new variable speed pulley designed for light, inexpensive machinery. The pulley mounts directly on the motor shaft and requires only standard V-belts. Features include short over-hang, forced lubrication, balanced sheave and all metal construction.



Both halves of sheave move giving accurate belt alignment at all times. The pulley faces are curved so that the belt has full contact at all pitch diameters. Speed ratios up to 2¾ to 1 available. Sizes up to ¾ h.p. Complete unit includes variable pitch pulley and adjustable sliding motor base. By turning the handwheel of the base, the motor moves backward or forward causing an increase or decrease in belt tension. This causes the pulley to open and



LINGO FM Turnstile Antenna

HERE'S WHY: It is a distinct, new improvement over all previous designs. It is the result of a basically sound process of development and its excellent performance has been proved by actual tests at the "birthplace" of FM—W2XMN, Alpine, N. J. Now WE are ready, when YOU are ready—to provide this new turnstile antenna for installation on your building roof or supporting tower.

COMPLETE TECHNICAL DATA ON REQUEST!

Quotations will be gladly submitted for individual applications only, and will include the essential tubular steel mounting pole, turnstile elements, coupling equipment, transmission lines feeding the elements, etc. Climbing steps, lighting equipment and sleet melting units are also available as optional equipment. Write today for complete facts and please indicate your proposed frequency, power and location.

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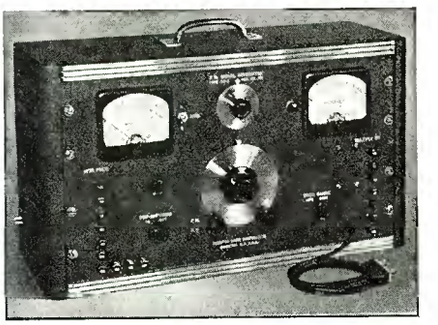
FREQUENCY MODULATED GENERATOR

Here is a signal generator developed specifically for use in the design of FM equipment. Built into it are the features requested by FM engineers. Both frequency and Amplitude Modulation available separately or simultaneously. All controls direct reading. Expanded scale meters. Power line regulation optional.



Brief Specifications

Frequency Ronge 41-50 MC ond 1-10 MC
Output from 0.1 μV to 0.1 Volt with attenuotor, ond 0.1 Volt to 1 Volt with special tap.
Deviotion from zero to 200 KC
Internol AF 100, 400, 1K, 4K ond 10K cycles.
RMA Pre-emphosis circuit.
Vernier F Control for selectivity.

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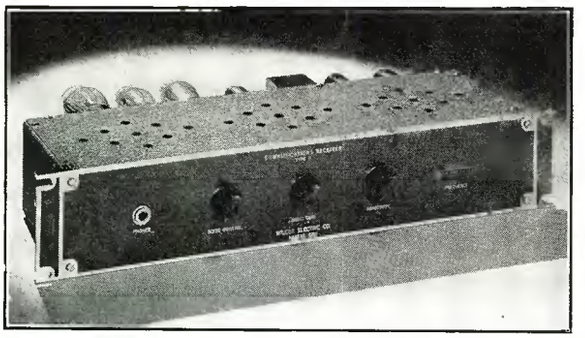

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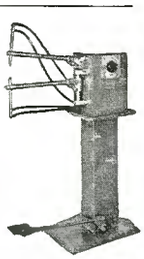

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close, changing the pitch diameter and the driven speeds. Speed changes are made while the drive is running.

METAL MATE OF GLASS

A new means of ensuring privacy to electrons that "live in glass houses" has won a patent for Howard Scott, research engineer at the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

The patent covers a new way of using Kovar, the Westinghouse alloy which is a perfect mate of glass, to seal parts of vacuum tubes used in the radio and electric power industries. Kovar is a mixture of iron, nickel, colbalt and manganese and has the unusual characteristic of expanding at the same rate as glass as the temperature rises. Thus it forms a "strain-free" seal to keep unwanted air out of glass vacuum devices in which electrons are at work generating X-rays or radio waves, or transforming alternating current into direct current.

Kovar also resists the corrosive action of metallic vapors, such as mercury and sodium which are used in some of these vacuum devices. It is used in conjunction with a hard, low-expanding type of glass.

ANTENNA SYSTEM

Since the time is past when a simple L- or T-type antenna system can serve the multiplicity of up-to-the-minute kinds of reception such as f-m, a-m, short-wave and television, the development of a single combination antenna system capable of serving all such functions automatically and satisfactorily, is a matter of timely interest.

The Taco combination antenna system introduced by Technical Appliance Corp., 17 E. 16th St., New York City, is made possible by selector transformers utilizing iron cores for maximum transfer of radio energy. The system starts with a dipole compromising two metal rods held by a center bracket mounted atop a mast. The two rods connect with the antenna transformer mounted on the mast, which transformer in turn feeds into the transmission line. Variations are available to suit any installation problem.

