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SEPTEMBER ★ CANADIAN V-H-F F-M TRANSMITTER ★ AACS WEATHER-TRANSMISSION SYSTEM ★ LATERAL DISC RECORDING AT THE NAVAL RESEARCH LABORATORY 1946

FRANKLIN AIRLOOPS now covered by basic patent #2,401,472

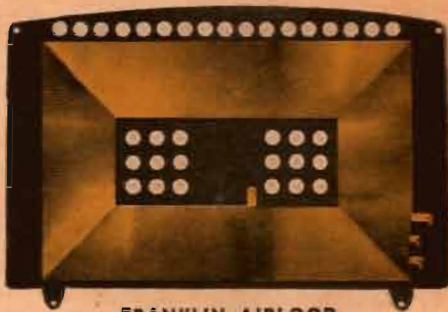
FRANKLIN AIRLOOPS NOW COVERED BY BASIC PATENT

Patent No. 2,401,472 covering the new loop antenna, known as the AIRLOOP, has just been issued by the U. S. Patent Office. The claims issued are basic in scope as is evidenced in claim No. 1 which is typical and follows:

1—An air dielectric inductance comprising a panel of insulating material and a continuous metal strip formed from a metal sheet and attached to one face of said panel in the form of a spiral, the planar width of said strip being equal to the pitch of said spiral and said strip being in channel form to provide a free air space between adjacent turns of said spiral.

In addition to the above, other patents are pending, domestic and foreign, covering the methods of manufacture and items such as stamped electrostatic shields, stamped disc type commutators, stamped inductance coils, stamped wiring circuits and for the molding of loops and creative metal designs in cabinets which are of plastic or inert materials.

The Franklin Airloop Corp., which has the rights to the use of this patent, offers its experimental laboratories to assist in the development of any item which can be manufactured by the stamping method covered in these patents.



FRANKLIN AIRLOOP

SHORT WAVE INDUCTANCE COIL

ELECTROSTATIC SHIELD

Illustrated are but a few of the items that can be manufactured by the method covered in this patent . . . many others are now in development . . . you, too, may conceive a use for this patented method and in such case the Franklin experimental laboratories will be glad to assist in its development.

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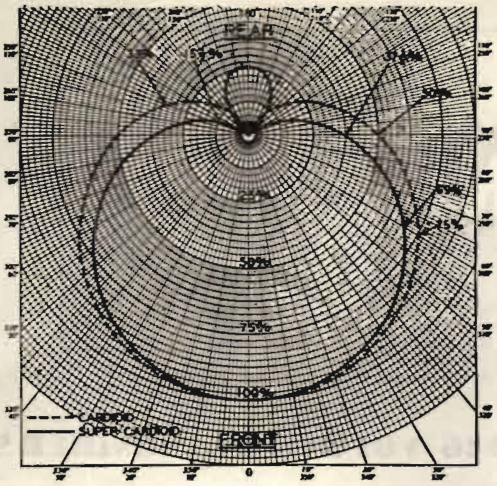

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The improvement in unidirectional operating characteristics of the SHURE Super-Cardioid Microphone over the cardioid is indicated by the comparative pickup patterns shown above.

★ Maximum sensitivity (100%) is achieved by sounds entering the front of the Microphone.

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MODEL	IMPEDANCE	CODE
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LEWIS WINNER, Editor

F. WALEN, Assistant Editor

We See...

Audio Facilities Research and development, now more active than ever, will soon provide the broadcaster with quite an assortment of outstanding audio tools.

Studios, control rooms, and equipment . . . all have profited by the exhaustive laboratory and field studies instituted by industry specialists.

In studio designs, provision has been made for both new and modified constructions with many unusual acoustical wall-treatment arrangements. One studio alteration development, recently demonstrated, required the modification of but one wall. This was made possible by the use of 12" to 36" semi-spherical diffuser forms arranged in random pattern.

Control rooms will feature such developments as . . . wide-range (frequency and power) speakers, in single and multiple arrays; streamlined consoles with maximum flexibility of studio-to-studio and level control; simplified cueing arrangements to aid the producer, console man and sponsor; light-weight pickups to increase record life and provide higher fidelity control; and record scratch-eliminator systems that will attenuate needle noise and yet provide wide-range reproduction.

Other recently completed audio facilities developments include . . . microphones that afford rigid control of directional or omnidirectional pickups; amplifiers with maximum power control at essential frequencies; intermodulation and other improved forms of audio checks with the aid of new audio measurement standards.

In view of the importance of these developments, we have arranged for a series of analyses covering many of these improvements, for early publication in Communications. Watch for this series!

Television Will Have its Own National Week . . . October 7th to 12th. And quite a coast-to-coast program has been planned by TBA. The highlight of the week will be the Second TBA Conference and Exhibition at the Waldorf-Astoria in New York City on October 10th and 11th.

Because of Paper Shortage it has been found necessary to reduce the page size of Communications. Effective with this issue the trim size will be 8¼" x 11¼". Sorry that we have to make this change now instead of next January, but paper problems just won't permit our waiting.
—L. W.

COMMUNICATIONS

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SEPTEMBER, 1946 VOLUME 26 NUMBER 9

COVER ILLUSTRATION

Control booth at WOR-Mutual. Dual speakers provide for monitoring of programs and rehearsals or remote-program listening for cueing. *(Courtesy Western Electric)*

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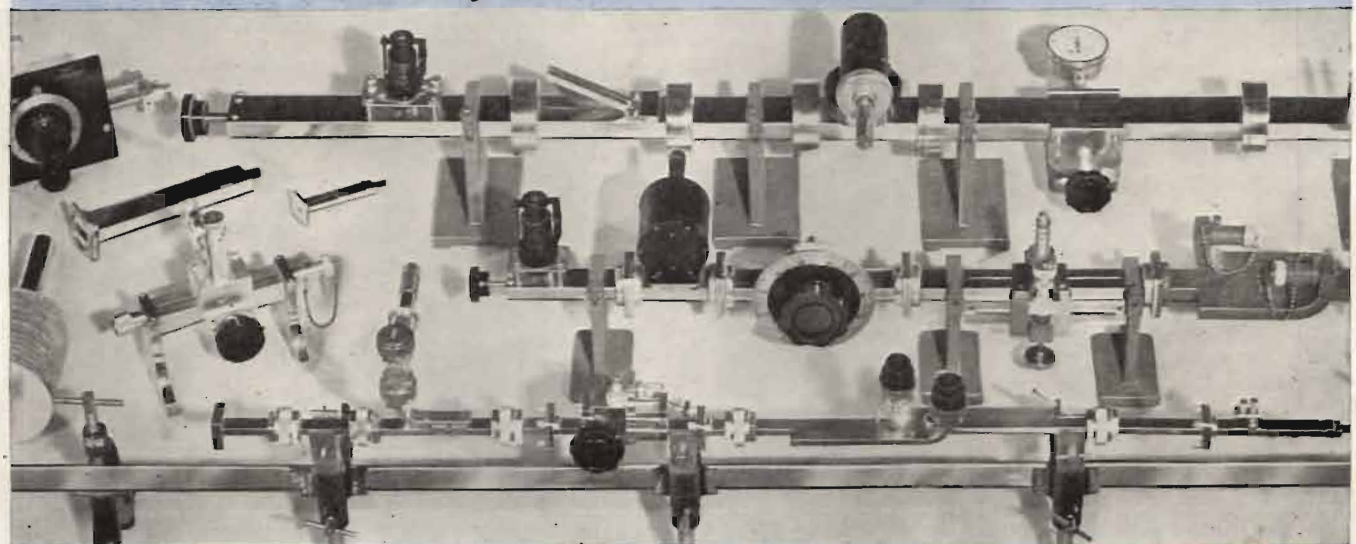

The complete line of De Mornay • Budd standard test equipment covers the frequency range from 4,000 mcs. to 27,000 mcs. It provides all R. F. waveguide units necessary for delicate, precision test work requiring extremely high accuracy in attenuation measurements, impedance measurements, impedance matching, calibration of directional couplers, VSWR frequency measurements, etc.

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The three test set-ups illustrated above include:

Tube Mount	Tunable Dummy Load
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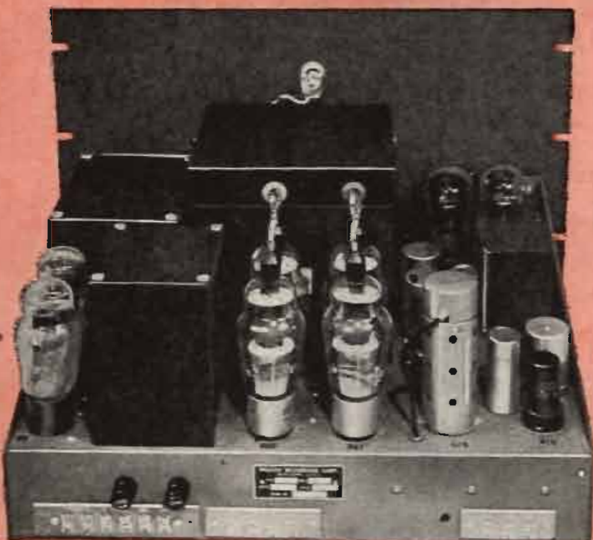

PRESTO 88-A amplifier has three calibrated frequency response curves...one flat from 30 to 17,000...two with rising high frequency characteristics complement either the NBC "Orthacoustic" playback system or standard high fidelity transcription playback equipment.

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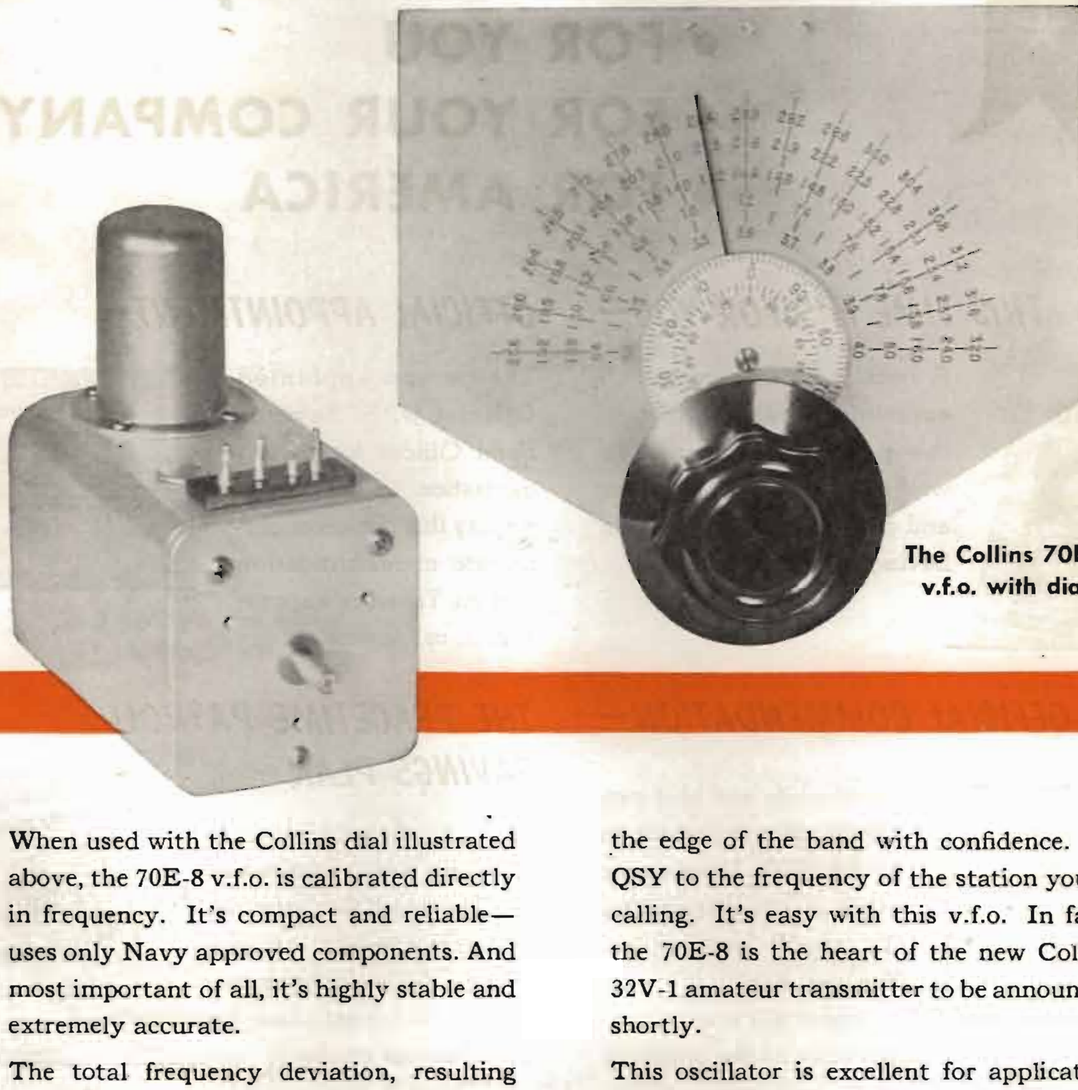

The Collins 70E-8 v.f.o. with dial

When used with the Collins dial illustrated above, the 70E-8 v.f.o. is calibrated directly in frequency. It's compact and reliable—uses only Navy approved components. And most important of all, it's highly stable and extremely accurate.

The total frequency deviation, resulting from all normal fluctuations in operating conditions, is less than .015% of the transmitted frequency. That means that the total error is not more than 150 cycles per megacycle. At 3.5 mc, the 70E-8 is within *515 cycles per second* of absolute accuracy!

Use the 70E-8 in your exciter, and work the edge of the band with confidence. Or QSY to the frequency of the station you're calling. It's easy with this v.f.o. In fact, the 70E-8 is the heart of the new Collins 32V-1 amateur transmitter to be announced shortly.

This oscillator is excellent for application in test equipment, too. Use it as an r-f signal generator, and in your heterodyne frequency meter. For smooth operation, with twice the precision of a micrometer, get a Collins 70E-8.

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Crystal detector—1946 model

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ONE INCH

Remember the crystal detector in the first radios — hunting for the right spot with a cat's whisker? For years the detector lay discarded in favor of the vacuum tube. But when microwaves came, and with them the need to convert minute energy to amplifiable frequencies, a Bell Laboratories' scientist thought back to the old crystal.

Silicon of controlled composition, he discovered, excelled as a microwave detector. Unlike the old-style natural crystals, it was predictable in performance, stable in service. From 1934 to Pearl Harbor, the Laboratories developed silicon units to serve microwave research wherever needed.

Then Radar arrived. The silicon crystal came into its own, and found application in long-distance microwave Radar. Working with American and British colleagues, the Laboratories rapidly perfected a unit which the Western Electric Company produced in thousands. It became the standard microwave detector.

Crystal detectors are destined to play a big role in electric circuits of the future. They will have an important part in Bell System microwave radio relay systems. In various forms, they may reappear in radio sets. Here again Bell Laboratories' research has furthered the communication art.

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COMMUNICATIONS

LEWIS WINNER, Editor

* * SEPTEMBER, 1946 * *

LATERAL DISC RECORDING At The Naval Research Laboratory

Description of NRL Recording System Facilities and Performances, with Details on Modifications Made on Commercial Equipment Used in System.

by ALAN T. CAMPBELL

Recording and Audio-Facilities Engineer

Formerly, Associate Radio Engineer, Sound Division, Naval Research Laboratory

THE PRODUCTION AND USE OF GOOD-QUALITY sound recordings materially aided several of the wartime research and development projects at the Naval Research Laboratory.

Various program sources are used at NRL. These include *speech (dialog); music; sound effects,* i.e. natural and artificial sounds occurring directly in the audible band and also supersonic sounds which are produced in the audible band with the aid of a local oscillator; and, finally, *vibrational phenomena,* which include test frequencies used in the evaluation of disc recorders and reproducers as well as material which is recorded for analysis studies.

Types of Records Produced at NRL

Many types of records were produced by the NRL recording laboratory during the last two years. On a volume-released basis, beginning with the largest volume, the records were for: demonstration, training, test, spectrum analysis, equipment tests, naval ceremonies and conferences.

1. Demonstration Records

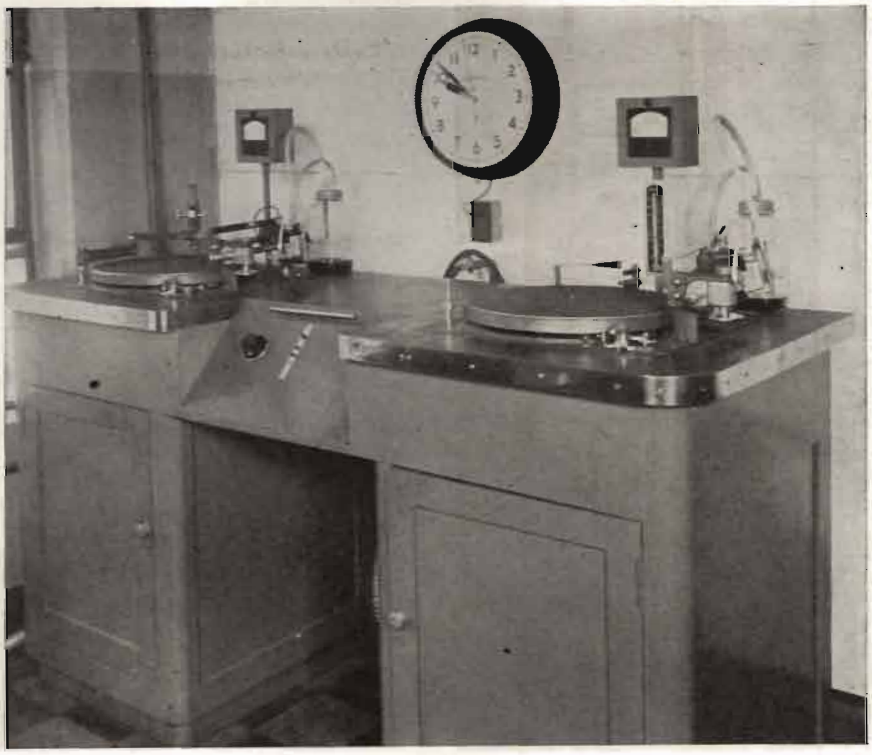
These records contained explanatory speech with sound effects and were used to *show-off* a particular set of data relating to the performance of sonar, radar, or radio equipment to people not familiar with the exact performance of such equipment.

2. Training Records

These also contained speech and

The opinions and assertions contained herein are those of the author and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

Figure 1
The dual-channel recording installation, showing the push-button control panel, volume indicators, and traps used for thread collection.



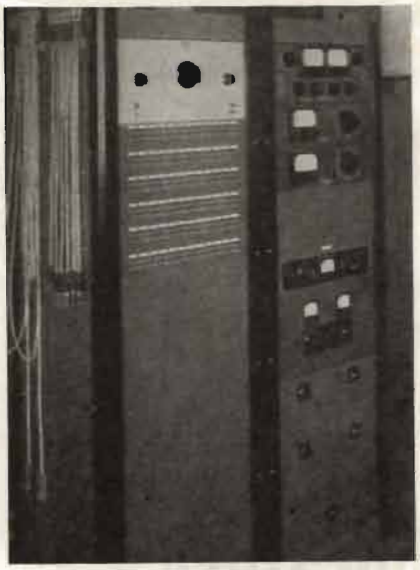


Figure 3
A view of the two speech input bays with associated measuring equipment.

Figure 4
The Scully recording machine.

Figure 5
The recording bay which contains power amplifiers for driving the recording heads, etc.

sound effects and were directed to personnel of the Fleet who used the material to help them in their understanding of the theory, operation and maintenance of new sonar, radar, and radio equipments.

3. Test Records

These were used in the evaluation of the frequency characteristics and inherent distortions of disc recording heads and disc reproducers. The discs contained test frequencies (or tones) consisting of sine waves in the 50 to 10,000-cps band.

4. Spectrum Analysis Records

These contained any mechanical or electrical vibrational phenomena with components within the 50 to 10,000-cps band. If mechanical, a suitable transducer was employed so that an electrical variation could be obtained for supplying the recording channel.

5. Equipment Test Records

These records contained spoken word lists used in making intelligibility studies in connection with voice transmissions through radio channels in which volume compression, volume limiting, peak clipping, etc., could be introduced. These same records, of course, could be used for intelligibility or articulation tests involving the transmission of speech through any type of channel.

6. Naval Ceremonies

Naval ceremonies and other events of historic interest to the Laboratory were recorded and filed for future reference.

7. Conference Recordings

These contained recordings of five to thirty persons taking part in technical discussions. In general, these records contained only dialog material.

Equipment

In the spring of 1942, the recording equipment on hand consisted of two portable recorders,[1] one preamplifier[2] and one amplifier[3] in a portable carrying case. Two unmounted preamplifiers[5] with rectifier, and one unmounted line amplifier[6] were available but were not used with the portable recording equipment. This recording equipment was used both for field work and local recording and therefore seemed to be always in a state of flux between being set-up or packed for field trips.

When the author became officially attached to the Laboratory, early in 1944, it was decided to set up permanent disc-recording facilities including a small speech studio and proper playback equipment, with mixing and monitoring facilities. As a step in this direction a consolette,[7] two transcription[8] turntables and two loudspeakers[9] were placed on order. Later, portable speech input equipment[10] was ordered for remote pick-ups where one or more microphones would be employed. About this time a recording amplifier, utilizing two 845 tubes in the output stage, for driving the recording heads,[11] was designed, constructed and placed in service with two recording machines.[12]. Later, the two turntables[8] and a room used as a speech studio were integrated with the console[7] so as

1, 2, 3 Presto 6N, 40A and 85 types, respectively.
5, 6 W. E. 104 and 105 types, respectively.
7, 8, 9 RCA 76-B2, 70-C1 and 64-B types, respectively.
10 W. E. 22D type.
11, 12 Presto 1-C and 6-N types, respectively.
13, 14 and 15 W. E. 120B, 104B and 121A types, respectively.

Figure 2
The playback turntables and mixing console. Note the cueing speaker mounted beneath the record rack.

to provide dialog and dubbing facilities for the dual recording channel.[12]

Figure 1 shows the dual recording-unit[12] installation; Figure 2 the playback turntables and mixing facilities. Two speech input bays were later installed using three preamplifiers,[13] one program amplifier,[14], one line amplifier,[15] two modified amplifiers[16] for monitor and turntable cueing, and a limiting amplifier.[17] The mixing facilities also included vu meters,[18] and a patch bay consisting of six double rows, for a total of 144 positions. Also included in these bays were a transmission measuring set[19] and an oscillator[20] which covers the 2 to 70,000-cps band. (An output coil was installed in the oscillator to provide an ungrounded source for the gain-set.) It was thus possible to measure rapid gain versus frequency characteristics from a single-operating position as the inputs and outputs of all speech input equipment, including those of the consolette,[7] appear in this jack bay.

A third disc recording machine[20-a] was placed in service in January 1946 to provide a second channel and also to furnish precision means for making masters for processing; Figure 4.

