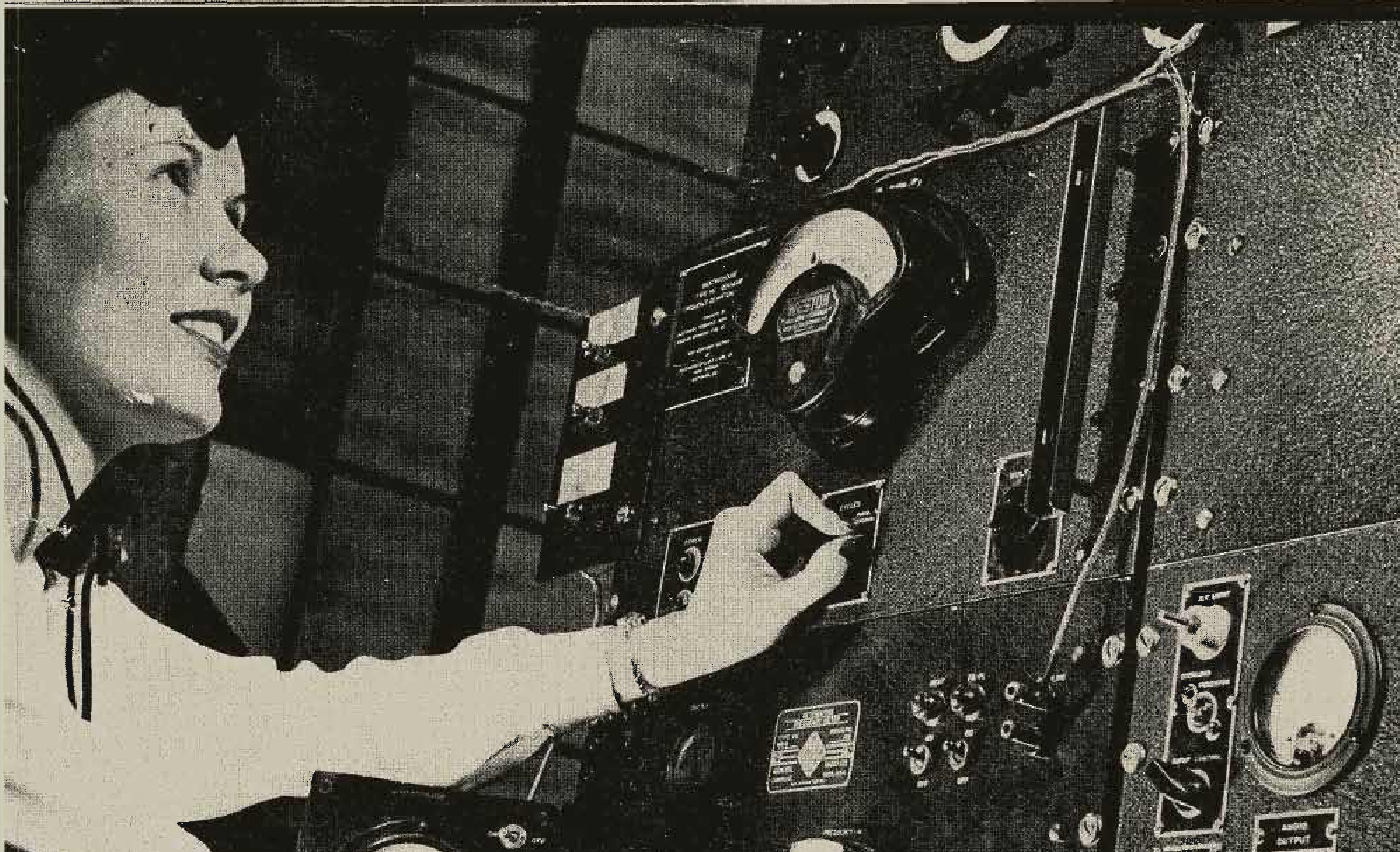
$1.00

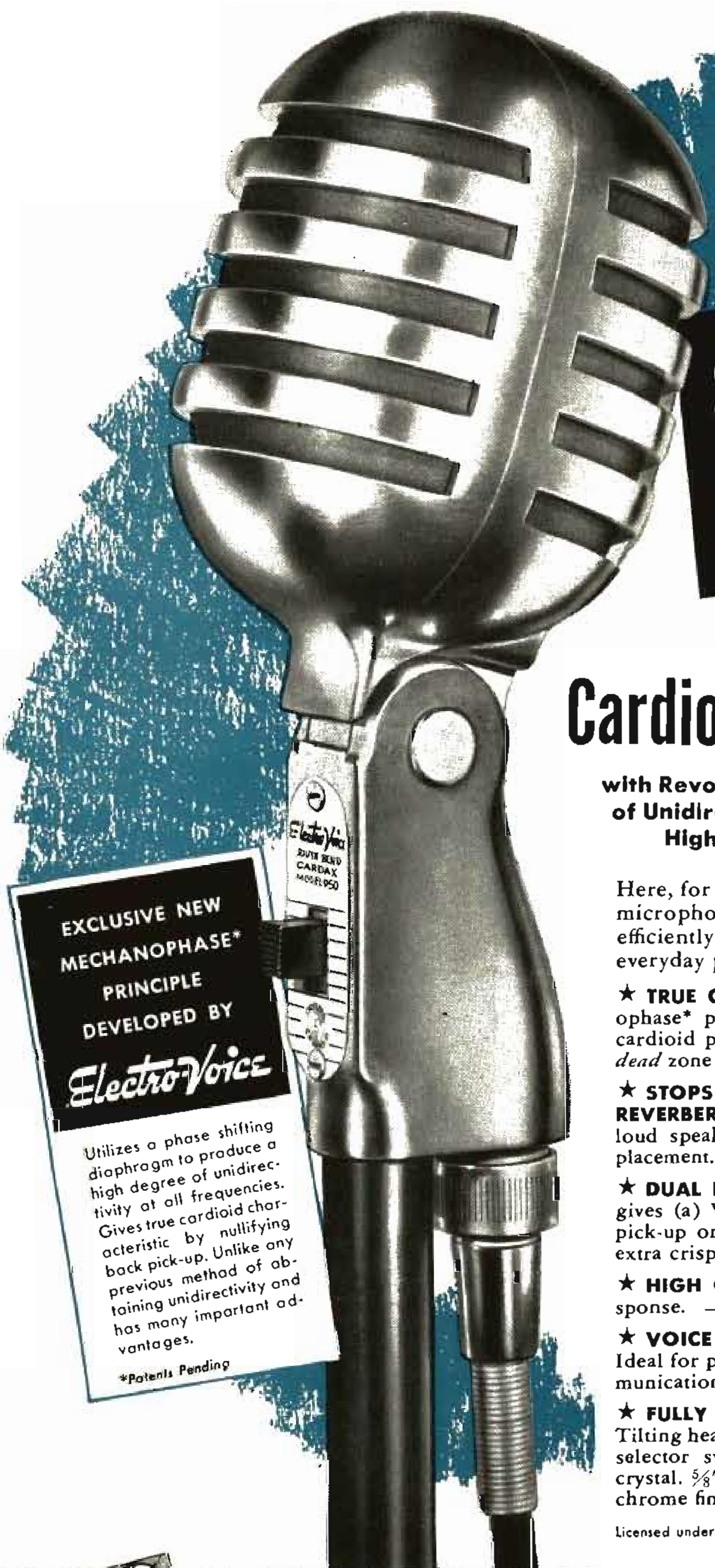
# COMMUNICATIONS

INCLUDING "RADIO ENGINEERING" AND "TELEVISION ENGINEERING"