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The transmission line may be of any length up to and even exceeding 100 feet if required. This means that the dipole can be placed high above the building for maximum signal pickup, while the transmission line and transformers cancel out noise pickup. For store demonstrations a special type transformer is used for each set, per-

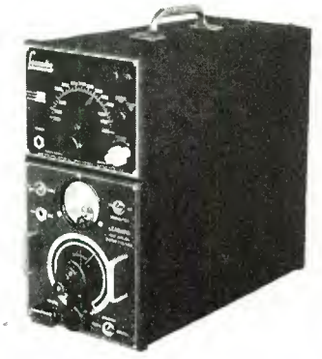
mitting as many as eight sets to be operated on the same system, simultaneously, without interference with each other and without detraction from individual performance.

A polarization bracket holding the dipole to the mast permits tilting the dipole at any angle from horizontal to vertical, for required polarization, as well as swinging the dipole flatwise to the desired transmitter. The mast is held to roof coping, pipe, water tank, wall or other available structure by means of brackets. At great distances from the transmitter or for locations where signal strength is extremely low, it is advisable to use a reflector comprising a second dipole supported a quarter wavelength behind and parallel to the first dipole by means of a crosswise bracket.

Inasmuch as the variety of present-day broadcast activities including f-m, a-m, short-wave and television, together with the receiver location and operating conditions, call for a more or less custom-built installation, or at least a particular selection of components to make up that antenna system best suited to the precise requirements, the Taco antenna system is really a choice of antenna kits, accessories, transmission lines, and antenna and set transformers, with which to make up that installation best suited to the case. The explicit literature makes it relatively simple to make up the required combination of elements.

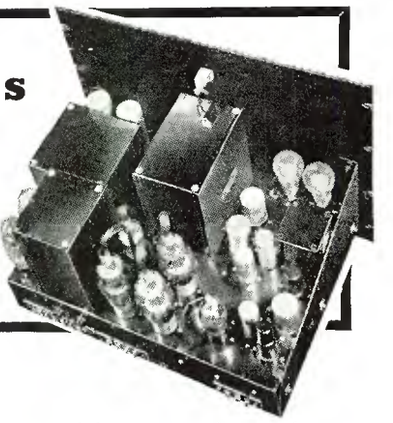
TWO-WAY PORTABLE RADIO

Lear Avia, Inc., Dayton, Ohio, announces the development of a new two-way portable radio. Originally designed for military use, this radio has been adapted and released for commercial and export uses. Compact



and rugged, the unit operates in the 3000-6000 kc band, and provides a means of communication between a ground station and aircraft in flight. The only installation provisions necessary are an antenna and a 12 volt d-c supply. Designated as Model TRM-204, the two-way unit is comprised of a small 10-watt transmitter and a companion receiver, both housed in a single carrying case. The power supply unit for both the transmitter and the receiver is a special type dynamotor.

Presto Offers a New 50 Watt Recording Amplifier . . .



. . . and the first *accurately calibrated* recording channel for making direct playback transcriptions. The new Presto 88-A amplifier, combined with the Presto 1-C cutting head, makes recordings identical in response to the finest commercial pressings. These recordings give you full range reproduction when played back on the N. B. C. Orthacoustic or standard lateral settings of your reproducing equipment. A switch on the amplifier selects either of the two recording characteristics.

You'll hear a new quality in your recordings when you use this Presto equipment . . . a fuller, more natural bass . . . crisper, cleaner highs. Pre-emphasized high frequency response reduces surface noise well below audibility. Output of the 88-A is 50 watts with 1½% distortion. Gain is 85 db. Noise level is 45 db below zero (.006 W). Use the 88-A in place of your present amplifier. You'll notice a tremendous improvement in your recordings. Your present Presto 1-B or 1-C cutter can be calibrated with an 88-A amplifier at a nominal charge. Catalog sheet on request.

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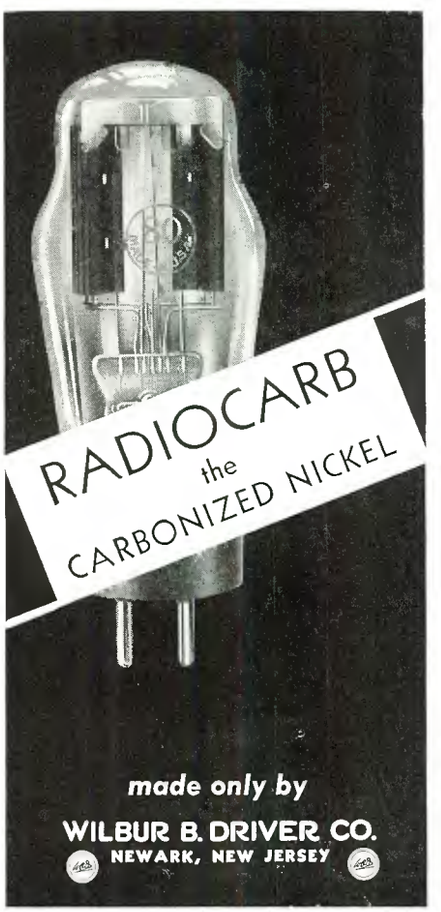