In Figure 5 appears the recording bay with, from top to bottom: broadcast and short-wave receiver (Navy model RBO), W. E. 124E type amplifier for driving the recording head associated with the disc recording machine,[20-a] patch bay of 48 positions,

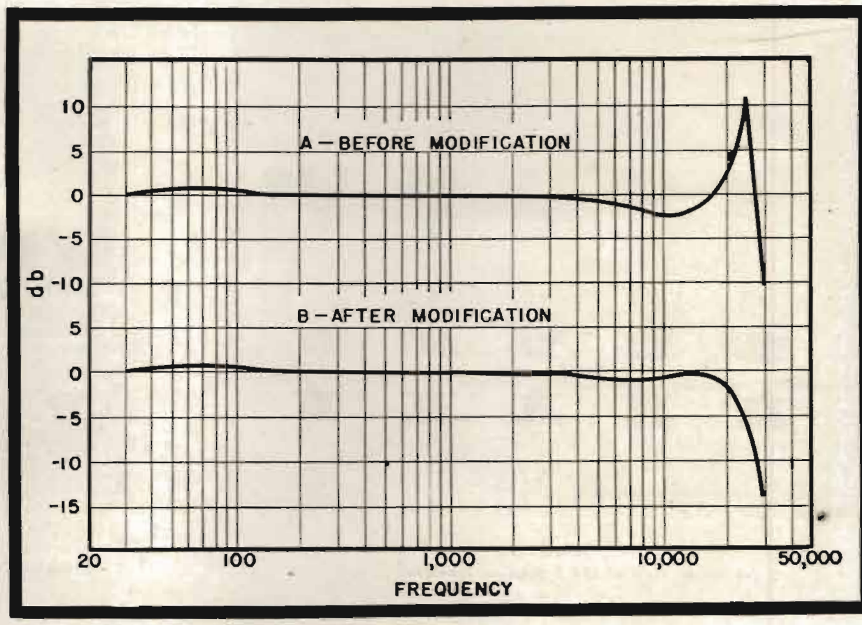


Figure 6

Gain versus frequency characteristics of mixing console before and after modification. The resonance shown in the upper curve occurred at about 25 kc.

panel containing an assortment of variable pads plus bridging and isolation coils, recording amplifier for the initially installed dual-channel[12] with power supply, and lastly a low-voltage rectifier used as a trickle-charger for the six-volt storage battery which supplied power for the local order wire facilities, relay control circuits, and signal light circuits. This recording bay was connected through six tie-lines to the speech input bays already mentioned.

The vacuum system, used to remove the thread or *chip* while recording, was conventional. The vacuum producer,[21] rated at 2 hp, was of the belt-drive type designed for continuous operation. The thread was collected in a simple water-trap at each recording machine (see Figure 1) insuring a non-clogged line at all times.

As the recording laboratory had to furnish the entire laboratory with recording services, wire line facilities were provided. A twenty-pair telephone cable was installed between the speech input bays of the recording laboratory and the telephone switchboard room. Sixteen of these pairs were permanently connected through the local underground telephone cables and terminated in positions frequently used as source positions for recording. The remaining four pair were kept as spares and tied-in when needed, again through telephone cable, to locations which could not be reached by the sixteen permanent lines. Two pair were provided to each remote location, one

[16 and 17]W. E. 124 and 1126A types, respectively.

[18 and 19]Daven 910-F and 6-D types, respectively.

[20]Hewlett-Packard 202-DR type.

[20-a] Scully type.

[21]Spencer Turbine Co. industrial vacuum cleaner.

Figure 7

A view of the new left end plate installed on the remote speech-input equipment.

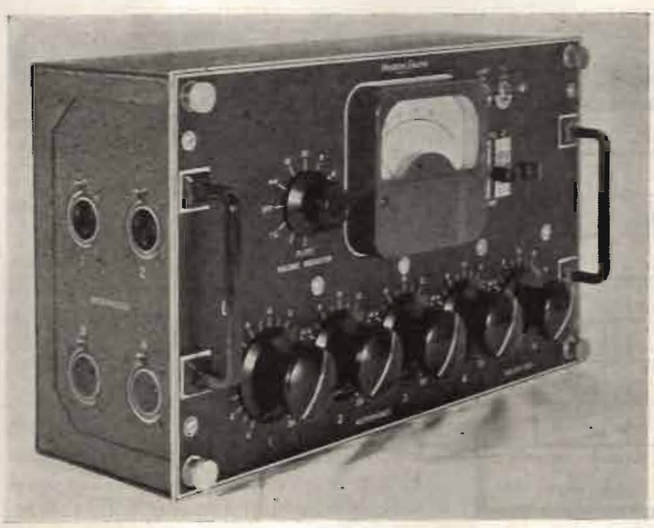


Figure 8

A right end view of the remote speech input equipment, showing the double and single jack positions as well as the new terminal block and power connector.

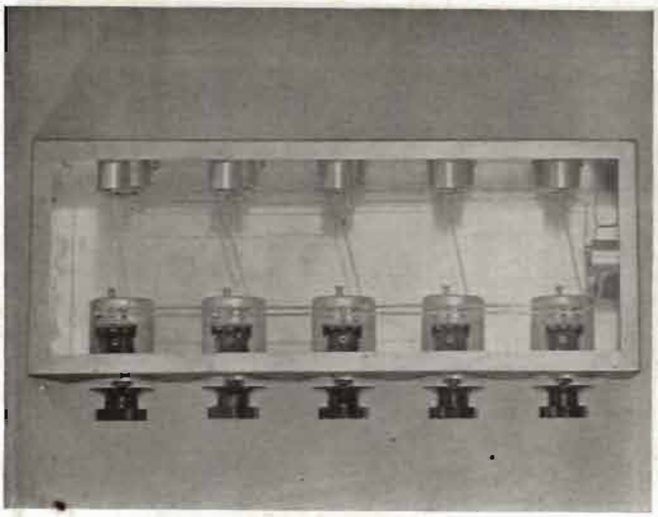


Figure 9
An inside view of the 5-position low-level mixer.

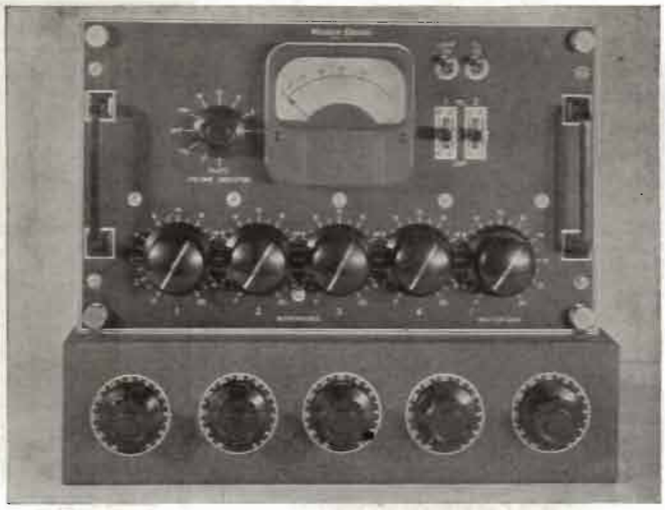


Figure 10
The 5-position mixer as used with the remote speech-input equipment.

being used as the program pair and the other for order wire or cue back facilities. These lines are not only used to supply program material to the recording laboratory, but are often used for playback to remote positions.

No equalizers were used on the program circuits, although the longer lines were fed and terminated at 150 ohms. The shorter lines were operated at 600 ohms. In all cases the loop tests indicated that the response was better than ± 0.25 db from 40 to 10,000 cps and was down only 0.5 db at 15,000 cps.

The adaptability of the speech input system for use in the broadcast field was demonstrated by the release of thirty-five weekly glee-club programs, using local Navy talent, and a few *special events* broadcasts over WWDC, Washington, D. C. These programs were picked up in the Naval Chapel and fed through local telephone cable to the recording laboratory which functioned as a master-control position, furnishing off-the-air cue, line cue, or operational information to the *remote* engineer. The program was then fed through about 11 miles of non-loaded telephone cable (no repeaters) to the speech input facilities of WWDC.

Equipment Characteristics and Modifications

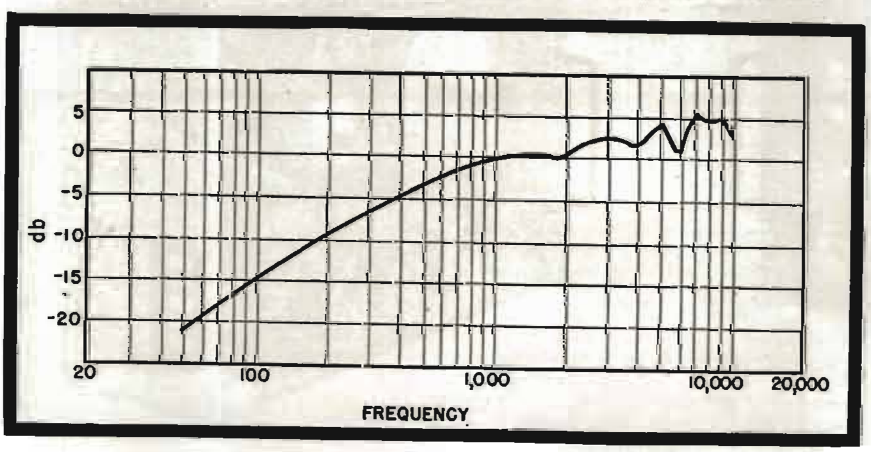
Some of the commercially-built equipment used was modified to better adapt it for use in this recording system.

The console[7] previously referred to was altered to give a flatter gain versus frequency characteristic as shown by comparing curves A and B of Figure 6. Although the original response was within the manufacturer's specifications from 30 to 15,000 cps, the sharp resonance which occurred outside the audible band, i.e., at about 25 kilocycles, produced considerable audible distortion within the pass band, as demonstrated by several listening tests made just before and after the final modification. The changes involved substituting a simple *RC* series network across the secondary terminals of the driver transformer in the program amplifier, for the capacitor originally across the primary terminals.

This console was also changed operationally since channels *1* and *2* were for the low-level disc reproducers. This change necessitated modifying the studio relay circuits so that all studio *A* functions would be controlled with channel *3* key, and all studio *B* functions would be controlled with channel *4* key. Normally, studio *A* functions were associated with channels *1* and *2* while studio *B* functions with channels *3* and *4*. It might be mentioned here that although two studios were available, only one (studio *A*, a small announce booth) could be viewed from the control position and was therefore used exclusively except when a large room was necessary or when two studio operation became more desirable. The larger studio, *B*, was operated *blind* as it is on another floor and quite removed from the recording laboratory proper.

The remote equipment[10] was also modified by replacing the left end-plate with a new one on which were mounted Cannon *P* type microphone receptacles, Figure 7. The right end-plate was also replaced and, as shown in Figure 8, contained a power receptacle, screw-type terminal board for line and order set connections, plus line and monitor multiples which appear on three double-jack positions. The original monitor and order set circuits available on single jacks were retained. A five position low-level mixer was built for use with the re-

Figure 11
A typical recording-head frequency characteristic obtained when cutting lacquer-coated discs.



mote unit,[10] a total of eight channels for use in conference recording.

The recording heads[11] in use on all three recorders were carefully adjusted for proper armature spring pressure and accurate armature positioning within the pole structure. Because of the large temperature coefficient of the damping material no attempt was made to modify the high-end irregularities existed in this head; a typical frequency characteristic is shown in Figure 11. This calibration was obtained by measuring the record light pattern as proposed by Buchmann and Meyer[22] above 1000 cps, and by using a calibrated reproducer below 1000 cps where, of course, the light pattern is difficult to evaluate due to its narrow widths at frequencies below the turnover frequency. The calibrated reproducer method cannot be used over the entire frequency range due to irregular resonances, which occur around 6000 cps, when playing back an instantaneous lacquer recording with a reproducer with an effective mass (referred to the stylus tip) as large as exists in current commercial reproducers. (This effect is often called *acetate record resonance*.) The reproducer used for the *low-end* data of Figure 11 was a W. E. 9A (no equalization) calibrated by means of a W. E. TRL-100 test record for which there is a calibration accurate within ± 0.5 db over its frequency range.

Advance-ball mountings, designed by the recording department at the USN Underwater Sound Laboratory, New London, Connecticut, were constructed in the NRL machine shop and installed on all recording heads. The use of the advance-ball type of recording-head support resulted in less vertical *flutter* and provided a more accurate means for adjusting and maintaining the proper depth-of-cut, than was experienced with the spring-loaded, vertical dash-pot type of support originally used.

The recording amplifier earlier mentioned was designed to provide the required power for driving the recording heads, with a margin of power of at least 10 db for peak program conditions, and with sufficient gain for operation from a + 8 vu program bus. Since a minmum number of stages was desirable, 6L6 beam tetrodes

(*Continued on page 50*)

[22]Gerhard Buchmann and Erwin Meyer, *A New Optical Method of Measurement for Phonograph Recordings*, E.N.T., pp. 147-152; 1930. (A translation by J. M. Cowan, Jour. Acous. Soc. Am., pp. 303-306; October 1940.)

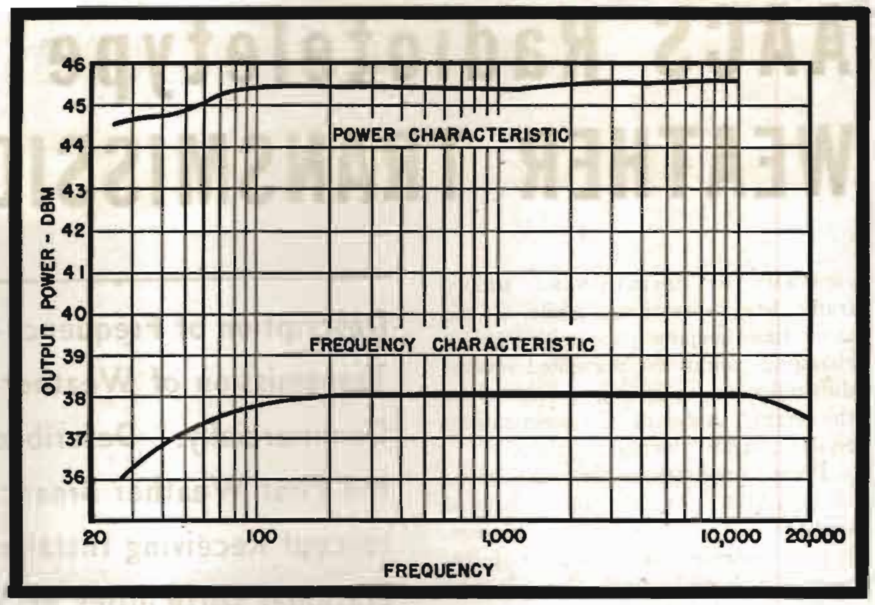


Figure 12
Power and frequency characteristics of the recording amplifier.

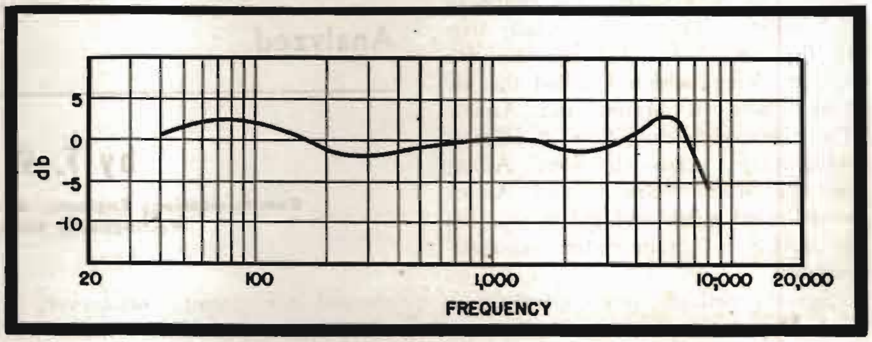


Figure 13
Overall-response obtained at 33 1/3 rpm using a lacquer disc and a WE 9A reproducer.

Figure 14
Another overall response at 33 1/3 rpm using the RCA 70-C1 reproducer. Note the resonance at about 230 cps.

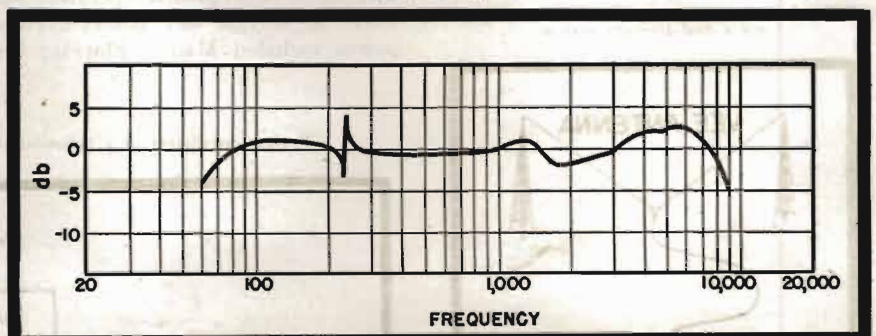
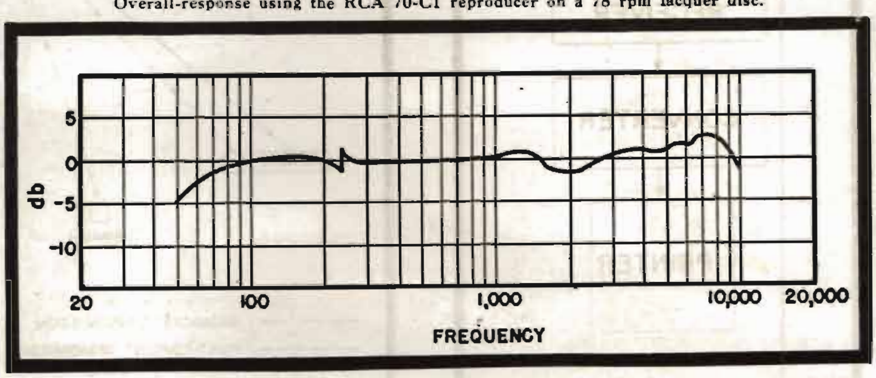


Figure 15
Overall-response using the RCA 70-C1 reproducer on a 78 rpm lacquer disc.



AACS Radioteletype WEATHER TRANSMISSION SYSTEM

Description of Frequency-Shift System, Used by AAF for Transmission of Weather Reports, Soon to be Employed Commercially. Described also are Methods Used During the First Weather Broadcasts by Radioteletype With Intercept Receiving Installations at Smaller Airfields. Operational Difficulties of Simplex Systems and Improved Results Obtained from Full Duplex Operation are also Analyzed.

by F. VINTON LONG

Communications Engineer, Aviation Division, Special Projects Dept.
Westinghouse Electric International Company

PROBLEMS OF MAINTAINING HEAVY traffic load operations, while at the same time keeping pace with rapidly changing conditions, presented several difficulties to operating personnel of the Army Airways Communications System, AAF, during wartime.

Point-to-point radio communications of the AACS at one time consisted entirely of manual transmission. While suitable for prewar requirements of comparatively light traffic loads, manual transmission was unable to carry the heavy traffic literally thrown at AACS after the outbreak of hostilities. This was especially true of the nets controlled by the 8th AACS Wing, which handled the air routes between Miami and Africa. The extremely heavy flow of aircraft being ferried across the South Atlantic via Miami, Brazil, and Africa necessitated quick and positive action by AACS to obtain faster communications.

Several methods were contemplated, including automatic c-w tape transmission, and activation of multi-channel c-w circuits. However, lack of operating personnel for c-w work, and scarcity of frequencies available required something better. Therefore, experimental installation of the comparatively untried frequency-shift method of radio-printer operation was made at several key points. These points included Miami, Florida; Borinquen, Puerto Rico; Albrook, Canal Zone; Waller, Trinidad; Atkinson, British Guiana; Belem, Brazil; Natal, Brazil; and Ascension Island, midway between Brazil and Africa.

Both simplex and duplex operation were attempted, with a forked simplex circuit between Borinquen, Waller, and Albrook. First results with sim-

Figure 2
Radioteletype weather intercept station. This is not a dual-diversity system.

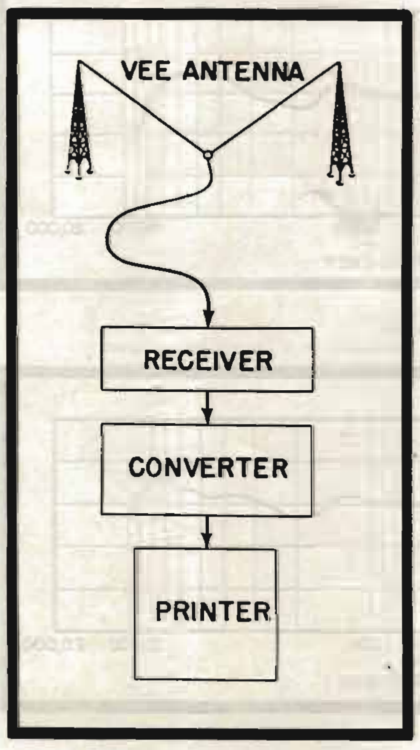
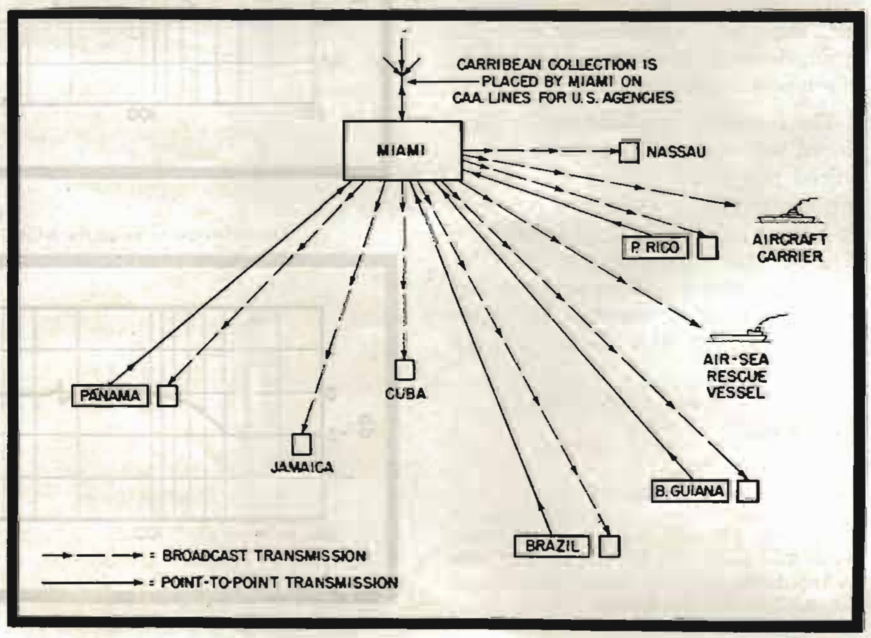


Figure 1
Typical installation of a radioteletype weather net, including broadcast facility.



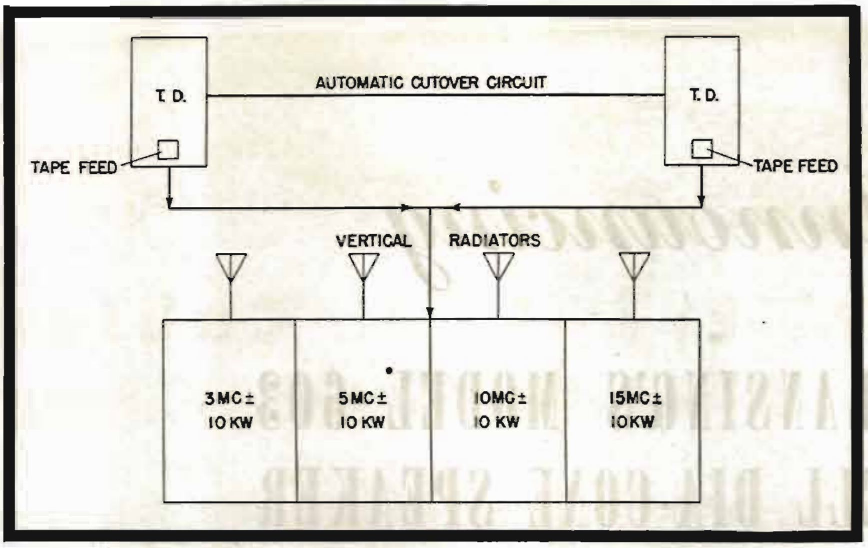


Figure 3
Block diagram of transmitting system used for weather broadcasting.

plex circuits, and particularly with the forked tri-station net were anything but desirable, due to two factors: 1—Lack of stable h-f oscillator for the receiving equipment; 2—poor co-ordination between operators at opposite ends of the circuits.