…UARY 1946

★ GLENN-MARTIN AIRCRAFT TEST NETWORK
★ UNIDIRECTIONAL CRYSTAL MICROPHONES
★ 25-WATT SHIP-TO-SHORE STATION
★ AERONAUTICAL COMMUNICATIONS
★ WIDE-RANGE ELECTRONIC SWEEPER
★ F-M FUNDAMENTAL RELATIONSHIPS
★ CAA ALASKAN DIVERSITY SYSTEM




EXCLUSIVE NEW MECHANOPHASE* PRINCIPLE DEVELOPED BY Electro-Voice

Utilizes a phase shifting diaphragm to produce a high degree of unidirectivity at all frequencies. Gives true cardioid characteristic by nullifying back pick-up. Unlike any previous method of obtaining unidirectivity and has many important advantages.

*Patents Pending

# Electro-Voice ANNOUNCES THE CARDAX

A NEW

# Cardioid Crystal Microphone

**with Revolutionary New MECHANOPHASE* Principle of Unidirectivity . . . Dual Frequency Response . . . High Output . . . and other big features!**

Here, for the first time, you get *all* these features in *one* microphone! With amazing flexibility, new CARDAX efficiently serves many applications . . . easily solves everyday problems of sound pick-up and reproduction!

★ **TRUE CARDIOID POLAR PATTERN** New E-V Mechanophase* principle gives wide-angle front pick-up in true cardioid pattern over wide frequency range. Sound at rear *dead* zone cancels out and is not reproduced.

★ **STOPS FEEDBACK—CUTS BACKGROUND NOISE AND REVERBERATION PICK-UP** Permits nearly double usable loud speaker volume. Simplifies microphone and speaker placement. Assures finer reproduction of just the sound wanted.

★ **DUAL FREQUENCY RESPONSE** Screw control on back gives (a) Wide range flat response for high fidelity sound pick-up or (b) Wide range with rising characteristic for extra crispness of speech or high frequency emphasis.

★ **HIGH OUTPUT LEVEL** —57 db for flat frequency response. —48 db for rising frequency response.

★ **VOICE AND MUSIC PICK-UP EXACTLY AS DESIRED** Ideal for public address, recording, remote broadcast, communications . . . indoors and outdoors.

★ **FULLY EQUIPPED FOR CONVENIENT OPERATION** Tilting head. Built-in "On-Off" switch. Dual frequency range selector switch. Cable connector. 20 ft. cable. Bimorph crystal. 5/8"-27 thread. New modern functional design. Satin chrome finish. **CARDAX Model 950, List Price........ $37.00**

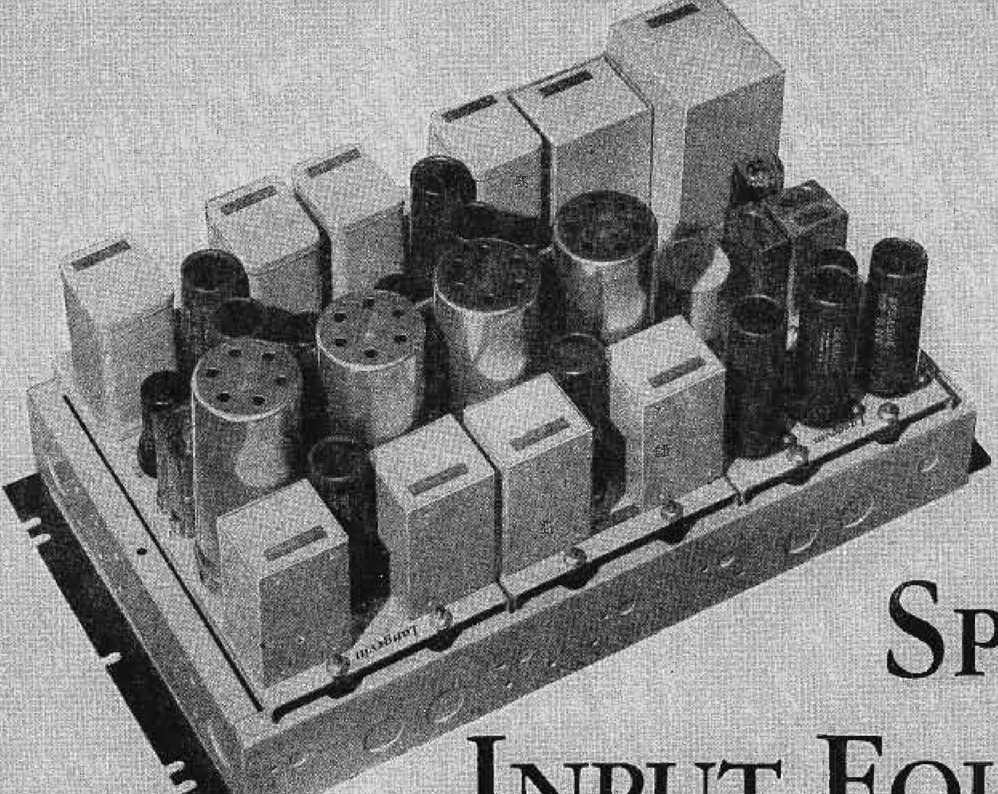
Licensed under Brush Patents. Electro-Voice Patents Pending.