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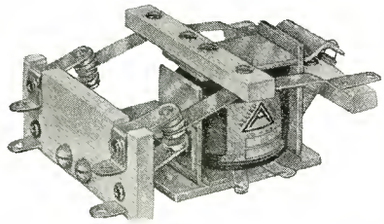

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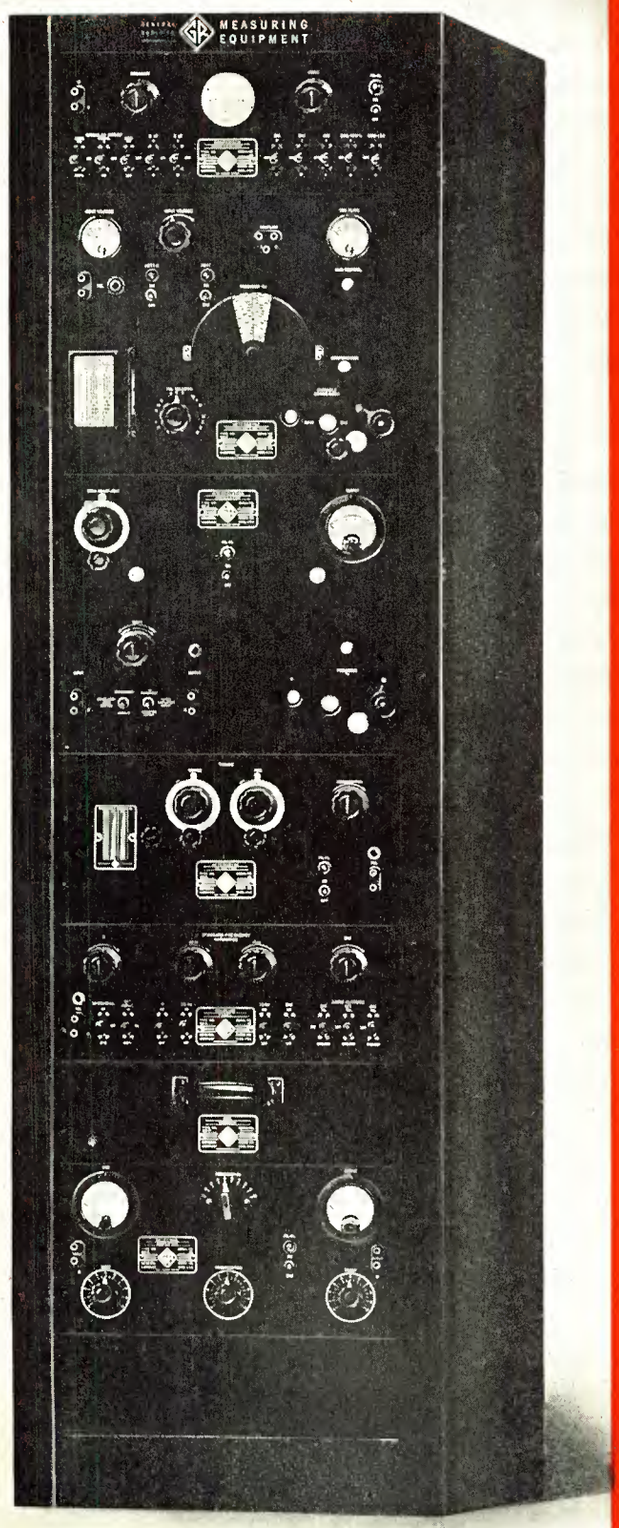

FROM THE G-R PRIMARY STANDARD OF FREQUENCY, fundamental frequencies of 50, 11, 10, 9, 1 and 0.1 kilocycles are obtained, By means of harmonic frequency multipliers in the primary standard, a large number of harmonics of each of these frequencies are available, also, at the output terminals of the standard.

For the precise measurement of frequencies in terms of these standard frequencies, suitable auxiliary and interpolation equipment is needed. The G-R Frequency Measuring Equipment assembly, with the Primary Standard of Frequency, makes possible the accurate, direct, precision measurement of *any* frequency from a few cycles up to 25 megacycles, or higher if external receivers are used.

The units comprising the measurement equipment are as follows:

Heterodyne Frequency Meter covering the range of 100 kc to 5,000 kc in sixteen steps. Sufficient harmonic output is obtained to produce beats in a high-frequency receiver operating at 30 Mc or more. For many measurements, sufficient accuracy is obtained through use of direct-reading finder and interpolation dials on the heterodyne frequency meter.