There was a definite problem of maintaining three transmitting and three receiving installations exactly on a common frequency. It must be remembered that any one of the three stations could throw on its carrier at any time and begin transmissions. If garbling was encountered through frequency drift at either of the other two stations' receivers, no means was available to ascertain the identity of the transmitting station, nor to which station the transmitted traffic was destined. It was then almost a certainty that in the resulting confusion two stations would start transmissions simultaneously, and blocking of the channel would further complicate the matter of progressive testing to ascertain the trouble. Delays in traffic handling rapidly mounted.

Much better operation was obtained with full duplex operation, and the majority of circuits now enjoy this advantage. Operator coordination is an easy matter, particularly in bandchanging. Straight simplex operation was later worked out, by thorough briefing of operating personnel, until few outages are now found except from interference or actual failure of the equipment used in the system.

The 8th Wing circuits used 850-cycle shifts, i.e. 425 cycles each side of the assigned frequency, with carrier frequencies ranging from 3,000 to 19,000 kc. Other Wings (such as the North Atlantic) employing low or intermediate carrier frequencies used shifts of 170 and 340 cycles respectively.

Diversity Reception

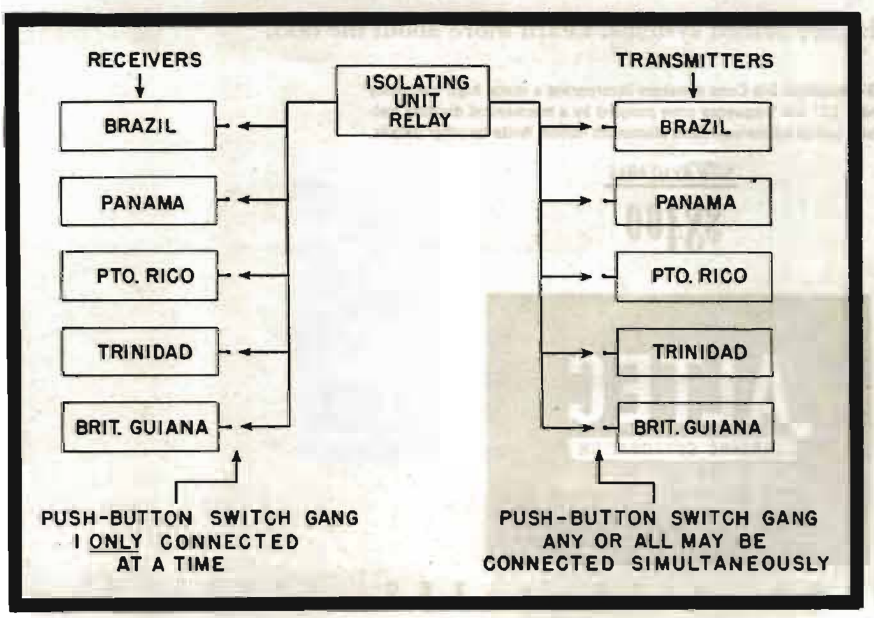
Diversity reception was used with rhombic antenna arrays. Receiving equipment converted the r-f signals into audible tones of 2975 and 2125 cycles, which were fed through band-pass filters to reduce extraneous noises. Limiter circuits served to keep signal strength at a constant level, and the two signals were fed into a polar relay circuit to give mark and space impulses.

Great difficulty was at first encountered in finding a suitable h-f oscillator for the diversity receiving equipment. Several items of equipment were tested, including the *McRae Oscillator*, designed by Col. Don C. McRae. At the present stage of equipment perfection, oscillator drift has been cut to a minimum and resulting outages eliminated.

Also a source of trouble was a transmitting keying oscillator sufficiently stable for constant two-frequency operation. At first, two-crystal keyers were employed, with the crystals so ground that there would be a 850-cycle carrier shift between them. An ordinary 255A polar relay served to connect the mark or space frequency crystal to the transmitter. This method, although theoretically suitable for the job, was discarded because production-line crystals available were not sufficiently accurate in frequency to give the correct shift under all conditions. (This, of course, would not hold true if, under postwar conditions, accurately ground crystals are obtainable.) A single-crystal reactance tube oscillator was substituted, with a 255A relay changing the circuit reactance sufficiently to provide the requisite 850-cycle shift of the carrier frequency. These keyers are now standard equipment in the 8th Wing.

Operating personnel were entirely untrained for the job, and at first no definite operating techniques were employed. This resulted in great confusion at times, especially on simplex or forked simplex circuits. Probably the greatest source of circuit outage was caused by bandchanging troubles, and at first those operations caused outages ranging up to several hours. Such occasions were always accom-

Figure 4
Automatic repeating circuit of weather transmission system.



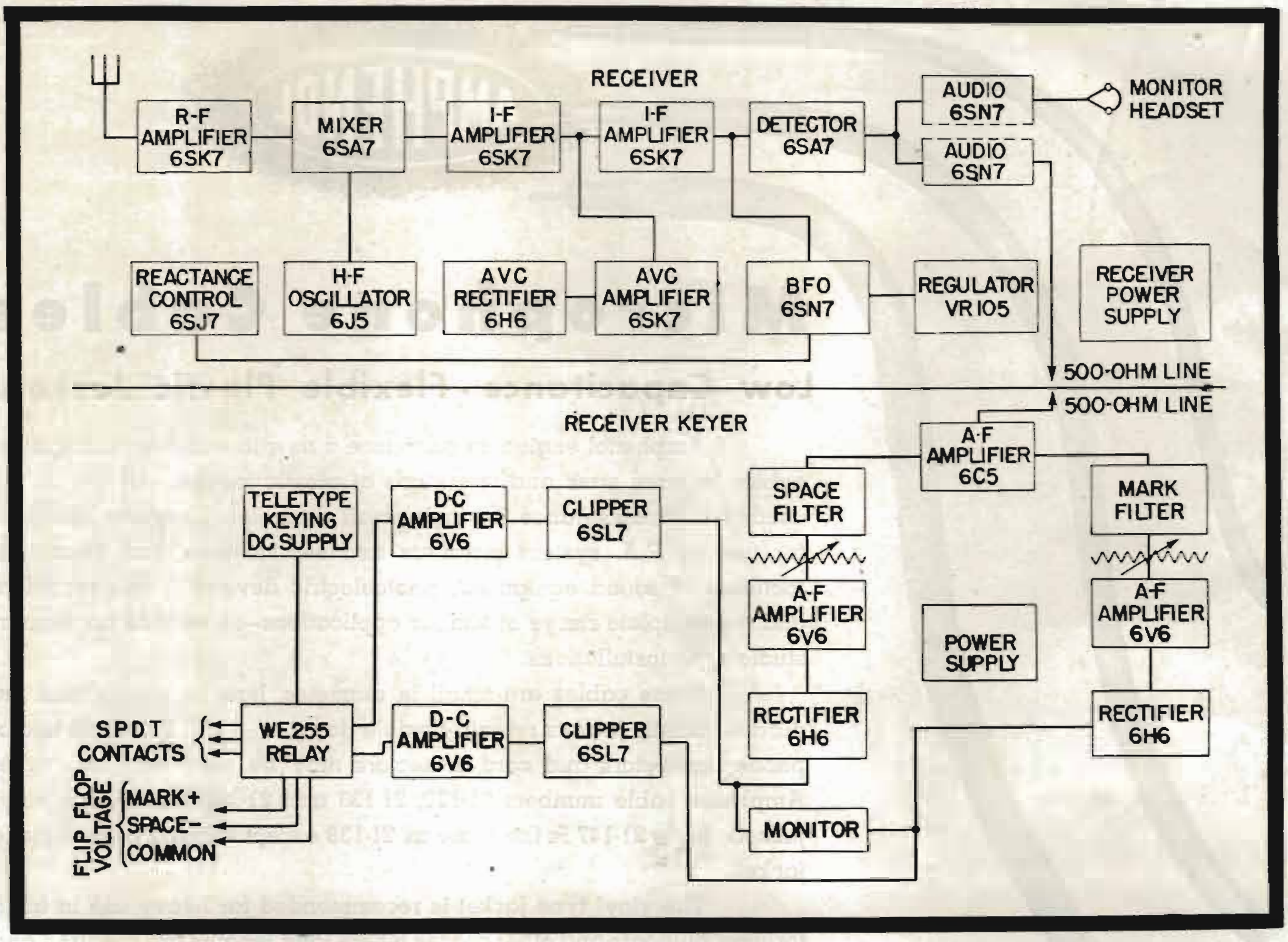


Figure 5
Typical setup for a crystal-controlled radioteletype receiving system.

panied by lengthy arguments between receiving and transmitting operators as to where the fault occurred; the transmitting men invariably blamed the receiving men for inability to set their receivers correctly, and the receiving personnel went to great pains to inform the transmitting station that their carrier frequency or shift spread (supposedly 850 cycles) was not correct. In the meantime thousands of groups of traffic piled up on the circuit.

The Wing Operations section, realizing that no traffic would be moved unless technical operating personnel worked together, took steps to simplify and standardize operating techniques so that all personnel in all stations would have one standard procedure to go through in bandchanging and other operations. Also, by this standardization, operating personnel could be transferred easily from station to station, and all men would understand the problems common to both transmitting and receiving personnel. Because of its high outage factor, bandchanging technique was concentrated on, and in some 6 months time, the process of bandchanging was reduced to an average of two minutes or less.

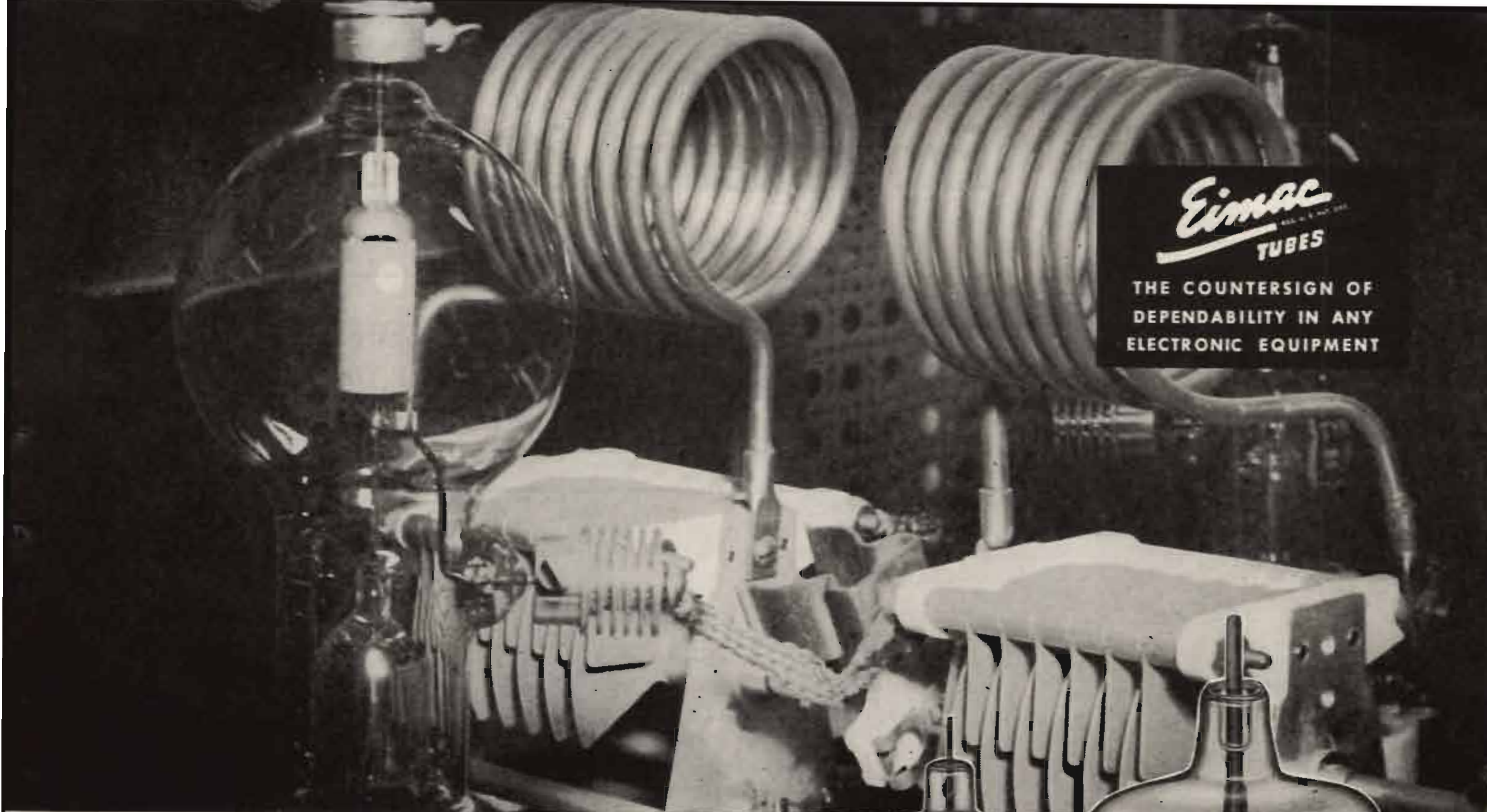
This technique was quite simple: Responsibility was placed on the transmitting station personnel to set the transmitter squarely on the assigned frequency at each bandchange. A standard Signal Corps type 211 frequency meter, together with a constant-voltage a-c power supply, was mounted in a monitor rack. This, together with an audio oscillator and an oscilloscope gave the operator positive proof that the carrier was on the assigned frequency and, sometimes more important, that the carrier shift spread was exactly 850 cycles. Hourly checks, with results entered on the station log insured that the transmitter remained in correct adjustment. After responsibility was thus placed on the transmitter operator for correct operation of the transmitting end of the channel, the receiving operator was instructed to set his receiver at all times on the transmitter frequency regardless of whether or not he personally believed it off frequency. An audio amplifier was connected to a speaker, which monitored the two audio tones supplied by the diversity receivers to the conversion and limiter equipment. After a little practice, the operators were able to instantly tell if the two tones were approximately the correct audio frequency. Thus a simple method of aural monitoring was established. Later installation of automatic frequency stabilizing receiving equipment further simplified the job of continuous reception.

Original receiving equipment consisted of two h-f/v-h-f receivers[1], with an external h-f oscillator common to both. It was necessary to manually retune each time a bandchange was necessary. These units were later replaced with band-switching equipment[2] which greatly simplified the procedure.

Complete tape operation was at first unknown. Also on each point-to-point circuit, there was a lack of coordination between operators on each end of the circuit. (*Teletype Room* personnel are now under discussion—as differentiated from technical personnel stationed at the remote receiving and transmitting station sites). If one leg (direction) of a duplex circuit was in difficulty, the entire circuit ceased

(*Continued on page* 52)

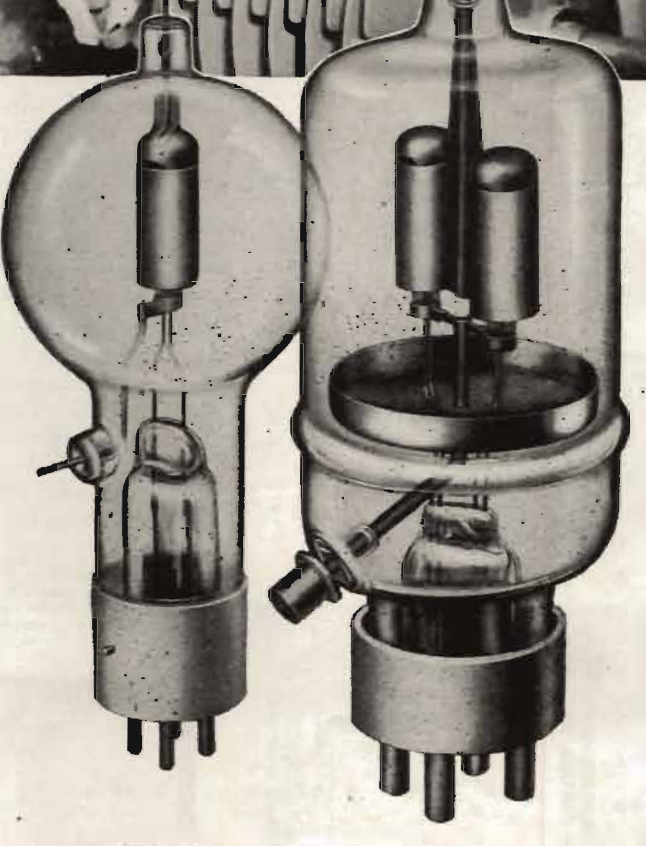
[1] Hammarlund Super-Pro.
[2] Wilcox and Press Wireless types.



HIGH POWER LOW PLATE VOLTAGE

The famous Eimac 75T is now available in both high and low amplification factor types (75TH-75TL). These exceptionally flexible triodes provide a high power output at low plate voltage, and require a minimum of driving power. These Eimac 75T's are suitable for use as oscillators, amplifiers, or modulators. For example: a pair of 75TL's in a class-C amplifier can easily be operated at 500 watts input with only 1500 volts on the plate. The required grid driving power for the two tubes would be only 12 watts. In a class-B modulator, two 75TL's operated within 1500 plate volts will deliver 280 watts of audio power, sufficient to more than 100% modulate the above mentioned RF amplifier.

The Eimac 152T has twice the power handling capacity and twice the transconductance of the 75T, but *less* than twice the already low grid-plate capacity. At 1500 plate volts, 500 watts input can be run to a single 152TL, or a full kilowatt can be run to a pair of 152TL's in a class-C amplifier. For class-B audio, a pair of 152TL's will deliver 560 watts with 1500 plate volts. Eimac 152T's are also available in high and low amplification factor versions. Literature giving full technical information on these triodes available now. Write today, or contact your nearest Eimac representative.



EIMAC 75T POWER TRIODE

EIMAC 152T POWER TRIODE

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RONALD C. BOWEN, 1886 So. Humboldt St., Denver 10, Colorado. Phone: Spruce 9468.

JAMES MILLAR ASSOCIATES, J. E. Joyner, Jr. (W4TO) 1000 Peachtree St., N. E., Atlanta, Georgia.

Experimental 88 to 108-mc

Transmitter Features Armstrong Phase-Shift System Modulator, With Center Frequency of Carrier Directly Controlled by Crystal for Stability.

by J. H. MARTIN

Development Engineer
Canadian Marconi Company

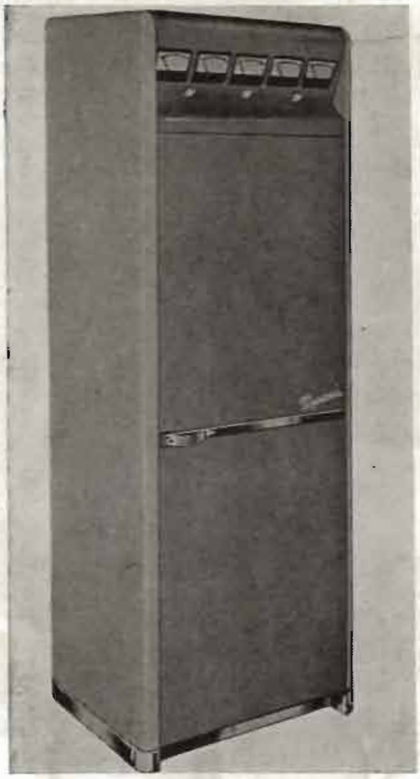


Figure 1
Front view of transmitter cabinet, which is 80" high x 30" wide by 24" deep.

WHEN THE 88 TO 108-MC BAND was allocated to f-m broadcasting, quite a few problems faced the transmitter designer. These included v-h-f power tubes, stability control, frequency multiplication, etc.

For our 250-watt basic-transmitter unit, we chose a modulator using the Armstrong phase shift system. This system offered several advantages; stability, low distortion and low-noise level. The center frequency of the emitted carrier is directly controlled by a crystal oscillator, thus assuring stability. Low distortion may be achieved, too, since this is a direct function of the frequency multiplication of the initial phase shift, maximum distortion occurring at the lowest modulating frequency and becoming negligible as the audio frequency is increased. This distortion is introduced at large values of phase-shift voltage, and is largely third harmonic. Odd harmonic distortion is also present due to certain undesired but unavoidable phase shifts occurring in the band-pass transformers.

Power-Amplifier Tubes

Selection of the power amplifier tubes was limited to pentode and tetrode types because of their low-driving power requirements. The types chosen were Eimac tetrodes, 4-125As. This choice was made mainly because neutralization of tetrodes is simpler than for pentodes. Neutralization was achieved by tuning the inductance of the screens to ground by means of a split-stator capacitor, thus insuring that the screens would be at r-f ground potential. This method was found to be effective, simple to adjust and, most important, eliminated the usual difficult mechanical problems which arise when conventional cross-

Figure 2 (below)
Front view showing modulator in place. Note the vertical construction and individual shields to prevent interaction.

Figure 3 (below, extreme right)
Transmitter with modulator unit swung out.

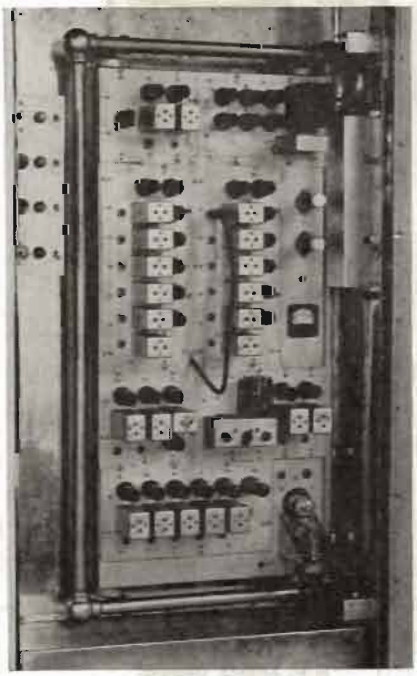
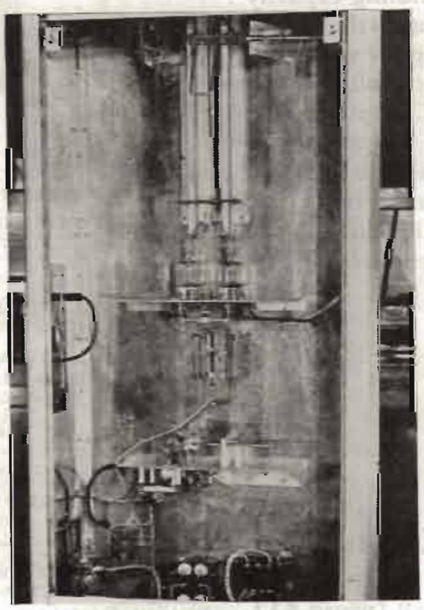
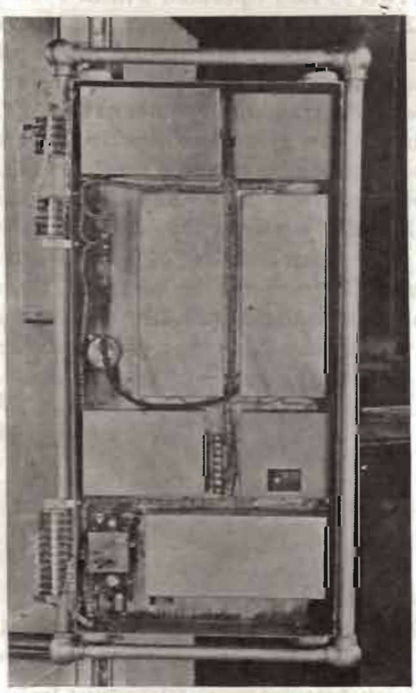


Figure 4
Rear construction of transmitter. At the bottom is the power amplifier and high-voltage power supply. The driver stage for the amplifier is above the power supply, while the power amplifier is at top of cabinet.