**SEND FOR BULLETIN NOW**
Get full facts about amazing new CARDAX! Describes Mechanophase. Shows how dual frequency response selector works. Includes diagrams and response curves.

*No Finer Choice Than* **Electro-Voice**

**MICROPHONES**

ELECTRO-VOICE, INC., 1239 South Bend Ave., South Bend 24, Indiana
*Export Division:* 13 East 40th St., New York 16, N. Y., U.S.A.—Cables: Arlab



AT LEFT. Two Langevin Type 111-A Dual Pre-Amplifiers and one Langevin 102-A Line-Amplifier mounted on a 3-A Mounting Frame. This unit provides four pre-amplifiers and one line-amplifier, or three pre-amplifiers, one booster-amplifier and one line-amplifier, all in 10½" of rack mounting space. External power supply such as the Langevin 201-B Rectifier, as shown below, is required.

# SPEECH INPUT EQUIPMENT

## *Worthy of an Engineer's Careful Consideration*

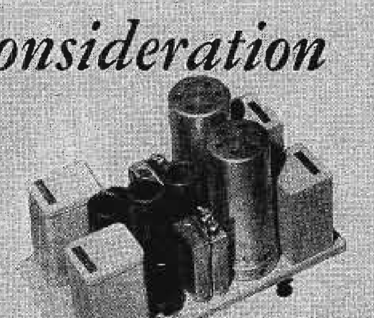
TYPE 102A Amplifier is one of the 102 Series Line Amplifiers of which four different types are available. The "A" is mostly used to drive the line after the master gain control. It is quiet, has excellent frequency characteristic and ample power output with low distortion products.

The 201-B Rectifier is one of the 201 Series Rectifiers, of which two types are available, the "B" having additional filtering, thereby giving a slightly lower ripple content than the "A." This unit is capable of supplying power for one 102 Series Line Amplifier and three 111 Pre-Amplifiers (six pre-amplifiers).

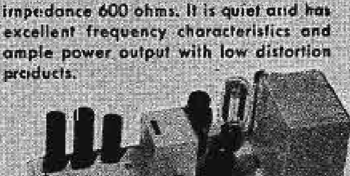
Every unit of Langevin speech input equipment is held to a rigid standard of performance. These units may be cascaded in accordance with good engineering practices and still be well within the allowable limits of FM requirements as to frequency response, noise and distortion products.

All Langevin speech input equipment units are mounted on standard 5¼" x 10¼" chassis. Three of these units can be mounted on a Langevin 3-A Mounting Frame, which occupies 10½" of space on any standard rack. Wall mounting steel cabinets for housing these units are also available.

We are proud of the products which bear the name ***Langevin***. It will only appear on good apparatus.