Interpolation Oscillator which is a direct-reading, linear-scale audio-frequency oscillator covering frequencies between 0 and 5,000 kc. It is used to measure the audio-frequency differences between the unknown frequency (or a submultiple thereof) and a standard 10-kc harmonic. When the difference is very small, use is made of the 9-11 kc standard harmonics to avoid measurements with very low audio frequencies.

Heterodyne Detector with plug-in coils covering the range from 25 kc to 25 Mc. This detector is used to obtain beats between the standard and the unknown radio frequencies.

Regenerative Selective Amplifier which is used to select any multiple of 1 kc between 1 and 10. This amplifier is particularly useful when the cathode-ray Comparison Oscilloscope is used in calibrations in the upper audio-frequency and lower radio-frequency ranges.

Comparison Oscilloscope with 100-cycle and 1,000-cycle smoothing filters, networks for obtaining circular sweeps at these frequencies, and switches for connecting units of the frequency standard and measuring equipment to the oscilloscope.

The assembly is housed in a steel cabinet and includes a built-in loudspeaker. Permanent shielded connecting cables between the measuring equipment and the Primary Standard and for all interconnections between units of the measuring assembly are furnished. All connections for actual measurements are made by suitable switching on the centralized coupling panel, through which the standard and unknown sources and the various measuring instruments are connected. Suitable power supplies for a-c operation from 115/230 volt and 50-60 cycle mains are individually built in each instrument.

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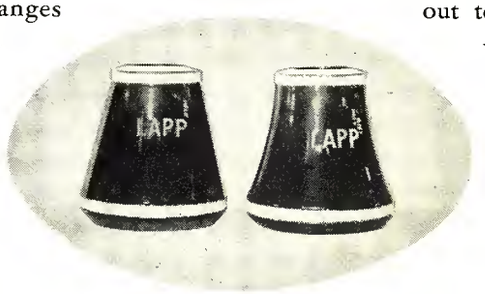
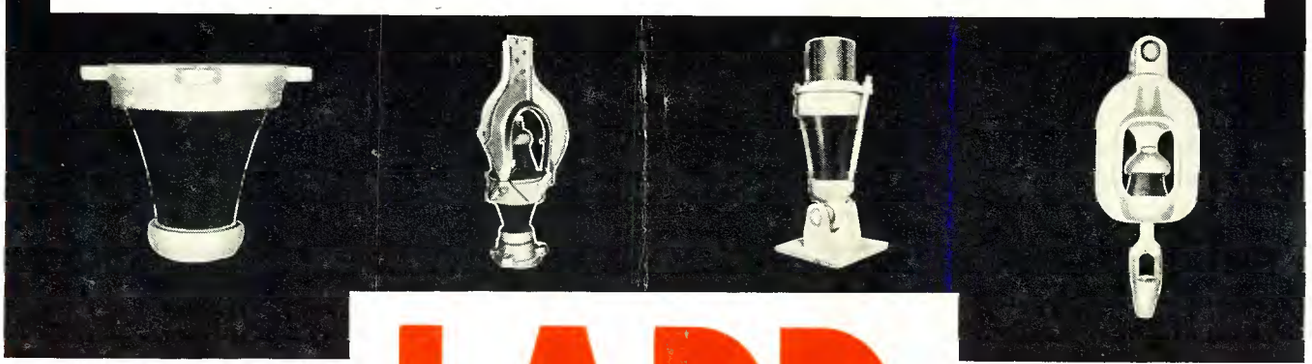
The advance of modern industrial science has been achieved largely through making minute changes in physical or chemical form to effect tremendous changes in performance characteristics. Consider the matter of steel. *If you know how,* you can take a pound of common nails, add about ⅛ ounce of carbon and make tool steel with double the tensile strength and five times the hardness. * * * As pioneers in radio tower insulation, Lapp men had to develop whole new engineering conceptions. Recognizing early that the tremendous mechanical loads could be carried by porcelain loaded only in compression, they developed the porcelain compression cone for use in all types of footing and guy insulators. And, then, not content with their first efforts along these lines, they set out to improve the design—with the result that by changing slightly the contour of the cone, they *doubled the strength of the insulators.* * * * It's the *know-how* of Lapp engineers that has kept Lapp the dominant force in insulation for radio broadcast. Today, if you contemplate installation of a new transmitter, or modernization of present equipment, you can't afford not to consider Lapp for tower footing and guy insulators, for porcelain water cooling systems, for pressure gas-filled condensers.



Left, early Lapp Compression Cone. Right, curved side compression cone—same dimensions, wall thickness and weight—twice the compression strength of the straight side cone—the design used in all footing and guy insulators (see below) since 1932.



LAPP

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