250-WATT F-M BROADCAST TRANSMITTER

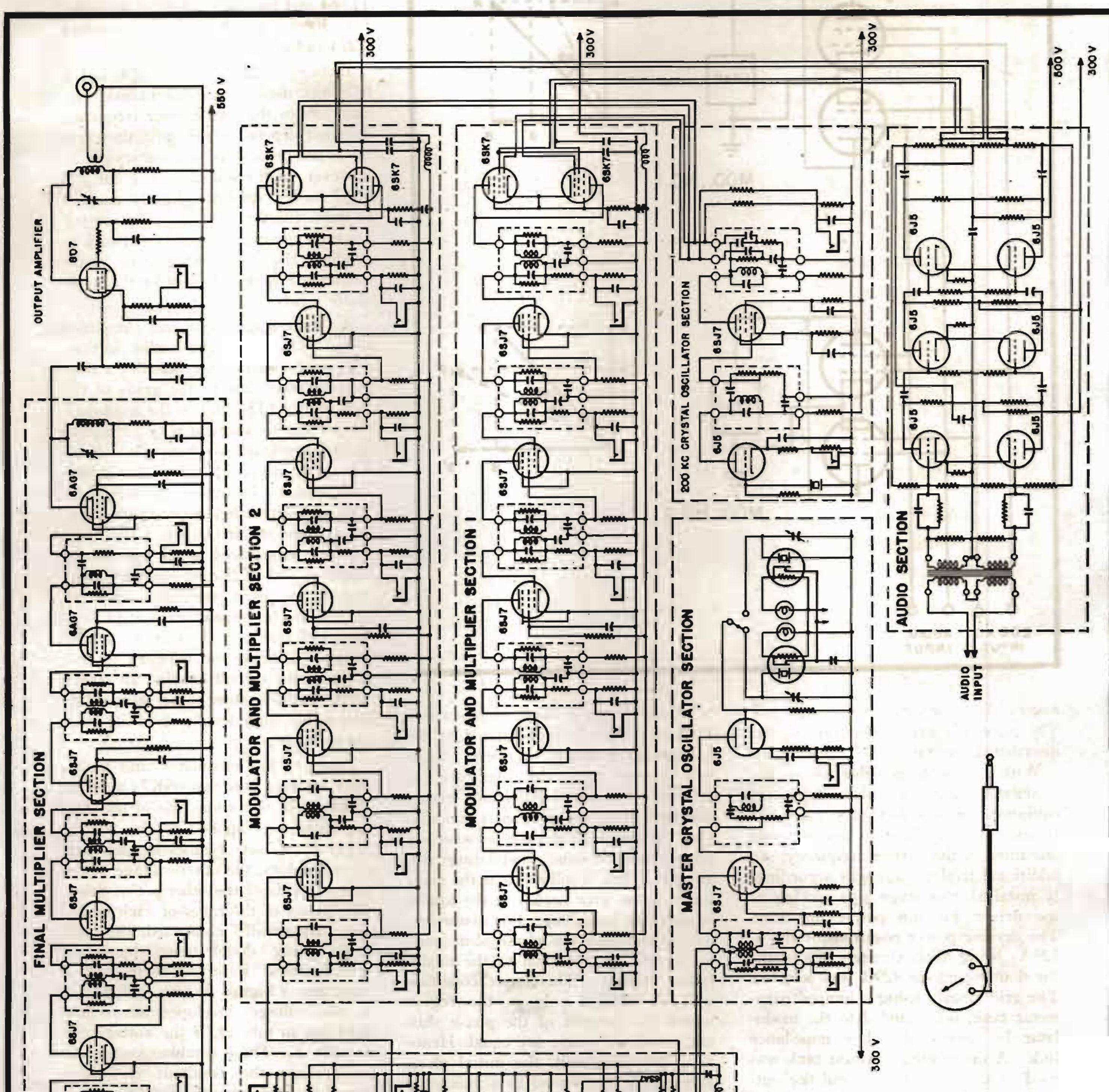


Figure 5
Circuit of modulator unit.

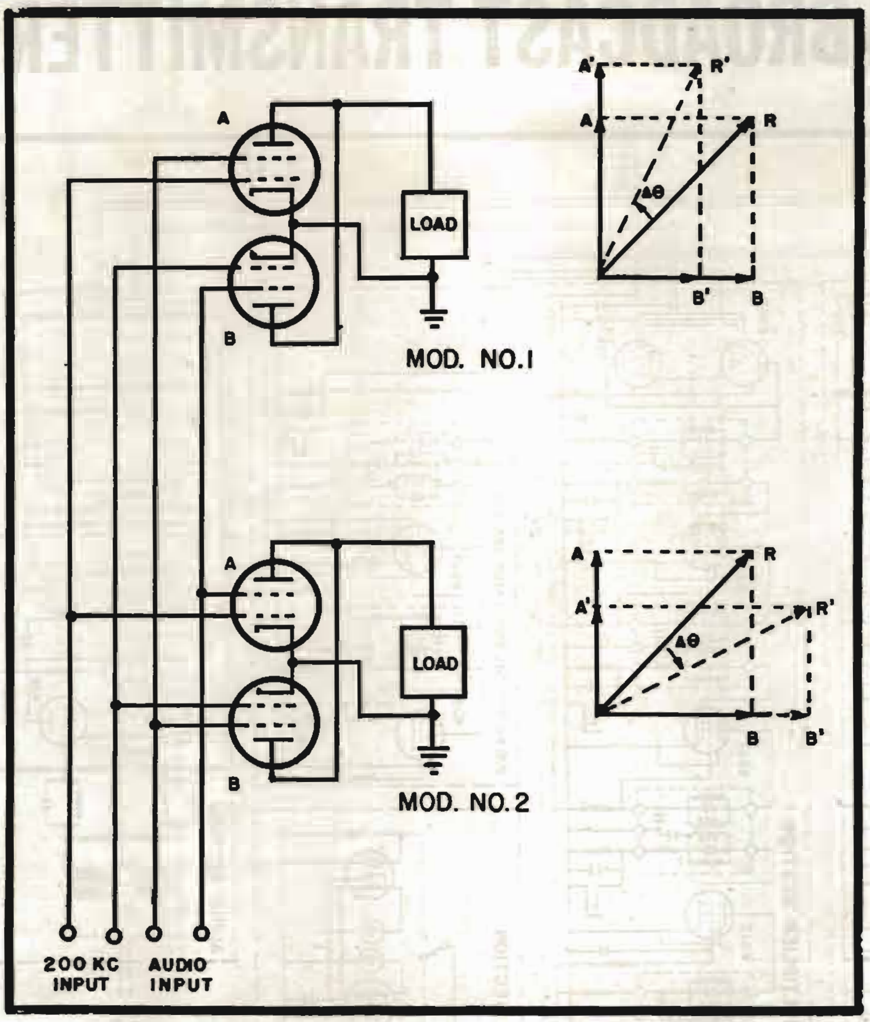


Figure 6
Simplified sketches of modulation system.

neutralized circuits are employed. The plate and grid tanks were of the distributed constant type.

With a view to possible use of the modulator unit in other types of equipment, it was decided to carry the frequency multiplication up to only one-third of the carrier frequency. An additional tripler stage was accordingly installed, this stage also serving as the driver for the power amplifier. The driving power required for the 4-125As being approximately ten watts, the double-pentode 829B was selected. The grid circuit, using a lumped parameter tank, was coupled to the modulator by means of a low impedance link. A distributed constant tank was used in the plate circuit and the output coupled to the power amplifier grid circuit through a second low impedance link. Conventional cross-neutralization was used in the tripler stage to improve plate efficiency, but since it is not critical, adjustment was not provided.

Modulator Features

The major consideration in the design of the modulator is the amount of multiplication of the original phase shift and the method by which it is to be attained. In a balanced modulator the phase shift is proportional to the modulating voltage. However, as is well known from the literature, to produce the same side-band energy distribution as for frequency modulation, the phase shift must be inversely proportional to the modulating frequency. Thus it follows that the maximum phase shift occurs at the lowest modulating frequency. For distortionless modulation the phase shift must be directly proportional to the modulating voltage. This latter condition will be fulfilled only in the region where the tangent of the phase shift angle and the angle are equal. Hence as a practical limit, the initial phase shift should be limited to a maximum of 0.2 radians. The multiplication necessary is therefore a function of the lowest audio frequency to be transmitted. At the start of the development, specifications were based on an audio frequency range of from 30 to 15,000 cycles. Then to produce a final frequency deviation of 75 kc, which is equivalent to a phase shift of 2500 radians at 30 cycles, a multiplication of 12,500 is required to limit the initial phase shift to 0.2 radians. The multiplication factor actually used is 11,664 and the phase shift at 30 cycles for 100% modulation is therefore 0.214 radians.

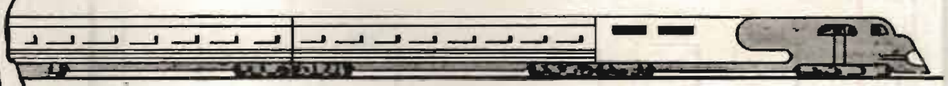
In the crystal oscillator (200 kc) a 6J5 was used in a conventional circuit. Since the final carrier frequency does not depend on this unit, the crystal is not critical as to accuracy; it is, however, of the low-drift, CT cut. A 6SJ7 buffer amplifier, lightly coupled to the oscillator, contains in its output circuit a resistance capacity network to produce the two voltages in phase quadrature required to drive the modulator grids.

A three-stage push-pull amplifier using 6J5s forms the audio section. The input transformer matches a 600-ohm balanced line to the grids of the first pair of 6J5s, and on the secondary side is a resistance-capacity 75 microsecond pre-emphasis network. Each side of the amplifier drives two modulator tubes. To obtain the necessary inverse relationship between modulating voltage and frequency, a corrector network was placed at the end of the amplifier. A 0.25-mfd capacitor connected from each modulator screen to ground made up the capacitive section, and also served as an r-f screen bypass. Placing the network at this point in the circuit enabled all stages of the audio system to be operated at reasonably high levels, resulting in a lower noise level.

Each of the modulator and multiplier sections uses two 6SK7s as modulators. In operation, one of the 200-kc voltages is applied to the control grids of one set of tubes in each pair of modulators, the other voltage to the control grids of the other set of tubes. The plates of the tubes of each modulator are parallel connected, the plate loads being double-tuned band-pass transformers. Referring to the vector diagrams, (Figure 6), we find that *A* is the voltage developed across the load due to tube *A*, *B* the voltage due to tube *B*. These combine vectorially to produce the resultant *R*, which therefore represents the condition with no modulation. If now a modulating voltage is applied to the modulator screens, connected as shown in the diagram, the outputs of the modulators will be varied. If at one instant the screen of tube *A* of modulator *1* is being driven more positive, the output of *A* will increase. Simultaneously the output of tube *B* will decrease. Hence, as we note from the vector, the phase of the resultant will be ad-

(*Continued on page 44*)

All aboard... to music!



Santa Fe Trains To Get Radio, Music Systems

In announcing forthcoming installation of musical wire reproducers, radio and public address systems on their passenger trains, Fred G. Gurley, president of the Atchison, Topeka, and Santa Fe Railway, yesterday disclosed that individual outlets will be placed in sleeping cars.

Each roomette, bedroom, compartment, and drawing room will be equipped with push-button selector, a loud speaker, and volume control, so that occupants may have their choice of radio or wire-reproduced popular or semi-classical music, Mr. Gurley stated. A pilot lamp, lighting automatically when the announcement system is in use, will be installed so that passengers may turn the system on if they so desire.

As a forerunner of this innovation, wire reproducing units providing programs of various types of music, will be placed on the Santa Fe dining car 1450 when it goes into transcontinental service on March 10. As soon as equipment and labor are available, the railroad president declared, similar installations will be made on both new and old dining cars, as well as sleeping, chair, and club-lounge cars.

Speakers will be placed in the ceiling of these cars to provide an even distribution of low-level sound throughout the car. The volume will be set at an advantageous point for both the listener and conversationalist, it was stated.

Farnsworth Television and Radio Corporation of Fort Wayne, Indiana, designed the over-all integrated system.

Reprinted from the Chicago Journal of Commerce, March 4, 1946.

New Program Distribution Systems Make Rail Travel More Pleasant; Will Increase Passenger Traffic!

Systems Produced by Pioneers in Quality Sound Reproduction, Communications and Television.

Music now brings its magic to the railway passenger—and gives railroads another tool with which to sell travel by rail!

In announcing the first modern electronic program distribution systems for railroads, the Farnsworth Television & Radio Corporation takes a logical step forward. Known for its superlative phonograph-radios, including The Capehart, for its pioneering in the fields of tonal reproduction, television and other forms of electronics, Farnsworth now extends its engineering knowledge and manufacturing skill to the field of passenger entertainment.

These new systems will meet the varying tastes of passengers and the specific operating conditions of individual roads. Based upon the knowledge secured from railroad-conducted surveys, the most complete Farnsworth system provides four channels for individual selection: one for classical and one for popular music; a third for radio programs; and a fourth for train announcements and travel talks. More simplified Farnsworth Systems are also available.

Farnsworth engineering has met and overcome the problems peculiar to pleasing sound reproduction in passenger cars, including the need for uniform, low-level distribution and automatic compensation for varying ambient noise levels.

With these comprehensive, flexible systems, railroads can now provide passengers with the same standard of entertainment and comfort they expect in their own homes. Farnsworth Television & Radio Corporation, Fort Wayne 1, Indiana.

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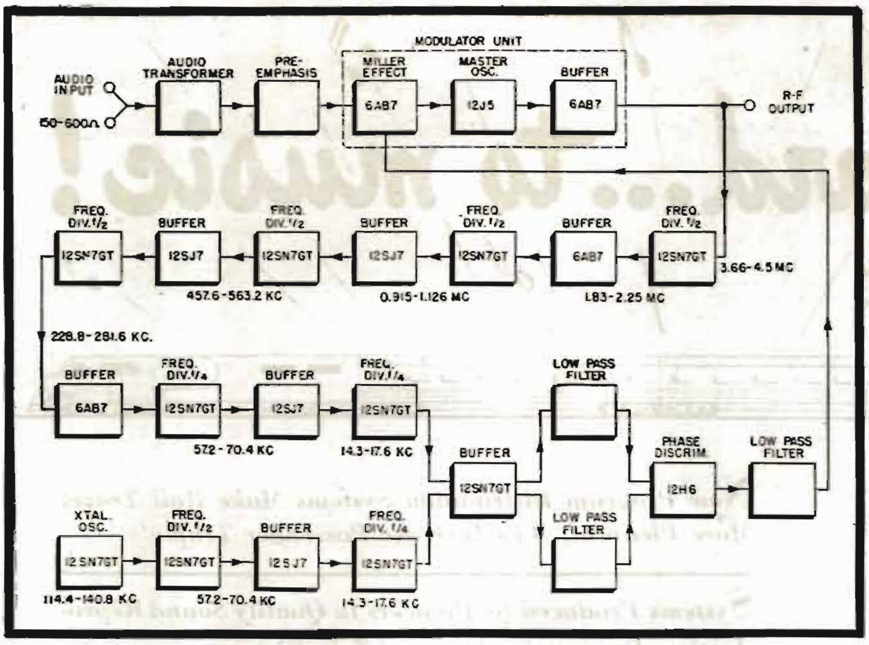


Figure 1
Block diagram of an f-m exciter unit employing an input capacitance modulator and a phase-discriminator center-frequency control.

(Courtesy FTR)

DIRECT

CONTINUING OUR ANALYSIS of direct f-m transmitters, let us now study an f-m exciter employing an input capacitance type of modulator (also called the *miller effect*) and a phase discriminator for center frequency control, Figure 1. The modulator unit, enclosed in a dotted line, consists of three tubes, a 6AB7 modulator, a 12J5 oscillator, and a 6AB7 buffer. It operates at a frequency of 3.66 to 4.5 mc.

We note that a small amount of r-f is taken off at the buffer output and passed through a series of dividers and buffers. It is divided by 256 to obtain a carrier frequency of between 14.3 to 17.6 kc. Inasmuch as at 3.66 to 4.5 mc the deviation has to be about ±3.1 kc, to obtain a 75-kc deviation in the 100-mc band, the deviation at 14.3 to 17.6 kc will be about 12 cycles. With that small a deviation the phase discriminator, in combination with a low pass filter, will operate very satisfactorily for carrier-frequency control.

The crystal operates between 114.4 and 140.8 kc. This is divided by 8 to obtain a frequency which is the same as the divided modulated oscillator frequency. A 12H6 is used as the phase discriminator. Its output, after passing through a low-pass filter to prevent any demodulation of the audio signal, is fed into the *miller-effect* tube for frequency control.

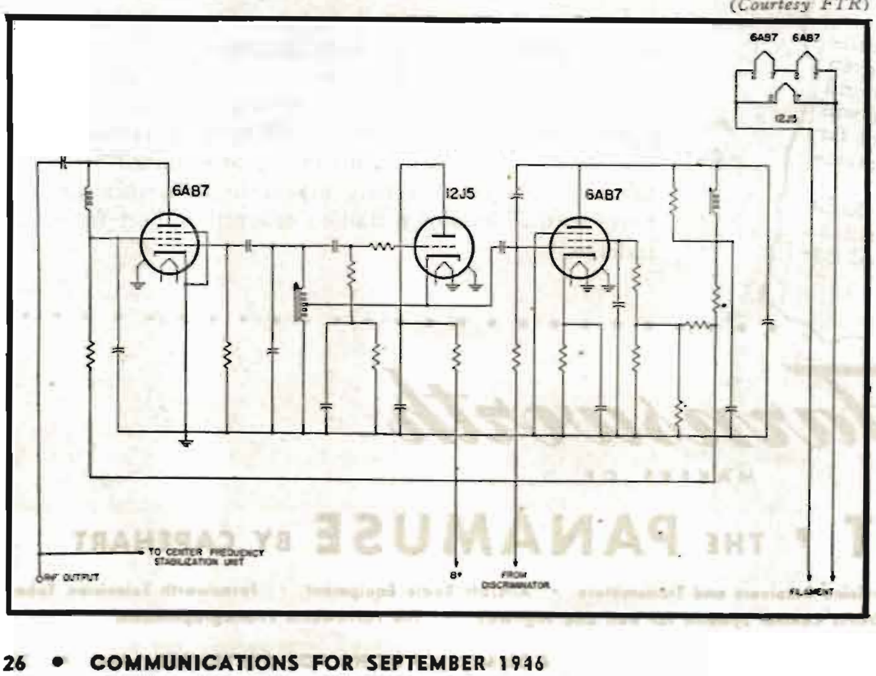
The circuit diagram of the modulator unit is shown in Figure 2. The 12J5 tube is used as an ordinary Hartley oscillator with a 6AB7 tube as the modulator. Modulation is effected by reflection of the effective capacitive variation in the grid circuit of this tube which is connected across the oscillator tuned circuit. The capacitive change is proportional to the total voltage on the modulator tube grid. The total voltage is the sum of the program audio-frequency input plus the regulation voltage obtained from the phase discriminator. Thus the modulator not only varies the frequency of the transmitted signal but is also used to adjust the center operating frequency. It will be noted that a capacitor has been shunted from plate to grid of the modulator tube. This tends to increase the input capacitance of the tube.[1] To obtain a fixed-frequency swing for a given change in input capacitance, as the oscillator capacitance is changed to cover the frequency band, an adjustable capacitance is used to couple the modulator to the oscillator. To reduce the r-f signal on the modulator grid, the capacitance is coupled across only a portion of the tank inductance.

In Figure 3 is shown a schematic diagram of a center-frequency control unit using the phase discriminator. This circuit follows the block diagram presented in Figure 1.

Figure 4 shows a picture of the control unit and modulator unit. The modulator unit is built on a separate small chassis and is removable from the main control chassis. The picture illustrates how the modulator is fastened on the chassis.

Figure 2
Circuit of input-capacitance modulator unit employing a 12J5 and two 6AB7s.

(Courtesy FTR)



Transmitters Using Phase-Discriminator Control

At the output of the exciter unit previously discussed there is available a frequency-modulated wave at a carrier

[1]N. Marchand, *Direct F-M Modulators*, COMMUNICATIONS; April, 1946.

F-M TRANSMITTERS

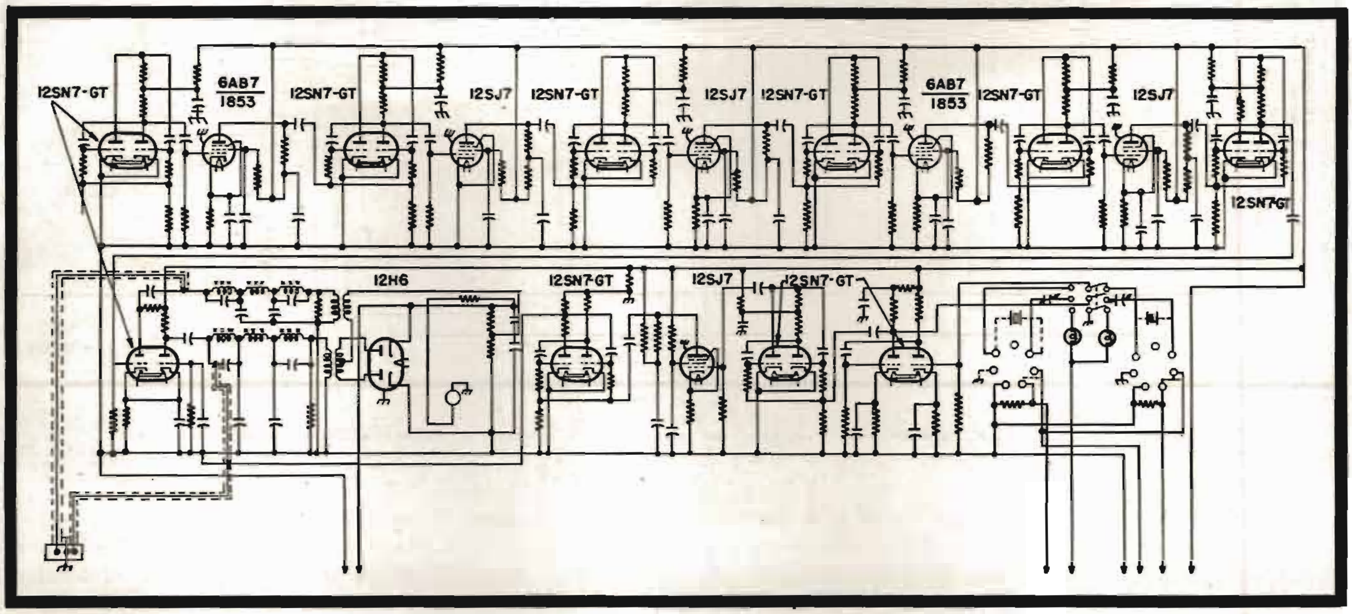


Figure 3
Circuit of a center-frequency control unit using a phase discriminator in the control circuit.
(*Courtesy FTR*)

Part IX of Series, Analyzing F-M Transmitter Design, Offers a Discussion of Input Capacitance, Phase-Discriminator Exciter and Pulse-Control Exciter Units.

by N. MARCHAND*
Consulting Engineer
Lowenherz Development Company

frequency between 3.66 and 4.5 mc. To transmit in the 100-mc f-m broadcast band it has to be multiplied with a factor of 24. The unit which accomplishes this is a 7-tube unit that has enough power amplification to deliver an output of 250 watts between 88 and 108 mc. The unit, called the intermediate-power amplifier and multiplier, can be used alone when a transmitter of only 250 watts is desired.

A simplified schematic of such a unit appears in Figure 5. It employs three 1614s, single ended for the lower power stages, each a doubler, and is followed by two 815s, the first of which is a tripler, the second a buffer. Each of the 815s is hooked up as a balanced amplifier. Transformer coupling is used to go from single ended to push pull. The final stage of the intermediate power-amplifier unit consists of two 4-250As in push-pull. The output from these two tubes is used as driver power for the power-amplifier stages.

Push-Pull Stages

Two 7C26s in push pull are used for the power amplifier stage in a 1-kw transmitter. The 3-kw transmitter is identical except that the plate voltage on the tubes is raised from 2,000 to 3,000 volts. However, in line with the RMA recommendations, the primary power of the 1-kw

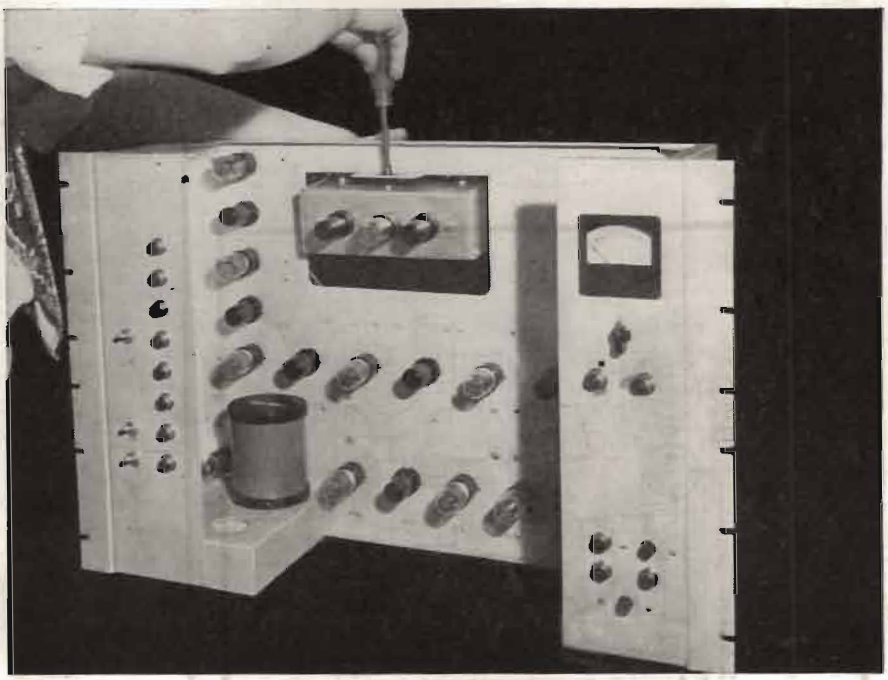


Figure 4
An input-capacitance modulator mounted in a phase-discriminator control chassis. The modulator is mounted on a separate chassis and is removable.
(*Courtesy FTR*)

Instructor in Graduate Electric Engineering courses, Columbia University.

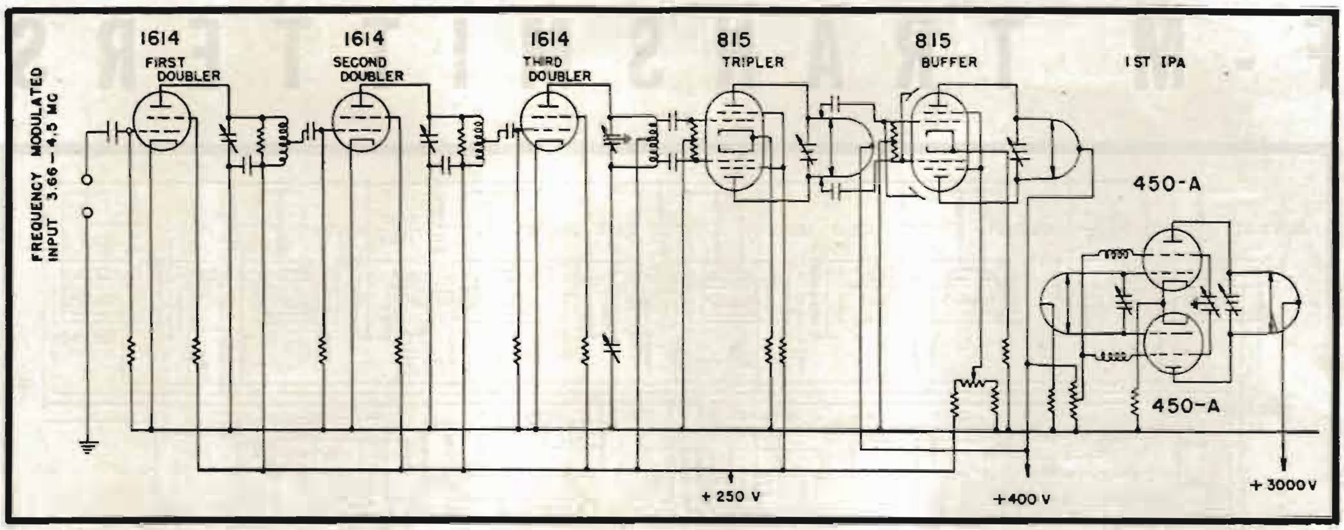


Figure 5
Simplified circuit of the intermediate power amplifier and multiplier unit, capable of delivering 250 watts of useful power.
(Courtesy FTR)

transmitter is obtained from a single-phase 220-volt source, while the 3-kw unit operates from a 3-phase, 220-volt source.

A block diagram for a 20- or 50-kilowatt phase-discriminator control transmitter is shown in Figure 6. A crystal oscillator at 1/768th of the assigned frequency is used to supply the standard frequency with which the output of the modulated oscillator is compared in the phase discriminator.

The power amplifier stages follow the multipliers and intermediate power amplifier; Figure 7 (20-kw transmitter). The first pair of tubes, two 7C26s, will yield an output of 1 kw. These are in a conventional grounded-cathode circuit with transmission line tuning of the plate and grid circuits. Following this stage is a pair of 7C27s in a grounded-grid circuit. In this manner it is possible to utilize some of the power output of the 7C26 tubes.* The two 7C27s deliver 10 kw of power to four 3X2500A3 tubes. These tubes are hooked up in two parallel pairs, each pair consisting of a push-pull circuit. The circuit used here is also of the grounded grid type so that some of the power available at the output of the 7C27s can be used in the output to the antenna. The antenna coupling is a balanced converter used to couple the push-pull output stage to an unbalanced transmission line.[2]

Constructional and Electrical Transmitter Chaacteristics

In the 50-kw transmitter, two D-16s are used in the final stage instead of four 3X2500A3 tubes. Whereas in all of the lower power transmitters air cooling is used, water cooling is used in the 50-kw transmitter.

The f-m noise present in the transmitted wave from these transmitters, measured under normal broadcast conditions, is –65 db below full carrier conditions. The 10-kw transmitter requires 24.5 kva for full power output, the 20-kw transmitter 45 kva and the 50-kw 100 kva.

A 3-kw transmitter using pulse control of center frequency is shown

*See Part One of this paper, COMMUNICATIONS; August, 1945.

[2]N. Marchand, *Transmission Line Conversion Transformers*, Electronics; Dec., 1944.

Figure 6
Block diagram of a 20-kw transmitter which employs a 3-kw and a 10-kw amplifier in the driver stages.
(Courtesy FTR)

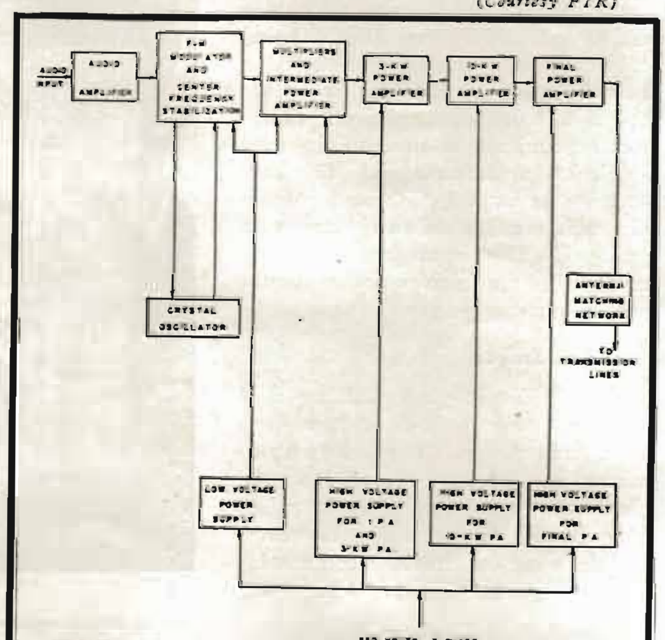
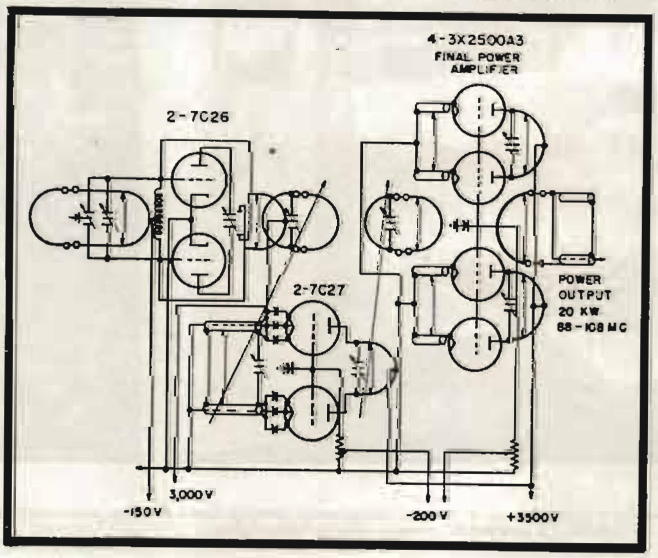


Figure 7
Simplified circuit of the power amplifier stages of a 20-kw transmitter.
(Courtesy FTR)



in Figure 9. A 1614 used in an electron-coupled oscillator triples the frequency in its plate circuit. The second r-f stage, using an 829, is a push-pull tripler, which is followed by a push-pull intermediate amplifier stage using another 829. An inverse feed-back loop around the oscillator, audio amplifier and modulator is accomplished by means of the feedback discriminator using a 6H6. The modulator is of the diode type which is said to have less noise than the conventional reactance tube modulator. In this circuit a 6H6 as a modulator is controlled by a 1614 which has a modulating signal impressed on the grid.

The modulated oscillator is operated at 1/9th of the assigned frequency of the transmitter. It has been found that simple tuned circuits in the multiplier stages provide adequate selectivity without cutting the side bands, when modulation is present in this frequency region. If frequencies very much lower were used, special band-pass filters would have to be employed to provide the necessary bandwidth and selectivity.

The frequency stabilizer unit[3] contains two plug-in crystal oscillator units, either of which may be selected by a switch on the front panel of the unit. The oscillator uses a 1614 in an electron-coupled circuit. The fundamental crystal frequency is 1/18th of the assigned operating frequency whereas the output from the oscillator is at 1/9th the assigned frequency.

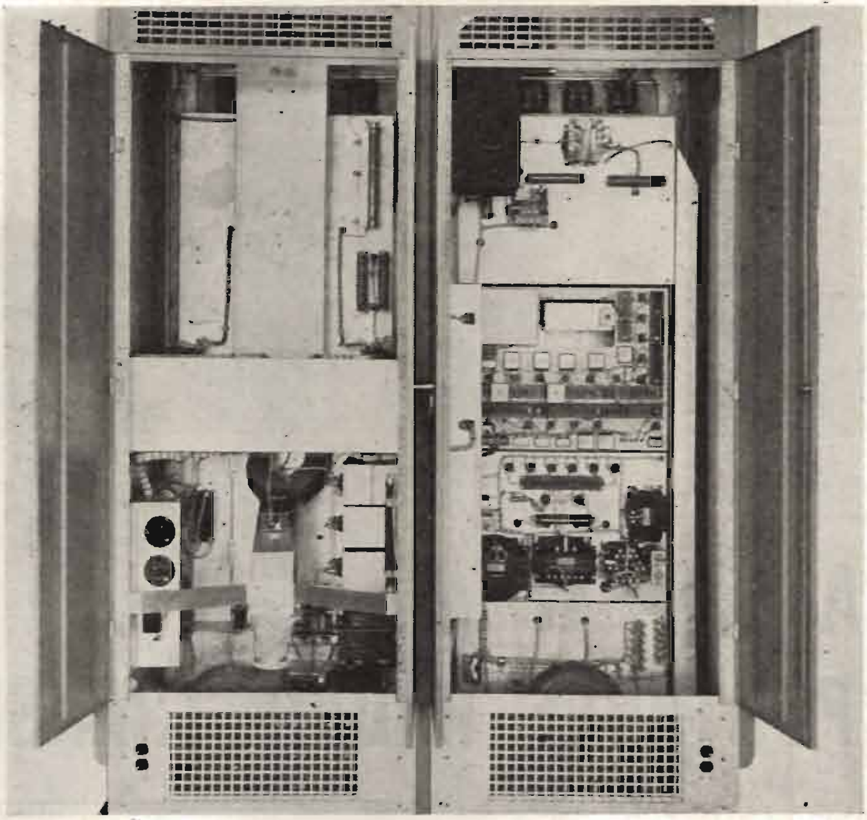
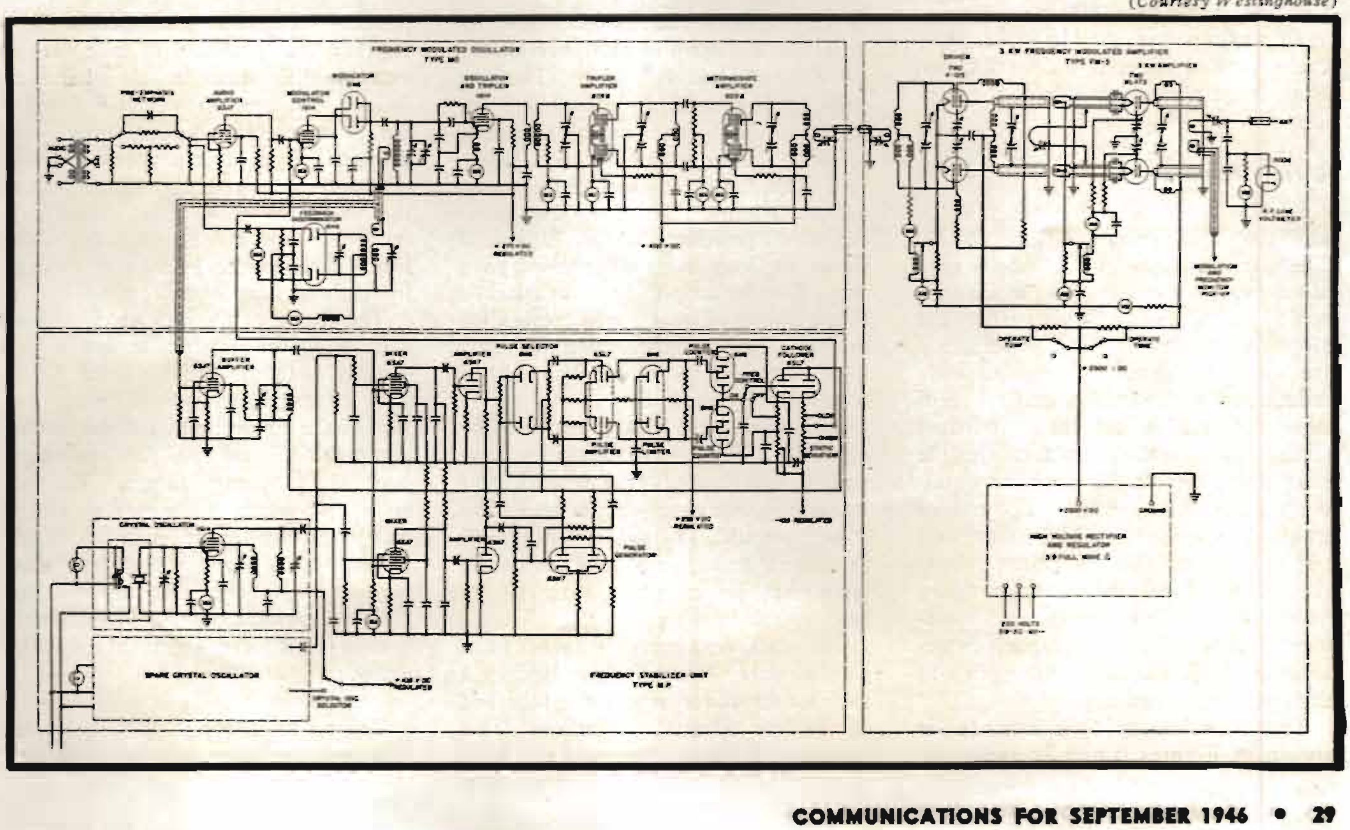


Figure 8
Rear view of a 1-kw transmitter. *(Courtesy FTR)*

This is accomplished by tuning the plate circuit of the 1614 to the desired frequency. Two 6SA7s are used as mixers and phase shifters. A 6SN7, used as a multivibrator, is triggered by the beat note between the crystal and the modulated oscillator frequencies. A 6H6 is used as the pulse discriminator. Each output of the pulse discriminator is fed into one section of a 6SL7 pulse amplifier-

(Continued on page 35)

Figure 9
Circuit diagram of a 3-kw transmitter using pulse control of frequency. *(Courtesy Westinghouse)*



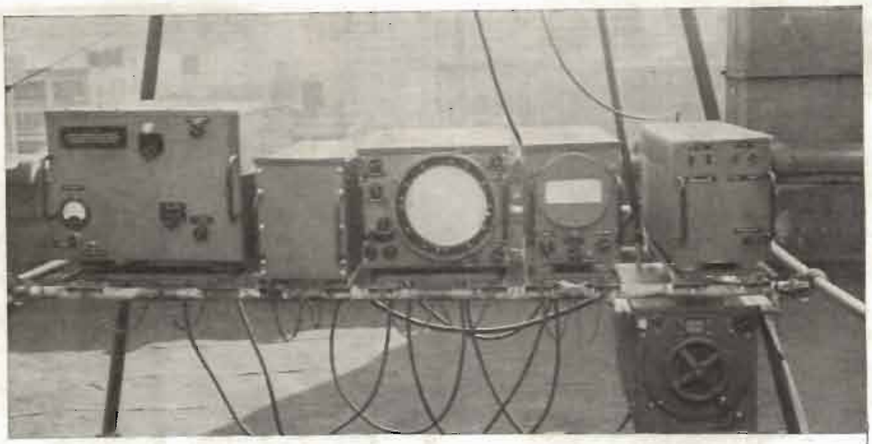


Figure 2
Equipment shelf. The units, from left to right, are: transmitter, duplexer, receiver and PPI, A indicator and low-voltage power supply. Unit below the shelf is the antenna control unit.

Figure 1
Antenna for 100-kw early warning radar.

A 100-KW PORTABLE RADAR TRANSMITTER

Unit Operating in the 200-mc Region Offers Many Features Useful in V-H-F Communications System Design.

by H. L. LAWRENCE

Aviation Equipment Engineer, RCA Victor Division
Radio Corporation of America

MANY UNIQUE DESIGN features that have wide v-h-f applications have been included in a recently designed early warning radar unit, SCR-602-T6, covering the 225 to 250-mc band.

The transmitter unit contains the r-f power-oscillator, modulator, high-voltage power supply, and a wavemeter for frequency measurement. Pulse power output (peak power) is 100 kw; average power output, 40 watts; pulse shape, half sine wave (approx.); pulse length, 1.6 microseconds at base; and pulse repetition rate, 600 cps.

Primary power at 115 volts, 400-cycle a-c and 28 volts d-c is obtained from a gasoline-engine-driven generator.

Circuit Features

Special radar oscillator tubes, 4C27, are used in a grounded-plate circuit. The plate structure of this tube is provided with radiating fins which are cooled with an air blast from the blower in the transmitter. Oscillation frequency is controlled by a variable inductance in the grid circuit. Use of this variable inductance eliminated sliding and rotating contacts in the grid-tuning circuit. Sliding and rotating contacts are a continual source of trouble, especially in high-power r-f circuits; a variable capacitor across the end of a parallel wire line gave insufficient range of frequency adjustment because of the low capacitive reactance of the oscillator tube grids at the operating frequency.

The variable grid inductance is shown in Figures 6 and 7; views are of an experimental model. The inductance is a strip of phosphor bronze 0.010″ thick and ⅝″ wide. The two ends of the inductance loop are attached to an insulator and an adjusting screw. The adjusting screw is operated from the front panel of the transmitter. Figure 6 shows the loop in its extended position, while Figure 7 shows the loop in its compressed position. The flat strip of bakelite attached at the center of the loop increases the tuning range by preventing the loop from assuming a heart shape when compressed, Figure 8.

Adjustable grid bias is provided by a switch. Early tube variations were such that a tapped grid resistor was found necessary to obtain maximum power output. The grid resistor must be non-inductive, since grid bias is re-established for each r-f pulse, and not held over between pulses.

The cathode circuit is tuned by a parallel-wire transmission line. A variable capacitor across the tube end of the line adjusts the tuning. This capacitor is adjustable from the front panel. An auxiliary adjustable shorting bar was provided to take care of extreme differences in tube characteristics. Adjustment of this shorting bar is unnecessary under normal conditions. Bypass capacitors between the heater lead and the cathode lead of the oscillator tubes have been built into the ends of the cathode tuning line. The heater leads run through the cathode-line conductors.

The output of the oscillator has been coupled to the antenna by connecting directly onto the cathode line. Oscillator loading is determined by the position of the connections, but the loading is not critical and need not be changed over the frequency range. The balanced impedance of the cathode circuit was converted to an unbalanced impedance of 50 ohms by a quarter-wave section of 150-ohm transmission line. This converter section is visible in the bottom view of the transmitter, Figure 9.

The r-f oscillator is plate-modulated by a gas-discharge tube pulse-forming

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The UTC VI-C Inductor is an exclusive item of tremendous value in filter construction. This inductor is tunable over a range of +100% —50% from the nominal value, permitting precise circuit tuning using commercial tolerance capacitors. Standard units are available in nominal inductances from 10 Mhys. to 10 Hys. These units weigh 5 ounces, measure 1¼" x 1-7/16" x 1-7/16"

HQA REACTOR

These reactors are designed for audio frequency operation with high Q and excellent stability. For a typical coil, (.14 Hy.), inductance varies less than 1% from .1 to 25 volts . . . Q is 120 at 5,000 cycles . . . hum pickup is low (toroidal structure), 70 Mv. per gauss at 60 cycles . . . variation in inductance less than ⅓% from —60° C. to +85° C. . . . hermetically sealed in drawn case 1-13/16" diameter x 1- 3/16" high . . . weight 5 ounces . . . available in inductance values from 5 Mhys. to 2 Hys.

HQB REACTOR

The HQB reactors are similar to the HQA series, but provide higher Q. For a typical coil, (.45 Hy.), inductance varies less than 1% with applied voltage from .1 to 50 volts . . . hum pickup twice that of HQA . . . variation of inductance less than ⅓% from —50° C. to +85° C. . . . Q is 200 at 4000 cycles . . . hermetically sealed in steel case 1⅝" x 2⅝" x 2½" high . . . 14 ounces . . . available in any inductance value from 5 Mhys. to 12 Hys.

3 AX EQUALIZER

The Universal equalizer for broadcast and recording service. Provides up to 25 DB adjustable aqualization at 25, 50, or 100 cycles for low end, and at 4000, 6000, 8000 or 10,000 cycles at high end. Calibrated controls read directly in DB equalization and frequency setting. The insertion loss effected is compensated for through special compensating pads so that insertion loss is constant regardless of setting. Rapid change in tone color can be obtained with negligible change in volume.

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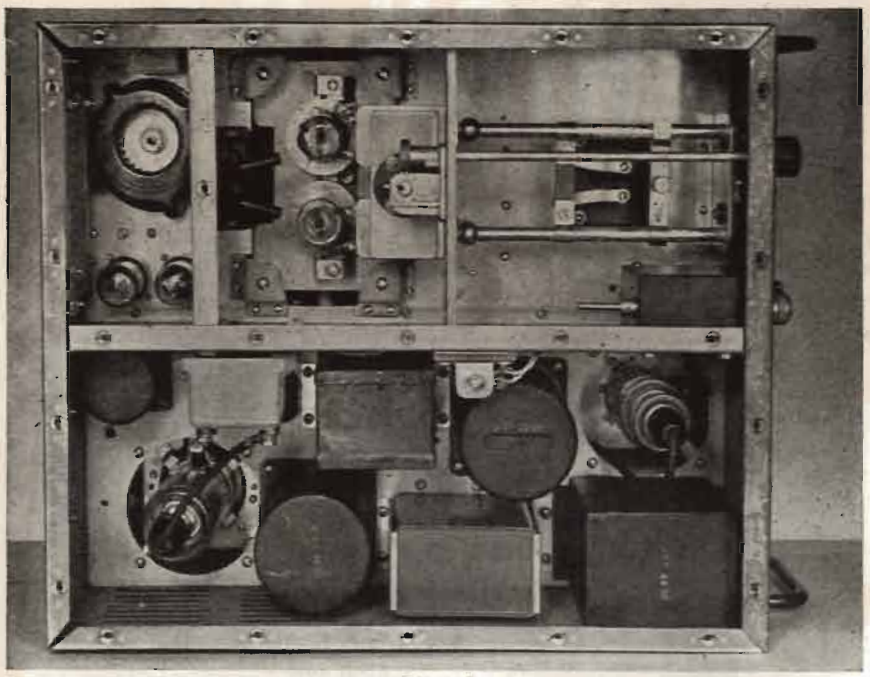
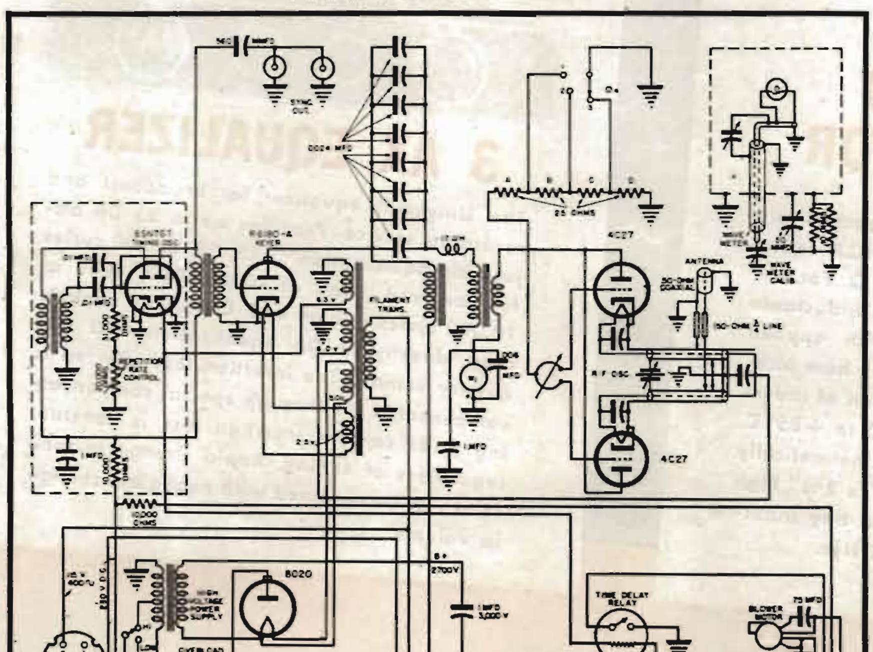


Figure 3
Top view of the transmitter unit with the cover removed. The r-f oscillator is in the top compartment. A blower and air filter for cooling the equipment appears in the upper left-hand corner. The modulator and high-voltage power supply are in the bottom compartment.

circuit. Pulse energy is accumulated by capacitors. These capacitors and a 17-microhenry inductance form the output pulse. A negative pulse having an amplitude of approximately 2,700 volts appears at the primary of a pulse output transformer. This pulse is inverted and stepped up in voltage by the output transformer.

The r-f output pulse shape is shown in Figure 10. The modulator output pulse is slightly wider than the r-f pulse because of the time consumed in starting the oscillator for each pulse. The starting time of this r-f oscillator is approximately 0.4 microsecond. A plate-current meter connected in the ground lead to the secondary of the pulse-output transformer aids in determining the condition of the r-f oscillator tubes.

Figure 4
Schematic of the radar transmitter.



The trigger pulse for the gas modulator tube is obtained from a specially-designed blocking oscillator. The circuit constants and components of this oscillator were chosen to obtain good frequency stability with temperature, voltage, and tube changes. The constants of the feedback transformer have a major effect on frequency stability. Wire-wound resistors and mica capacitors are used in the grid circuit. Temperature variations between –40° C and +75° C cause a frequency variation of less than 1.5%. Frequency change for a 10% line voltage change is less than 1%, while the frequency variation with tube changes is less than 3% between extreme tubes. The repetition rate control is used only to make the initial factory frequency adjustment. Readjustment should not be necessary during the life of the equipment.

Power Supply

An 8020 tube in a half-wave rectifier circuit supplies the high voltage. The high power-line frequency makes it possible to use a single 1-mfd capacitor as the filter element. The high value of the charging reactor allows it to function as a filter reactor as well as a charging reactor. A tap is provided on the power transformer primary to allow operation at half power while tuning and while seasoning new r-f oscillator tubes. A thermal time-delay relay[1] automatically provides 100 seconds time delay between application of the tube heater voltage and the plate voltage. Interlock switches prevent application of high voltage when either the top or bottom cover is removed from the transmitter. An overload relay protects the equipment in case of the failure of any part of the high-voltage circuit.

Wavemeter

An absorption wavemeter for checking the transmitter frequency is mounted in a corner of the r-f oscillator compartment. This wavemeter uses a coaxial line circuit modified for purposes of easy production. The frequency scale behind the tuning knob is the same for all transmitters. It is not necessary to calibrate each wavemeter individually. Two adjustments are provided to match the wavemeter tuning to the frequency scale. The low-frequency end of the tuning range is set by the position at which the tuning capacitor is connected to the center conductor of the line. The high-frequency end of the scale is adjusted by the trimmer capacitor at the end of the line. The high-frequency adjustment

[1] Amperite type.

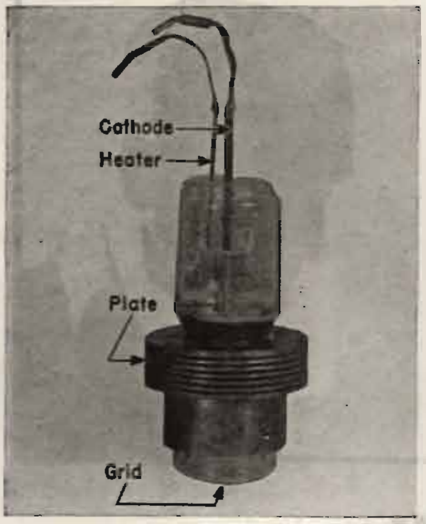


Figure 5
Type 4C27 radar oscillator tube. A pair of these tubes will deliver a peak output power of 100 kw.

is made with the tuning capacitor set to the high-frequency end of the dial scale.

A small dial lamp indicates wavemeter resonance. Both incandescent and gas (neon) lamps have been used. Neon lamps have the advantage of being mechanically more rugged than small incandescent lamps.

The wavemeter is coupled to the r-f oscillator by a slot approximately 1/32" wide. Circulating r-f currents in the transmitter case couple energy into the wavemeter. The amount of coupling is controlled by a variable capacitor shunted across the center of the slot. A five-ohm carbon resistor is connected across this capacitor to reduce resonant effects that tend to vary the coupling over the frequency band. The coupling adjustment is not critical and is not an operating adjustment.

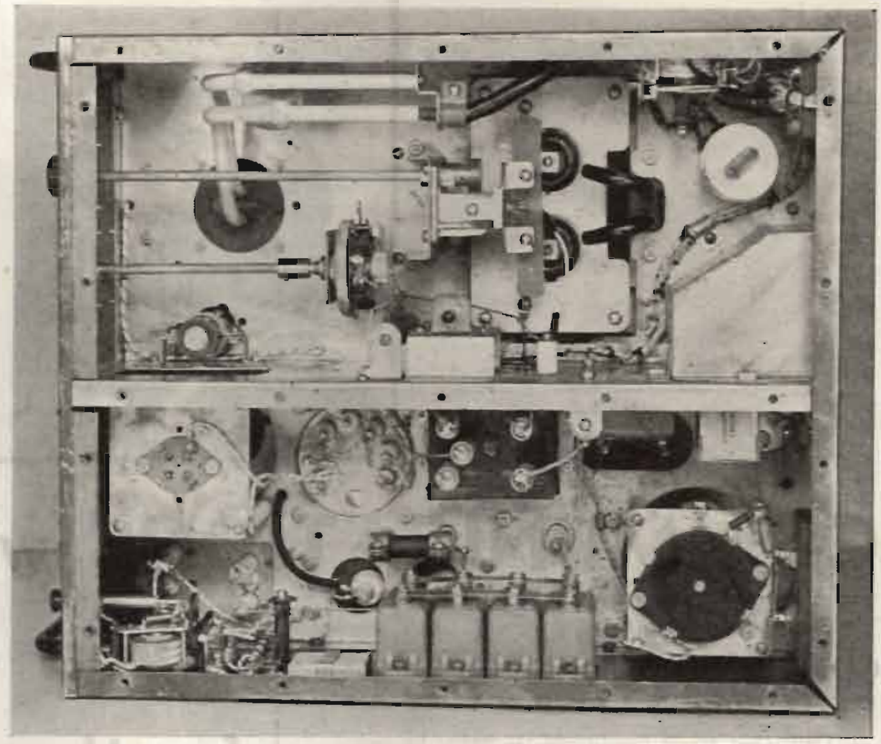


Figure 9
Bottom view of the transmitter. The 150-ohm quarter-wave matching section is at bottom, right.

Figure 10
The r-f output pulse, approximately the shape of a half sine wave; it is 1.6 microseconds long at its base.

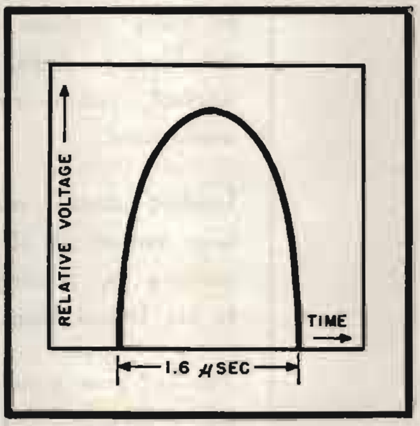


Figure 11
Sectional view of the wavemeter.

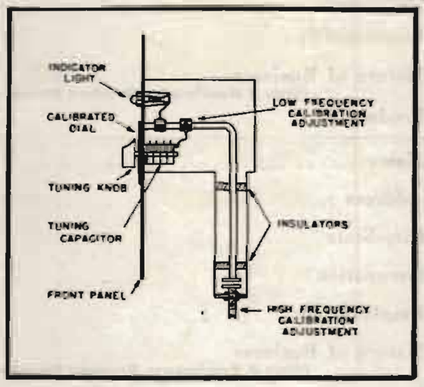


Figure 6
The variable grid inductance tuning mechanism. The grid inductance is shown in its maximum inductance position.

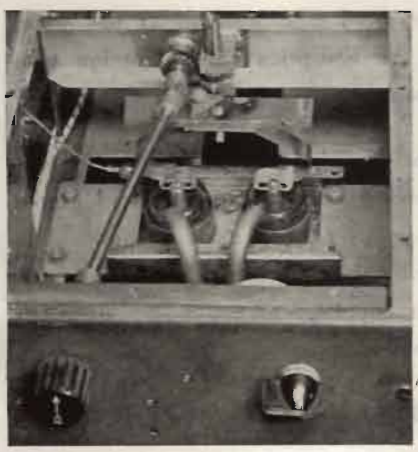


Figure 7
Grid tuning inductance in its minimum inductance position.

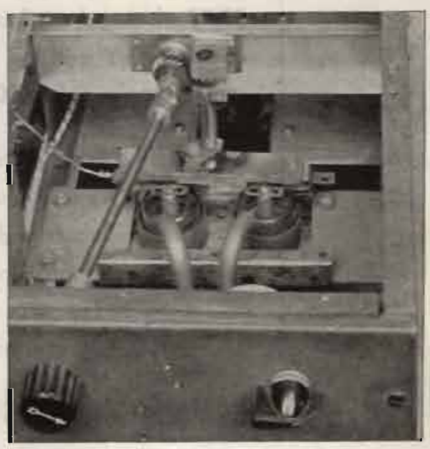
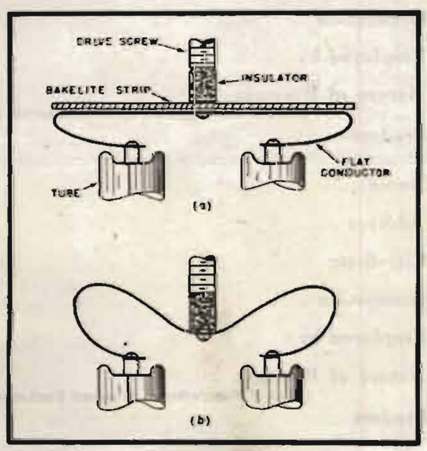


Figure 8
Bakelite strip used to increase tuning range by preventing the tuning inductance from assuming a heart shape when compressed.



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DIRECT F-M

(*Continued from page 29*)

limiter. The two pulse outputs are then fed into two 6H6 pulse counters arranged in a balanced circuit to control the charge in the storage capacitor. It is this charge that controls the center frequency of the modulated oscillator.

The output of the modulated oscillator is fed into a 829B tripler amplifier push-pull circuit. It is followed by another 829B intermediate amplifier The 1-kw transmitter has a 4-125A as a driver driven by the 829B and is followed by a single WL-473 in a grounded-grid circuit. The 3-kw transmitter, shown in Figure 9, uses two 4-125As in push-pull as a driver stage, followed by two WL-473s in a push-pull grounded grid circuit. The plate voltage is also 500 volts higher in the higher power transmitter. A 9006 diode is used in a r-f line voltmeter circuit.

The stability of the transmitter is better than ± 1,000 cycles. It is capable of being modulated up to ± 100 kc. The f-m noise level is at least 65 db below ± 75 kc swing and the a-m noise level is at least 50 db below 100% a-m.

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*For a complete discussion of this type of regulating circuit see N. Marchand, *Direct F-M Frequency Control Methods*, COMMUNICATIONS; August, 1946.

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COMMERCIAL MARINE RADAR

Above: Capt. Even Solberg operating marine radar equipment recently installed aboard the bulk freighter, George F. Rand. Below: Antenna of marine radar aboard the Atlantic Mariner. Looking on are E. B. Dunn, radar engineer, communications department, Atlantic Refining Co., and Captains J. C. Hahs and Martin Johansen of the Atlantic Refining fleet. (*Courtesy Raytheon*)

PREVENTIVE MAINTENANCE for Broadcast Stations

Maintenance cleaning kit in portable storage cabinet.

Part IV of Series Analyzes Seven Basic Preventive Maintenance Procedures . . . Feel, Inspect, Tighten, Clean, Adjust, Lubricate and Measure.

by CHARLES H. SINGER

Assistant Chief Engineer
WOR-WBAM

THE ACTUAL WORK OF PREVENTIVE MAINTENANCE consists of seven basic operations:

F. . .*Feel*
I. . .*Inspect*
T. . .*Tighten*
C. . .*Clean*
A. . .*Adjust*
L. . .*Lubricate*
M. . .*Measure*

Abnormalities are detected by the *E* (feel), *I* (inspect) and *M* (measure) operations during the regular maintenance period. Any abnormalities found can then be corrected by the other four basic operations. The selection of any particular operation is based on a general knowledge of the equipment requirements. For example, dust filters into the equipment no matter how much care is taken to prevent it. Changes in climatic conditions such as heavy rains followed by blistering heat, excessive dampness, snow and ice, all tend to cause deterioration of exposed surfaces and parts as well as internal changes in equipment necessitating adjustments. Unless continuous inspection is the rule, and the necessary work of tightening, adjusting, cleaning, and lubricating is done, the equipment will soon become erratic in performance, wholly undependable, and subject to breakdown when least expected.

Impending failure of a component, or part not revealed during the regular operating period can be found while performing preventive maintenance. The cause of the abnormality should be investigated and if the future operation of the component or part is questionable, it should be replaced, renewed or repaired. In this way the probability of that part failing at some critical moment can be reduced.

Definitions of Basic Preventive Maintenance Operations

F . . . Feel: This operation uses the sense of touch to detect such equipment irregularities as:

(*1*) Rise in temperature above normal operating values.
(*2*) Excessive vibration.
(*3*) Roughness of parts.
(*4*) Binding of rotating parts.
(*5*) Chipped, cracked, broken, loose parts.
(*6*) Misaligned mountings, assemblies, connectors, connections and parts.

Abnormal uniform high operating temperatures can be detected by feeling bearings, housings connections carrying high currents or transformer and capacitor cases. In addition, hot spots can be detected by feeling transmission lines or transformer and capacitor cases. Careful search should be made for loose mounting and assembly bolts and screws, loose clamping rings and connections. If a connection is believed to be loose, a test can be made by feeling the lug, wire or terminal screw. The placement or routing of wiring or parts must not be changed during this process.

All parts should be felt for overheating as soon after shutdown as possible. Otherwise, little will be gained because of normal cooling.

I . . . Inspect: This operation uses the sense of sight to detect such equipment irregularities as:

(*1*) Presence of dirt.
(*2*) Corrosion.
(*3*) Rust.
(*4*) Mildew.
(*5*) Fungus.
(*6*) Other foreign matter.
(*7*) Displacement of parts.
(*8*) Mechanical injury or wear.
(*9*) Discoloration.
(*10*) Chipped, cracked, broken parts.
(*11*) Misaligned mountings, assemblies, connectors, connections and parts.

Overheating is evidenced by signs of discoloration, blistering or bulging of a part or container, leakage of insulating oils or compounds, and oxidation of contact surfaces. Dirt, corrosion, rust, mildew, fungus growth and moisture are sources of possible trouble and can be detected by thorough inspection. Any unit in which moisture is present should be thoroughly dried out before use. A lamp or heater may be used in conjunction with an electric fan. During inspection wires and cables should be disturbed as little as possible. Every part of the equipment should be closely

Portable fuse wagon at WOR.

scrutinized for any visible abnormality.

T...Tighten: This operation involves the application of the proper procedures and tools to the connectors, connections, mountings, assemblies and parts in order to restore them to their normal state of security.

All parts subject to an unusual amount of vibration often become loose and require tightening. However, they should not be overtightened by using the improper tool and excessive or suddenly applied pressure.

C...Clean: In this operation approved tools and materials are used to keep the equipment in a normal state of cleanliness; free from dirt, dust, moisture, rust, mildew, fungus, and all other foreign matter.

A...Adjust: This operation, by making a mechanical or electrical change on a part, will restore either the normal mechanical condition of the part (as determined without the aid of indicating or measuring devices), or the reading or setting of any indicating or measuring device so that it will conform to specified tolerances.

The typical adjustments to restore the normal mechanical condition of a part would be the tensioning of brush or relay springs, correcting the end play in a motor shaft or restoring the proper spacing in a spark gap. Examples of the second class mentioned would be the resetting of any control (such as potentiometer or resonant circuit) which is not normally changed by the operator.

L...Lubricate: In this operation approved lubricants are applied to moving parts so as to reduce mechanical wear and lessen friction, or to certain ferrous parts to prevent rust or corrosion.

This operation applies to parts such as gears, shafts, windings, bearings,

(*Continued on page* 38)

NEWS BRIEFS

U. S. NAVY ECHO-SOUNDING BOOKLET

A complete description of a portable echo sounding equipment, developed for the U. S. Navy during the war for measuring water depths to 200 fathoms, appears in a 96-page book (Report PB-18071) released by the Office of Technical Services, Department of Commerce, (photostat, $7; microfilm, $1).

A recorder and a transmitter receiver unit are the main parts of the echo sounding device. May be used in any small boat having a 6-volt direct current power source, capable of a steady drain of 15-20 amperes.

In operation, the transmitter unit produces a supersonic impulse of about 21 kc, which sends a sound wave to sea bottom. The receiver converts reflected sound waves into electrical energy, which is then amplified sufficiently to produce a mark on a chart paper corresponding to the depth of the water.

* * *

REPORT ON GERMAN 1000-KW TRANSMITTER

A 1000-kw German Navy radio transmitter, erected at Calbe, Germany, that could be heard by submarines submerged in the Caribbean, is analyzed in a 14-page report published by the Office of Technical Services, Department of Commerce.

The Navy transmitter tuned from 15 to 60 kc and used four RS-300 tubes in parallel push-pull.

The antenna sytem consisted of three 820' towers, arranged in a large triangle. Each was surrounded by six 720' towers. A flat-top was formed on each tower group, and the feed-point was in the center of the triangle. A ground resistance of 0.01 ohm for the system as a whole was achieved through an extensive grounding system.

The report, prepared by Comdr. C. G. Lloyd for the British Intelligence Objectives Sub-Committee, also covers miscellaneous wire and radio communication systems and equipment, including teletype and facsimile systems, a transmitter tuning device, high dielectric ceramics, voice recording, and radio tube manufacture in Germany.

The German Army radioteletype network, which once covered Paris, Rome, Crete, Smolensk, and Narvik, is also described briefly. Two methods of transmission were used: amplitude modulation, with three telegraph channels in parallel, and frequency shift of the carrier.

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SYLVANIA PROMOTIONS

George C. Connor has been appointed general

(*Continued on page* 39)

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PREVENTIVE MAINTENANCE

(*Continued from page 37*)

bearing seats and certain parts made of material subject to rust corrosion, or thermal agitation.

M...Measure: This operation determines the mechanical dimensions or electrical values present in a part or component of the equipment, by the use of a measuring or indicating device which is not an integral part of the equipment.

These external measurements disclose any deviations from the prescribed operating tolerances, for such electrical values as voltage, current, or power; or, for such mechanical values as relay spring tension, the opening between relay contacts, or spark gap spacing. Any deviations are then corrected through the *adjust operation.*

sales manager of the electronics division of Sylvania Electric Products, Inc.

Mr. Connor has been with Sylvania Electric since 1934.

M. D. Burns has been named general manufacturing manager of the radio tube division, Sylvania Electric Products, Inc. He will direct tube manufacturing operations in Pennsylvania at Emporium, Brookville, Montoursville, Mill Hall, Johnstown, Altoona and Huntington, W. Va.

Mr. Burns joined Sylvania in 1921.

G. C. Connor

* * *

RALPH POWELL OPENS SALES OFFICE

Ralph C. Powell, formerly general sales and advertising manager of the Presto Recording Corporation, has opened a sales office, operating as R. C. Powell & Co., Inc., at 730 Fifth Ave., New York City. The company will handle the national distribution of electronic devices through offices located in ten cities.

* * *

SILBAR JOINS LEAR

Howard J. Silbar has been named coordinator of advertising and public relations for Lear, Incorporated. Mr. Silbar will assume the duties of Jean H. DuBuque, who has become Director of Aviation for the City of Dallas, Texas.

* * *

H. G. HART JOINS COLLINS

Herbert G. Hart has joined the Los Angeles office of the Collins Radio Company, Cedar Rapids, Iowa.

Mr. Hart was formerly with the U. S. Navy.

* * *

PAUL GALVIN DENIES MOTOROLA SALE RUMOR

Paul V. Galvin has reported that there is no foundation to the rumor that he was giving up active management of the Galvin Manufacturing Corporation.

Commenting on the rumor, Mr. Galvin said: "I have no intention of selling my interests and I am not even discussing the matter of sale with anyone. Nor do I have any idea of giving up my active management of the affairs of the Galvin corporation."

* * *

DX RADIO MOVES

The factory and general offices of DX Radio

(*Continued on page 40*)

NEWS BRIEFS

(Continued from page 39)

Products Co., Inc., have been moved to 2310 W. Armitage Ave., Chicago, Ill.

* * *

T. B. ALDRICH NOW PRESTO G-S-M

Thomas B. Aldrich has been appointed general sales and advertising manager of Presto Recording Corp. to succeed R. C. Powell.

Mr. Aldrich has been with Presto for the past ten years.

* * *

CLARK RODIMON NOW RAYTHEON MARINE DIV. S-M

Clark C. Rodimon has been named sales manager of the marine division (formerly Submarine Signal Company) of Raytheon Manufacturing Company.

James J. Tynan is assistant sales manager; Kenneth V. Curtis application engineer and H. W. Hollis equipment service manager.

* * *

CONCORD RADIO SURPLUS MATERIALS SERVICE

A surplus division has been announced by the Concord Radio Corporation, 265 Peachtree Street, Atlanta 3, Georgia. George Manassa, formerly with the War Assets Corporation, in charge of site sales at the Atlanta A. S. F. Conley Depot, has been named manager. Headquarters and warehouse will be located at the Atlanta Chandler Warehouse. In addition, all available surplus materials will be on display and offered for sale at 265 Peachtree Street, Atlanta, Georgia.

* * *

FARNSWORTH APPOINTS DR. CURRY AND W. H. MYERS

Dr. R. O. Curry has been appointed audio and acoustical engineer for the Farnsworth Television & Radio Corporation.

Dr. Curry previously has been engaged in audio research for the Capehart division.

William H. Myers has been named chief engineer of the receiver division of Farnsworth.

Mr. Myers succeeds J. H. Pressley, who has been retained as a consultant to the company.

Dr. R. O. Curry

W. H. Myers

* * *

BASIC PATENT ISSUED FOR FRANKLIN AIRLOOPS

Patent 2,401,472 covering the Airloop, produced by the Franklin Airloop Corp., has just been issued by the U. S. Patent Office. Claims are said to be basic.

* * *

PODOLSKY HEADS SPRAGUE ELECTRIC FIELD ENGINEERING SERVICE

Leon Podolsky has been named manager of a new field engineering department of the Sprague Electric Company, North Adams, Mass.

* * *

ABC CHICAGO RECEIVES VIDEO CP FOR CHANNEL 7

The American Broadcasting Company has received a construction permit covering a new television station in Chicago to operate on channel seven, 174-180 mc. Visual power is 30 kw, aural 15 kw, with antenna height of

613 feet. The grant is contingent upon the approval of the CAA.

• • •

NEZERKA BECOMES V-P AND S-M OF TURNER

William J. Nezerka has been named vice president and sales manager of the Turner Company, Cedar Rapids, Iowa. He was also elected to the board of directors.

• • •

BOYD AND ATHERSTONE WINNERS IN AMATEUR TRANSMITTER CONTEST

Jay C. Boyd, W6PRM, 3276 DeWitt Drive, Los Angeles, California, and T. E. Atherstone, W7IV, 1921 Dover Street, Denver, Colorado, were winners of the first prizes in the recent contest initiated by Taylor Tubes and co-sponsored by Aerovox, Amphenol, IRC, Gothard, UTC, Solar, E. F Johnson, Bliley and Barker and Williamson.

Mr. Boyd won first prize ($1,125 in bonds) in the 250-watt transmitter class, while Mr. Atherstone's entry was a 1-kw transmitter design ($1,000 bonds as a prize). Transmitters described will be built for both winners by Taylor Tubes.

• • •

ELECTRO-VOICE MICROPHONE CATALOG

A catalog and selection guide has been published by Electro-Voice, Inc., 1239 South Bend Avenue, South Bend 24, Indiana.

Catalog offers data and information on cardioid, dynamic, crystal, velocity, differential, and carbon microphones. Selection chart facilitates microphone choice. Catalog also contains a technical section.

• • •

SECOND EDITION OF FTR HANDBOOK

The second edition of the "Reference Data for Radio Engineers" handbook has been published by the publication department, Federal Telephone and Radio Corporation, 67 Broad Street, N. Y. 4, N. Y.

Second edition has been expanded to 336 pages.

New chapters on transformers and on room acoustics have been added. The room acoustics chapter was written by Edward J. Content.

Data on radio propagation and radio noise has been rewritten. Chapter on cathode-ray tubes has also been expanded.

• • •

GLOVER TO DIRECT SCOTT DISC NOISE-SUPPRESSOR LICENSING

Licensing activities and licensee relations of the Scott phono-record needle-scratch suppressor system, will be under the management of Ralph P. Glover, 1024 Superior Street, Oak Park, Illinois.

The Technology Instrument Corporation, Waltham, Mass., of which Mr. Scott is president, has been exclusively licensed to use the invention in the manufacture of broadcast station equipment.

The noise suppressor reduces the needle scratch to a point where the frequency range need only be limited by the records themselves or other factors in the remainder of the phono system.

• • •

HONNELL RECEIVES LEGION OF MERIT

Colonel Pierre M. Honnell, associate professor of electrical engineering, University of Illinois, recently received the Legion of Merit for his work as instructor and his contributions to the planning and engineering supervision of the electronics laboratory at the Military Academy, West Point.

THE INDUSTRY OFFERS . . .

BRADLEY REPLACEMENT DISC RECTIFIERS

A universal type copper-oxide replacement rectifier, CX2E4U, has been announced by Bradley Laboratories, Inc., 82 Meadow St., New Haven 10, Conn.

As a half-wave rectifier the unit carries a rating of 6 or 12 volts a-c at 3 milliamperes d-c or 12 volts a-c at 5 milliamperes d-c. As a double half-wave unit, the rectifiers are rated at 6 volts a-c for either 3 or 5 milliamperes d-c. In full wave, back-to-back, applications, the unit's rating is at 6 or 12 volts a-c, at 5 milliamperes d-c and as a full-wave bridge it is rated at 6 volts a-c, 5 milliamperes d-c.

Three-inch flexible leads are color-coded and pre-soldered. Pellets are said to be gold-coated.

* * *

LEACH AIRCRAFT RELAYS

A d-c solenoid-type relay for feeder-type planes and small personal aircraft, that is said to be capable of operating at altitudes up to 50,000 feet and at temperatures between —54° C and +71° C, has been announced by Leach Relay Co., Los Angeles, Calif.

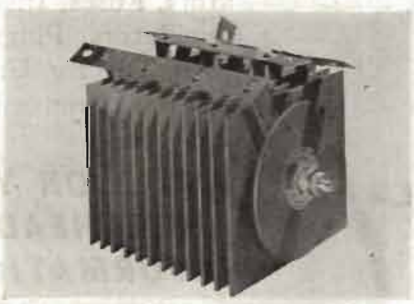
Contacts of silver alloy, are ⅜" diameter, and rated at 100 amperes at 12 volts d-c or 75 amperes at 24 volts d-c. Contact arrangement is SPST, double break, normally open. Dependent upon the voltage and operating requirements, the coils have a resistance of from 9.5 to 110 ohms.

There are two types, 7064-534, with intermittent duty coils for motor-starting applications, and 7064-534 C with coils for battery switching, motor control, aircraft and marine radio switching and lighting.

* * *

RADIO RECEPTOR SELENIUM RECTIFIERS

Selenium rectifier plates, 5"x5½", built on aluminum, are now being manufactured by the Seletron Division of the Radio Receptor Company, 251 West 19th Street, New York 11, N.Y. Developed specifically for high-current capacity, and applicable for electro-plating and battery charging.



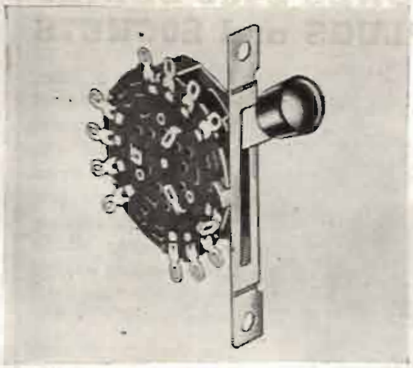
* * *

MALLORY LEVER SWITCHES

Lever action switches, 5000 and 6000 series, have been announced by P. R. Mallory & Co., Inc., 3029 Washington St., Indianapolis 6, Ind.

Switch said to offer a total of 26 circuit combinations, 13 each shorting and positive non-shorting, including two, three and four positions, all with positive indexing at 20° between positions.

Switch contacts will make and break 120 milliamperes at 110 volts d-c and 50 milliamperes at 250 volts d-c, both based on resistance load for 10,000 cycles of operation.



* * *

WATERPROOF ELECTRIC H-F CONVERTER

A converter for the 1500 to 2000 kc band, with built-in pre-selection, for use with either broadcast, auto, or communications receivers, has been announced by the Waterproof Electric Company, 70 East Verdugo Avenue, Burbank, California.

Has 27-30 mc bandspread, 8-1 vernier.

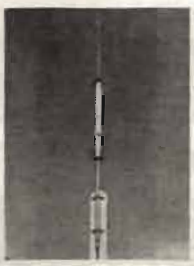
Tubes: 6AK5 r-f, 6AK5 mixer, 6C4 osc, OB2 voltage regulator.

* * *

ANDREW COAXIAL ANTENNA

A 108 to 180-mc coaxial antenna, 704, for transmitting or receiving, has been announced by Andrew Company, 363 East 75th Street, Chicago 19, Ill.

Antenna, a vertical dipole, is fed at the center by a coaxial feed line passing concentrically through the lower radiating element.



* * *

BROWNING FREQUENCY CALIBRATOR

A frequency calibrator, RH-10, pre-tuned for 5 and 30 mc, has been developed by Browning Laboratories, Inc., Winchester, Mass.

Provisions are made for coupling secondary standards or other r-f sources and comparing their fundamentals or harmonics with the standard frequencies transmitted by WWV.

A cathode-ray indicator permits frequency comparisons to be made to at least 1/10 cycle. Dual filter allows the selection of either the 440 or 4000-cycle modulation.

Sensitivity is said to be better than ½ microvolt; image rejection ratio more than 50 db. Dimensions, 9" x 19" x 11"; weight, 30 pounds.

* * *

SYLVANIA TUBE TESTERS

Two tube tesgters, counter type (139) and portable (140) for all standard receiving and several special types of tubes have been announced by the radio tube division, Sylvania Electric Products, Inc., 500 Fifth Avenue, New York 18, N. Y.

Design of the testers includes extra sockets and switch contacts for modernization as new types of tubes are developed. Provision also made for noise testing.

Both instruments are supplied for 105-125

(Continued on page 46)

250-WATT F-M

(Continued from page 24)

vanced. At the same time the resultant voltage due to the modulator tubes in *2* will be retarded in phase. Thus over the audio cycle modulator *1* is produced a modulation of $\mp \Delta_\theta$ and modulator *2* a $\pm \Delta_\theta$ modulation.

As we pointed previously, to produce frequency-modulation by the phase-shift method, an inverse frequency correcting network was included in the audio system. Therefore the outputs of the modulator tubes are truly frequency-modulated; hence the symbol $\pm \Delta F$ can be used in place of $\pm \Delta_\theta$.

Each modulator was followed by two tripler stages, a buffer-amplifier stage, then two more tripler stages. All stages use 6SJ7s.

The tank circuits were designed to pass a band of ± 20 kc from the center frequency. This bandpass was more than sufficient as the modulation factor was still small enough so that only the first sideband pair was significant, allowing a margin of safety so that frequent alignment was unnecessary. At the output of modulator and multiplier section *1* there was therefore a voltage of $16.2 \mp 81 \Delta F$ mc, and from modulator *2* a voltage of $16.2 \pm 81 \Delta F$ mc.

The master crystal oscillator, controlling the carrier frequency, operates at 1/72nd of the final frequency. The crystal is the standard broadcast type, using a thermostatically controlled oven type holder, with an adjustable air gap. An amplifier stage, loosely coupled to the oscillator tank, provides push-pull output at the crystal frequency.

The output of the master oscillator, applied to the signal grids of two 6SA7s, were connected as a balanced mixer. The control grids, connected in parallel, are excited by the output of modulator and multiplier *2*. The 6SA7 plates were connected in push pull, thus balancing out the 16.2-mc frequency. An isolating amplifier using a 6SJ7 follows the balanced mixer, its output being applied to the signal grid of a second 6SA7. The control grid of this second mixer receives its drive from modulator and multiplier 2.

To follow the action of the mixer section, let us assume a crystal frequency of 1.5 mc. This is mixed in the first mixer with $16.2 \pm 81 \triangle F$ mc, the output circuit being tuned to the difference frequency. Therefore, applied to the second mixer through the isolating amplifier, we have a frequency of $14.7 \pm 81 \triangle F$ mc. This is mixed with $16.2 \mp 81 \triangle F$ and the output circuit is again tuned to the difference frequency, a frequency of $1.5 \pm 162 \triangle F$, or the master crystal oscillator frequency and the sum of the frequency deviations. It will be noted that the frequencies produced from the 200-kc oscillator are balanced out, so that this oscillator exercises no control over the carrier frequency.

In the final multiplier chain we used four 6SJ7 stages, an amplifier, a tripler, a doubler and an amplifier. This last amplifier was followed by two 6AG7 doublers, the output of the second 6AG7 driving the 807 output.

All tank circuits were designed to pass a band sufficiently wide to transmit all sideband pairs which are significant at the particular frequency concerned, thus avoiding sideband cutting and consequent distortion. A multiplication of 24 has been achieved in this section, so that the output of the multiplier contains a frequency deviation equal to 3888 times the original amount produced. This when followed by the tripler stage (829B) provided a total multiplication of 11,664.

Two power supplies were included: a low-voltage supply delivering 550 volts for the plates of the 807 and 829B and power to an electronic regulator supplying 300 volts for the modulator, and a high-voltage rectifier delivering 2,000 volts for the plate circuit of the power amplifier.

The control circuits permit remote control of the equipment and provide the usual protection for personnel. Depressing the start button energizes the filament contactor which locks in on its contacts, applying all filament voltages and energizes the time delay relay. After the relay operates, the high and low plate transformers are connected to the line in sequence, thus placing the transmitter in operation. Filament and plate supplies are protected against overload by circuit breakers in the supply line. Overload and bias interlock relay protect the power amplifier tubes from overload.

Shock mounting of the unit was provided to prevent modulation due to vibration.

THE INDUSTRY OFFERS . . . —

(*Continued from page 43*)

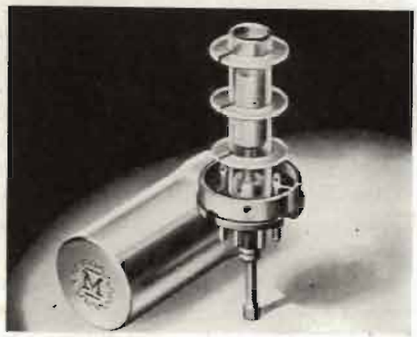
volts, 50-60 cycle a-c operation and are rated at 20 watts.

* * *

MILLEN TUNABLE COIL FORMS

Permeability tuned, shielded plug-in coil forms, 74001, have been developed by James Millen Manufacturing Company, Inc., 150 Exchange St., Malden, Mass.

Standard octal base of mica-filled bakelite, polystyrene ½" diameter coil form, aluminum shield, h-f iron tuning slug suitable for use up to 35 mc. Adjusting screw protrudes through center hole of standard octal socket.



* * *

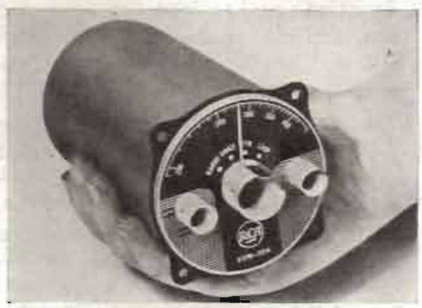
RCA AIRCRAFT RECEIVER

An aircraft receiver, AVR-104, covering the radio range, weather, and traffic control band, that can be mounted on an instrument panel, has been announced by the RCA Engineering Products Department.

A master function switch of the r-f unit provides a separate pre-tuned traffic control channel fixed at 278 kc.

Built-in range filter permits the elimination of unwanted 1020-cycle side-tone when it is desirable to hear traffic instructions or weather reports from the range station.

A choice of power sources is available, permitting the use of a dry battery pack or either of two vibrator supply units designed for 6, 12 or 24-volt battery systems.

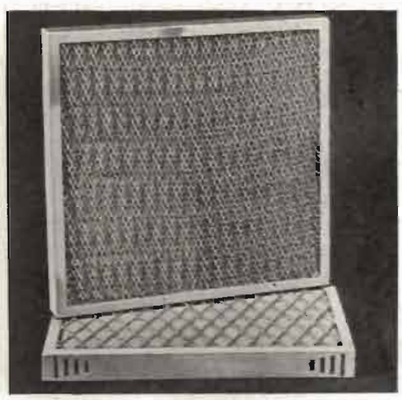


* * *

AIRCO BLOWER TRANSMITTER MOTOR FILTERS

Blower motor filters, designed to trap particles of dust in the incoming air, and retard moisture before entering channel, have been announced by the Air Filter Corporation, Milwaukee, Wisconsin.

Filters can be used either as a dry filter or



as a viscous filter by charging with filter adhesive oil.

Can be used to eliminate dust in capacitor plates, tube sockets, etc.

* * *

CINEMA EQUALIZERS

A diameter equalizer, (3991) said to be capable of equalizing 8 db at 5" recording disc diameter down to 0 db at 12" diameter at 10,000 cycles, has been announced by the Cinema Engineering Company, 1510 W. Verdugo Road, Burbank Calif.

Equalizer is adjusted automatically as the cutting head of the recording lathe progresses across the disc. A spring return arrangement controls the action and can be cord-connected to either the cutting head or the carriage of the lathe. Insertion loss is 10 db. Impedance is 500 ohms.

The unit is 3⅝" diameter and 3¼" high overall.

* * *

AEROVOX RESISTANCE-CAPACITANCE BRIDGE

A resistance-capacitance bridge, model 76, has been announced by Aerovox Corporation, New Bedford, Mass.

Measures capacitance from 100 to 200 mfd in six ranges; resistance from 10 ohms to 200 megohms in six ranges; power factor from 0 to 50%. Provides d-c polarizing potential for leakage measurements, from 0 to 600 v d-c, continuously variable and calibrated in volts. Checks leakage of electrolytic capacitors or insulation resistance of paper or mica capacitors.

* * *

ERCO RADIOTELEPHONE

A 18 to 22-watt, 3 to 6-mc radiotelephone, type 137-TR, for 6, 12, and 32-volt d-c or 110-volt a-c operation, has been announced by Erco Radio Laboratories, Inc., Hempstead, Long Island, New York.

Pretuned and crystal controlled. Push-to-talk operation with hand microphone or handset.

* * *

JFD CABLE DISPENSER

A handy spool line with cables and cords wound on a metal spool and housed in transparent glassein container, has been produced by the JFD Manufacturing Company, 4117 Fort Hamilton Parkway, Brooklyn 19, New York. All-metal spool is said to prevent cable from unraveling, kinking, or tangling. Glassein container is said to render the cable weather-resistant and moisture-proof.

Available in a jobber's counter display containing 50 100' spools and on a bench-stand rack with 5 100' spools.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

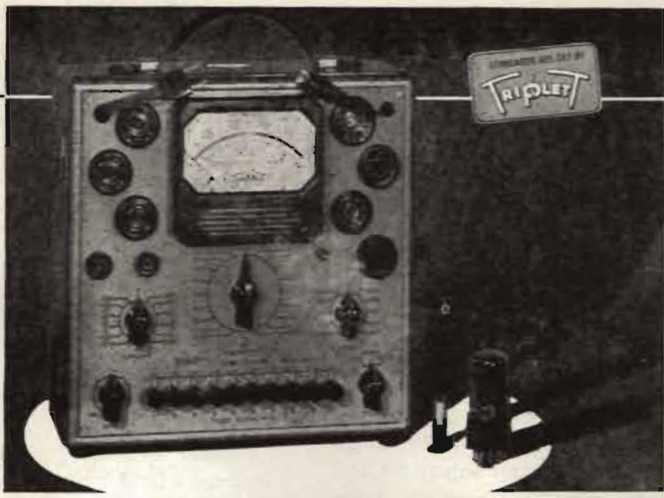
Personals

LT. COMDR. B. F. BORSODY, U.S.N.R., winner of the Hallicrafters' SX28A at our recent dinner, will soon be in Japan with the War Department Radio Division . . . Life member W. E. Beakes, chairman of the board of Tropical Radio Telegraph Company, continues to enjoy Florida weather . . . Life member William J. Barkley, vice president of Collins Radio, was recently elected to the board of directors of RMA . . . Captain Pierre H. Boucheron, U.S.N.R., is now in charge of the radio and television broadcasting activities of the Farnsworth Television and Radio Corporation . . . Leroy Bremer is back in Alaska for his annual stint as technician in charge of a group of fisheries radio stations . . . J. A. Balch, formerly president of the Mutual Telephone Company of Hawaii, has spent the last few years in Washington, D. C. . . . Harvey R. Butt is now sales manager of the Radiomarine Corporation of America . . . Veteran member George F. Duval is busily engaged in supervising the changing of bands of television receivers in the New York area . . . Life member Dr. Allen B. DuMont, president of Du Mont Laboratories, recently sent a note of congratulations, for the outstanding NBC Louis-Conn telecast, to honorary member Niles Trammel, president, National Broadcasting Company. Dr. Du Mont said that all of the Du Mont staff were unanimous in their praise of the quality of the image and the skill with which the job was done. Television received a great impetus, he emphasized. Vice president and chief engineer of NBC, O. B. Hanson, who supervised the telecast, is a life member of VWOA. Our congratulations to him . . . Veteran member W. T. Marshall of the New York Telephone Company radio staff recently completed a course in mobile radio at the Bell Laboratories School . . . Pleased to see genuine veteran 'Bob' Miller of the Radiomarine staff looking hale and hearty . . . VWOA honorary president Dr. Lee de Forest is currently engaged in the perfection of amplification of present-day television screens at the American Television Laboratories in Chicago. His plans call for the development of a screen limited in size only by the dimensions of the room . . . John V. L. Hogan recently received a medal of liberation from King Christian X of Denmark in recognition of his contributions to the Danish cause for the period of Nazi occupation.

VWOA life member O. B. Hanson, vice president and chief engineer of NBC, who directs engineering activities of the television, and a-m and f-m broadcasting divisions of NBC.

WE'VE RECEIVED an interesting note from Preston L. Stocum, saying: "The column in COMMUNICATIONS is very interesting and to one so far away from the center of things, almost a necessity. Since my release from active duty with the Army I have been maintenance technician in charge of the Civil Aeronautics Administration airways station at Moses Point, Alaska. In available spare time at my Moses Point habitat I have been working on a ham rig, call letters KL7BD, and hope to contact VWOA members throughout the States in the near future. A hearty welcome awaits VWOArians. Just drop in via Pan American Airways for some of the finest salmon fishing in the world; they all but jump into the boat" . . . A graduate of St. John's College, Annapolis, Maryland, and for ten years Chief Radio Officer for various steamship companies during which time he held commercial extra first class and amateur extra first class licenses, veteran member Alfred Dowd during the war worked as installation supervisor on PT boats and until called to active duty in the Naval Reserve served as assistant purchaser of electronic equipment at the Signal Corps General Development Laboratories at Fort Monmouth, N. J. On active duty with the Navy he was Communications Supervisor at the Naval Frontier Base on Staten Island, N. Y., and then went to the Canal Zone as Officer-in-Charge of the Electronics Group in the office of the Industrial Manager.

FROM G. HAROLD PORTER has come a letter, commenting on our year book. He says: "Through the unfailing thoughtfulness and courtesy of my highly esteemed friend, Col. T. H. Mitchell, I received a copy of the 1946 Year Book, a splendid piece of work upon which you are to be congratulated. Perusing the history and reviewing the faces of many old friends awakened a keener appreciation of my honorary membership in the VWOA than I have heretofore realized. I recalled with pleasure the occasion in 1929 when General J. G. Harbord, Herbert Hoover and I were elected honorary members, each for contributions to the advancement of wireless. I was officially notified and presented with a membership card dated December 31, 1929" . . . H. F. Wareing, vice chairman of the Chicago chapter of VWOA is radio engineer of the Department of Police of the City of Milwaukee, Wis. Mr. Wareing is becoming increasingly active in VWOA affairs rounding up new applicants and making Milwaukee's radio population VWOA conscious . . . Life memeber Raymond F. Guy is a candidate for the IRE board of directors for the period 1947-1949. Here's one vote, RFG.



A New

TRANSCONDUCTANCE READING

Tube Tester

For the Man Who Takes Pride in His Work

Microhmo (Dynamic mutual conductance) readings and simplified testing—are two of the 20 exclusive features found in the new model 2425 tube tester. Transconductance readings are made possible through a simple measurement directly proportional to Gm and a properly calibrated measuring instrument. No possibility of grid overloading. "Short" and "open" tests of every tube element. Gas test rounds out full check of *all* tubes. New Easy-Test Roll Chart. These exclusive features, amplified by Triplett Engineering, make Model 2425 the outstanding 1947 tube tester

Precision first ...to last

Triplett

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO

FOR RADIO AND ELECTRONICS

PARTS
EQUIPMENT
SETS

ask NEWARK *They'll have it!*

IF YOUR NEEDS in radio or electronics parts, sets or equipment are available **ANYWHERE**, save time by phoning or wiring Newark Electric. Our tremendous stocks are complete and up-to-the-minute in all three stores.

COMPETENT TECHNICAL MEN handle your inquiries and orders at Newark. They know what you are talking about and can handle all requests intelligently and promptly. They know the stock — they know industry's problems and needs. They can give you prices and delivery dates on specific merchandise.

IN NEW YORK AND CHICAGO you get speedy door-to-door delivery. Out-of-town orders are shipped the day they are received.

Uncertain, industry-wide conditions have delayed our complete catalog, but we'll gladly send you literature on ANY manufacturers' products. Send your inquiries by mail, telegraph or phone. They will be answered completely and promptly. When writing, address Dept. L1.

★ In New York or Chicago you'll enjoy our big bargain counters, loaded down with unusual surplus radio and electronics items, fascinating to those with inquiring minds.

★ The Public Address departments in all stores are full of interesting merchandise. Industrial buyers are invited to take advantage of Newark's set and appliance departments in both New York stores.

NEWARK ELECTRIC COMPANY, INC.: Dept. L1,
Please send informative literature on the following:

NAME: ______
ADDRESS: ______
CITY: ______ STATE: ______

NEW YORK 242-50 W. 55th St. New York 19, N. Y.
NEWARK ELECTRIC COMPANY, INC.
CHICAGO 323 W. Madison St. Chicago 6, Ill.

New York City Branches: 115-117 W. 45th St., & 212 Fulton St.

LATERAL DISC RECORDING

(*Continued from page* 15)

were incorporated in the pushpull driver stage, resistance-capacitance coupled to the output stage utilizing two 845 triodes. (Transformer coupling was first tried, but due to the high insertion loss encountered, the driver tubes had to be operated well above their normal overload point to provide sufficient grid drive for the output stage.)

Typical Power Amplifier Analysis

In describing the performance of a typical power amplifier, Cousins[27] showed two characteristic curves; a gain characteristic, and a power output characteristic. More recently, Hilliard[28] emphasized the value of this *power characteristic* which is a graph of the amplifier output-power as a function of frequency for a given value of distortion. The usual gain versus frequency characteristic, measured at some point (say 3 to 6 db) below the maximum output power, is also important. The power characteristic for this recording amplifier (Figure 12) was measured at a constant 5% third harmonic distortion which is within 1% of the total harmonic distortion (rss) at the higher power levels. For comparison, a gain versus frequency characteristic is also shown in Figure 12. Again referring to the power curve, Figure 12, it can be seen that this amplifier will deliver 45.5 dbm (35 watts), ± 1.0 db from 25 to 10,000 cps, which is adequate for its intended use. Although the third harmonic could not be measured above 5000 cps with available apparatus, the wave form as viewed on an oscilloscope did not deteriorate between 5000 and 10,000 cps at the same power level and therefore the curve was extended to 10,000 cps.

The overall performance of this recording system using lacquer-coated discs is shown in Figures 13, 14 and 15. In Figure 13 appears the response obtained at 33 1/3 rpm at a diameter of 15″ using a recording amplifier (845's), Presto 1-C recording head, W. E. 9A reproducer and equalizer, and RCA 76-B2 console. Using this same recording channel with another 1-C recording head, but substituting the reproducer and equalizer of the RCA 70-C1 turntable combination, 33 1/3 rpm at a diameter of 11″, and 78 rpm at a diameter of 6″, responses were as shown in Figures 14 and 15 respectively. It will be noted that definite resonances occurred at about 230 cps. As would be expected, this reproducer-resonance was not observed with ordinary point-by-point calibrations, but became quite apparent when the response was measured with the aid of a continuous frequency sweep and graphic level recorder.

Overall Response Measurements

It should be mentioned here that all overall response measurements shown in the figures were measured with a level recorder[29] linked to an oscillator.[30] In making such measurements, the output of the oscillator (output level ± 0.25 db 20 to 20,000 cps) was fed to the recording amplifier and a record was made while the oscillator was swept through its range by the recorder and link mechanism. Markers at two or three frequencies were made by momentarily breaking the circuit with a key. The record was then played back and the channel output fed to the level recorder which traced the resulting response. The correct frequency scale was restored by lining up the marker points made while recording. The frequency characteristic of this oscillator level-recorder combination is better than ± 0.5 db from 50 to 10,000 cps and may therefore be neglected in evaluating the foregoing measurements.

Although the overall responses were not *flat* and left much to be desired, the performance of the system proved very satisfactory when original records were produced and quite good even after three or four dubbings were made, using the types of program material earlier outlined in this paper. New recording heads (RCA MI-11850-C) ordered several months ago are expected to provide an improved high-end characteristic along with a reduction of the inherent distortion products.

Another step in improving the performance of the present system is the intended NRL manufacture, and subsequent use, of a new, low-mass, low-stiffness disc reproducer which recent tests indicate will materially reduce the so-called *acetate record resonance*. A pre-production model of this new reproducer, developed by E. F. McClain of the *electronic special research division* of this laboratory, is of the electrodynamic type (moving coil) and has the following electrical and mechanical characteristics: equivalent mass referred to the stylus tip, 3.5 mg; effective lateral stiffness, 0.6 x 10^6 dynes/cm; effective vertical stiffness, 0.8 x 10^6 dynes/cm; tracking weight, 5 grams; output impedance, 10 ohms; and a frequency response, in vinylite, of ± 1.5 db from 40 to 10,000 cps. Such a reproducer should be especially suited for playback of instantaneous recordings on lacquer-coated discs due to its low wearing effects on such soft material, reduction of *acetate-record resonance*, and its allowance for *pinch-effect* (due to its vertical compliance) which prevents damage to the side-walls of the pinched sections of the grooves.

Credits

The author is grateful to J. K. Wilkinson, formerly of the recording laboratory, for his generous assistance with the early development of this installation, and to R. H. Carson of the sound division for providing the measuring assembly for the many tests run in the laboratory. Credit is also due W. H. Ward for his assistance in collecting the graphical data presented.

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[27]V. M. Cousins, *The 86 Type Amplifier*, Bell Laboratories Record, pp. 400-404; August 1936.

[28]J. K. Hilliard, *Intermodulation Tests for Comparison of Beam and Triode Tubes Used to Drive Loudspeakers*, COMMUNICATIONS, pp. 15-17; February 1946.

[29]Sound Apparatus Co. type FR.

[30]General Radio 913-B.

AACS WEATHER

(*Continued from page 20*)

handling traffic, because individual receipts were required for each message. To speed up traffic handling, the Wing gave instructions that individual receipts for each message were unnecessary, that only an hourly traffic check and a midnight 'closer' were to be used. Furthermore, regardless of whether or not reception from the far end of a duplex circuit was being obtained, the transmitting end was to continue sending traffic continuously and indefinitely until positive proof in shape of a radioteletype or c-w message was received from the far end advising that traffic should be stopped. This procedure speeded up traffic immeasurably, and it was found that in very few cases did both legs of a duplex circuit become faulty at the same time.

At the same time, the Wing initiated the *normal* method of traffic routing, in which each relay station had definite responsibility for certain satellite stations, and for certain relay routes to other main relay points. This eliminated the need for lengthy headings on book messages. Once placed on the circuit, each relay station automatically relayed the message via its proper route to the correct destination. *Off-normal* routes were also designated, in the event that key routes became inoperative.

The foregoing methods speeded up point-to-point traffic handled over the system, and reduced manual transmission to those satellite stations whose traffic load would not warrant radioteletype circuits. However, as the operational traffic load was increased through increased operating efficiency, it was found that requirements for transmission of weather traffic had sharply risen until it comprised some 70% of total traffic. This weather traffic was considered of urgent priority, and conflicted sharply with operational traffic concerning the movements of aircraft. The Weather Command of the AAF considered that reception of a great volume of weather data was invaluable to all airfields; that if more information was available, better forecasting and routing would result and therefore accidents would proportionately decrease. This was undoubtedly true, especially during the rainy season.

To alleviate a condition rapidly becoming serious because of congested circuits, the Wing Operations section again sought a formula for a simple method of handling both operational and weather traffic efficiently, without conflict as to priority, etc. This was solved in two steps.

Solutions

Automatic repeater units were installed at all radioteletype stations. These units, locally constructed at each station, consisted merely of a 255A polar relay, with isolating circuits to segregate individual keying channels. The relay was connected to a small switch key panel, mounted alongside the transmitter-distributors of the transmitting position. It was so connected that one weather tape would key any or all transmitting circuits simultaneously, or (at other key positions) the receiving line from any chosen receiver would key any or all of the transmitting channels. With this arrangement, any relay station could simultaneously key all of its transmitting channels from any receiving channel chosen. An operating procedure was devised whereby all main radioteletype stations, on bi-hourly schedules, transmitted weather available to them from local observations or from manual pickup from satellite stations.

Each transmitting station down the line (from Miami to Brazil) transmitted in turn, each sequency lasting some 60 seconds. Schedules were worked out so that each station had a definite turn, and started transmission some 5 seconds after end of transmission of the preceding station. If, after 10 seconds delay, a station did not come on the air, the succeeding station down the line came on with its broadcast, until all were completed. Each station had the responsibility of receiving the broadcast from all other transmitting stations on its particular net, and would throw a switch key at the proper time so that it would relay over all its own transmitting channels the incoming transmissions from the stations immediately above and below it in the line. By this method each station on the route from Miami to Africa automatically received all weather from all other stations on the route. The entire procedure consumed some 6 minutes each half-hour schedule, and enabled the entire Caribbean area weather data to be quickly transmitted to all consumers without the necessity of time-consuming relays. Although the circuits were tied up exclusively for weather approximately 12 minutes hourly, an enormous saving in circuit time was made through the elimination of point-to-point relays. It will be noted that by interconnecting all circuits, the stations received incoming weather from two or more different sources (circuits). This, although somewhat wasteful of printing paper, gave the advantage of multiple reception of material, thus guaranteeing at least one perfect copy.

The second, and more important device, was the broadcast of weather by a central multichannel transmitting station, and its reception by intercept radioteletype receiving stations at all interested airfields. It could be clearly seen that weather transmission was primarily a one-way communication. While each field contributed a small bit of local weather data, this amount was only a small portion of the data required by the station (from other stations) to enable accurate forecasts and maps to be made. This essential one-way weather requirement could be compared to a broadcast station serving many listeners in the field of entertainment. It also compared to the landline weather teletype drops installed by CAA at airfields in the continental U. S. whereby the field, regardless of its size, or amount of originated traffic, had access to all reports transmitted by CAA over its landline nets.

It was felt that the point-to-point

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transmission of weather was obsolete; the time had come to handle the overseas radio transmission of weather as it was handled by landline in the U. S. This decision was made especially important because at the same time, the Gypsy Task Force of the 20th Air Force presented weather requirements which could not be met by ordinary operating methods. Therefore, at Miami, the first radioteletype broadcast of weather, with intercept receipt, was inaugurated. It meant that all airfields, large and small, would have access to a great quantity of broadcast weather data, regardless of whether their traffic load would warrant point-to-point radioteletype circuits.

The broadcasts, placed on the air eleven days after authorization had been obtained, were made over four 10-kw transmitters operating simultaneously, keyed by a single tape. Dual transmitter-distributors were employed, with an automatic cutover, so that prepared tape could be placed in both, and no delay encountered in changing tapes. Intercept stations were set up throughout the Wing, with frequency-diversion reception employed at some locations. With this method, no time was lost in band-changing; one receiver remaining on one band while the other searched the 3 remaining bands for best reception.

Because transmission paths varied from 200 to 3,500 miles, four widely separated frequencies were necessary to give coverage to all intercept stations at the same time.

This broadcast has been in continuous operation since its inauguration on February 28, 1945, with an average daily transmission of 75,000 groups of clear and ciphered weather data. A similar system was later installed in the Pacific area, and it is contemplated that installations in other parts of the world will eventually eliminate the point-to-point weather handling procedure formerly used.

Later developments, not yet in use by the AACS, will undoubtedly employ simultaneous transmission of single-channel manual transmission and radioteletype on the same carrier. This can be done by modulating the transmitter with a suitable audio tone, and copying manually the signals transmitted with this tone, somewhat in the manner of old type spark equipment. The receiver b-f-o would of course be turned off. This is a simple method of obtaining two services from one assigned frequency and one transmitter, and requires no changes or additional equipment at the receiving stations. If a suitable audio tone were used, no interference to the frequency-

(Continued from page 54)

shift radioteletype keying channel would occur. Radiotelephone can also be used, instead of manual-tone keying, if the audio requirements will permit the 'wobbulation' of the carrier caused by the frequency-shift keyer. The manual radioteletype combined method is especially valuable when changing over from c-w to radioteletype transmission, and the changeover must be made on existing frequency assignments. Keying with an audio tone enables manual transmissions to be carried on with stations not yet equipped with radioteletype receivers, while simultaneously similar material can be transmitted on the same transmitting frequency via radio teletype to those stations already converted.

MECHANICAL FIELD RECORDER

Dave Driscol, left, WOR director of news and special features, and Charles H. Singer, WOR assistant chief engineer, with BBC-type spring-wound motor recorder, imported by WOR for remote recorder use. Unit records three minutes at 78 rpm.
(See COMMUNICATIONS *Feb. 1945, pp. 33, 34 and 35 for complete recorder details.)*

RAILROAD V-H-F ANTENNA

A 14" antenna, 50' above ground, on the diesel engine house at Auburn, Washington, used in a fixed station v-h-f setup during a recent series of tests conducted by the Northern Pacific R.R. *(Courtesy Western Electric)*

RCA TELEVISION

Above, telephoto lens installed on the image orthicon television camera. Below, portable camera control and switching units required to operate two television cameras. From left to right, on top of desk: two individual camera controls, master switching unit and master monitoring unit. Left to right, under the table: camera power supplies, master power supply, pulse-shaping unit and pulse-forming unit.

Below, RCA microwave link equipment used for television relaying.

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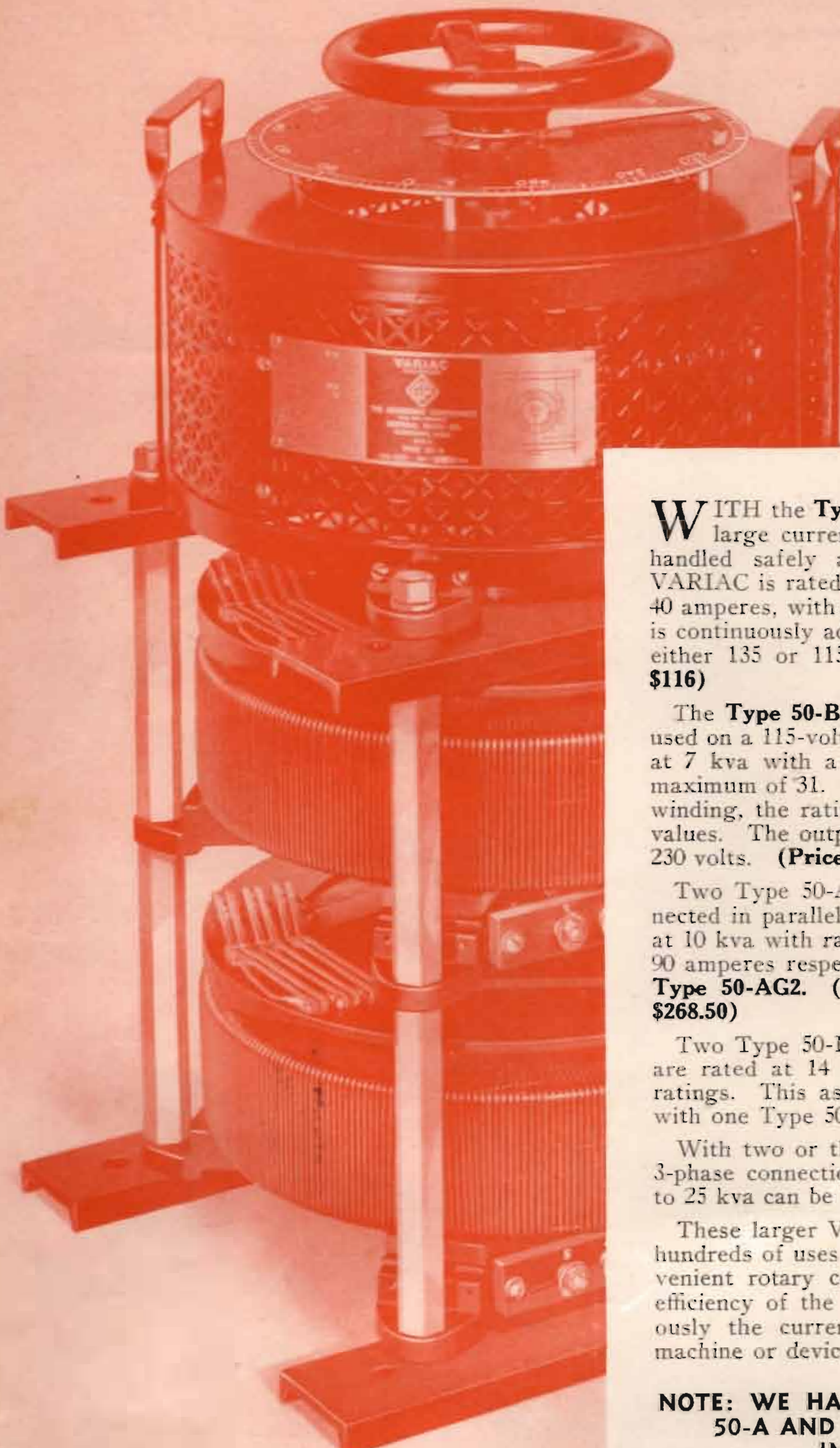

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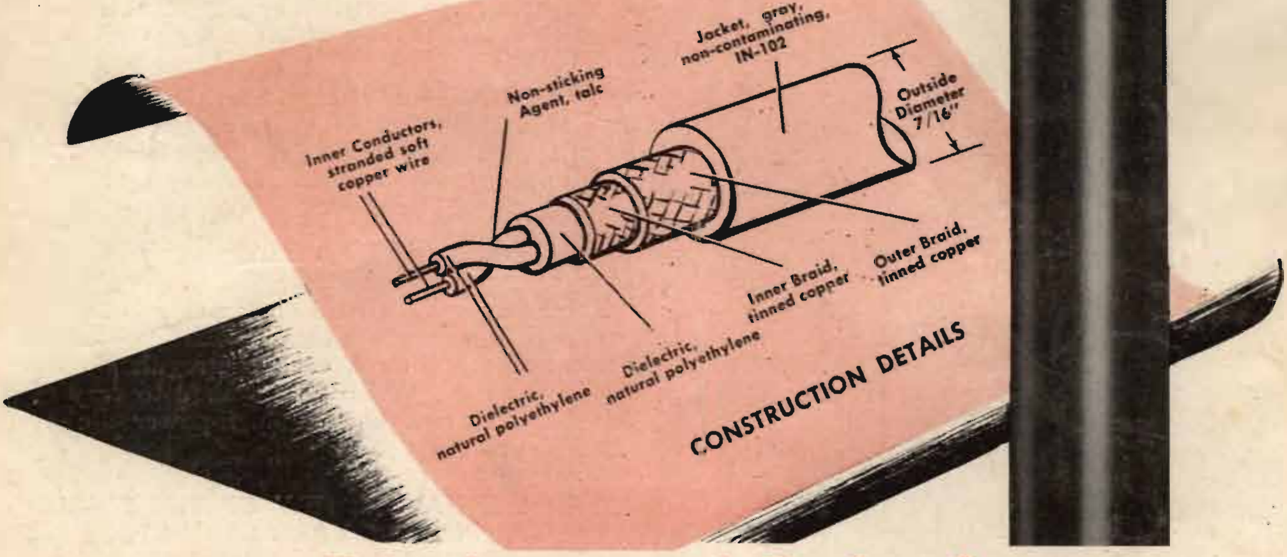
Volts (rms)	2000



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