The 111-A Amplifier consists of two individual pre-amplifiers on a single chassis for use in high quality speech input equipment. Its compact unitized construction saves rack space. Input impedances of 30, 250 and 600 ohms; output impedance 600 ohms. It is quiet and has excellent frequency characteristics and ample power output with low distortion products.



The 108-A Amplifier is one of the 108 Series Monitor Amplifiers, of which four different types are available. The "A" is ordinarily used to drive a monitor system from a 600 ohm or bridging source. Its distortion is low for this type of service. It is quiet and has ample power with excellent frequency characteristics.

# *The Langevin Company*

INCORPORATED

SOUND REINFORCEMENT AND REPRODUCTION ENGINEERING

| NEW YORK | SAN FRANCISCO | LOS ANGELES |
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LEWIS WINNER, Editor

F. WALEN, Assistant Editor

# We See...

EFFORTS TO SOLVE TWO PROBLEMS OF MAJOR IMPORTANCE TO A-M AND F-M broadcasting . . . *more or fewer clear channels for a-m, and the upper or low v-h-f bands for f-m* . . . were at long last initiated by the FCC in January. The final solutions to these vital phases of the art should provide new operational standards and concepts.

In the clear-channel issue we will eventually learn whether or not 50-kw peak power will be the maximum power permitted. Conferences have disclosed that powers up to 750-kw have been recommended as entirely practical for real clear-channel coverage. In fact, many of the clear-channel stations have at one time or another applied for higher powers, and in many instances up to 750,000 watts. However, broadcasters on the western coast feel that additional 50-kw clear channels are necessary for their areas. At present only six of the 46 clear-channel stations are on the Pacific coast. These are spread over California, Washington, Utah, Colorado and New Mexico. Witnesses at FCC hearings have argued that the western listener is under-serviced by this restricted coverage.

According to coverage surveys conducted by various government agencies for the FCC, there are at present 10,000,000 people outside of the daytime primary service area and 20,000,000 outside of the nighttime area. An area reclassification of the clear channels and powers should be great help here, they say.

The clear-channel problem is also closely allied to the listener-saturation problem. Actually we are far from the saturation point. The survey reports have revealed that there are 24 states predominantly rural where the listener coverage is very low, a problem that clear-channel adjustment may solve.

To analyze clear-channel coverage thoroughly, a committee has been appointed to study conductivity, boundaries of areas of violent fading, interference between closely spaced stations and field strengths at distances of 50 to 250 miles from the transmitter.

The clear-channel issue is also closely tied in to f-m transmissions in that coverage relationships must be determined. If the rural areas are to be serviced by f-m stations effectively, additional or more powerful a-m stations may not be necessary. In addition if f-m stations program features that are particularly adapted to rural interests a-m coverage may not be necessary. There are, of course, definite areas where either a-m or f-m will be required for complete coverage. The exact areas will have to be determined, and thus this phase is under investigation too. The FCC have taken steps in this direction by providing for more than 1200 metropolitan and rural f-m stations in a tentative allocation pattern. Incidentally, in this plan, an effective radiated power of 20 kw and an antenna height of 500 feet above average terrain has been used as a basis.

The clear-channel project is so vast that investigations will be continued until the spring and perhaps the summer.

In the meanwhile, the f-m frequency allocation question appears to have been answered. For we have learned that the 88 to 108-mc band will be the f-m band. Stations will go on the air at the higher frequencies as soon as equipment becomes available. Additional quantitative data may alter that decision perhaps in a year and provide for a lower band or extension of the bands. But at the present, the decision calls for the upper band use. Results on these bands will certainly be watched with deep concern by everyone.—L. W.


# COMMUNICATIONS

Including Television Engineering, Radio Engineering, Communication & Broadcast Engineering, The Broadcast Engineer. Registered U. S. Patent Office.

Member of Audit Bureau of Circulations.

**JANUARY, 1946**

**VOLUME 26 NUMBER 1**


## COVER ILLUSTRATION

Quality control setup in the development laboratory of Westinghouse Electric.




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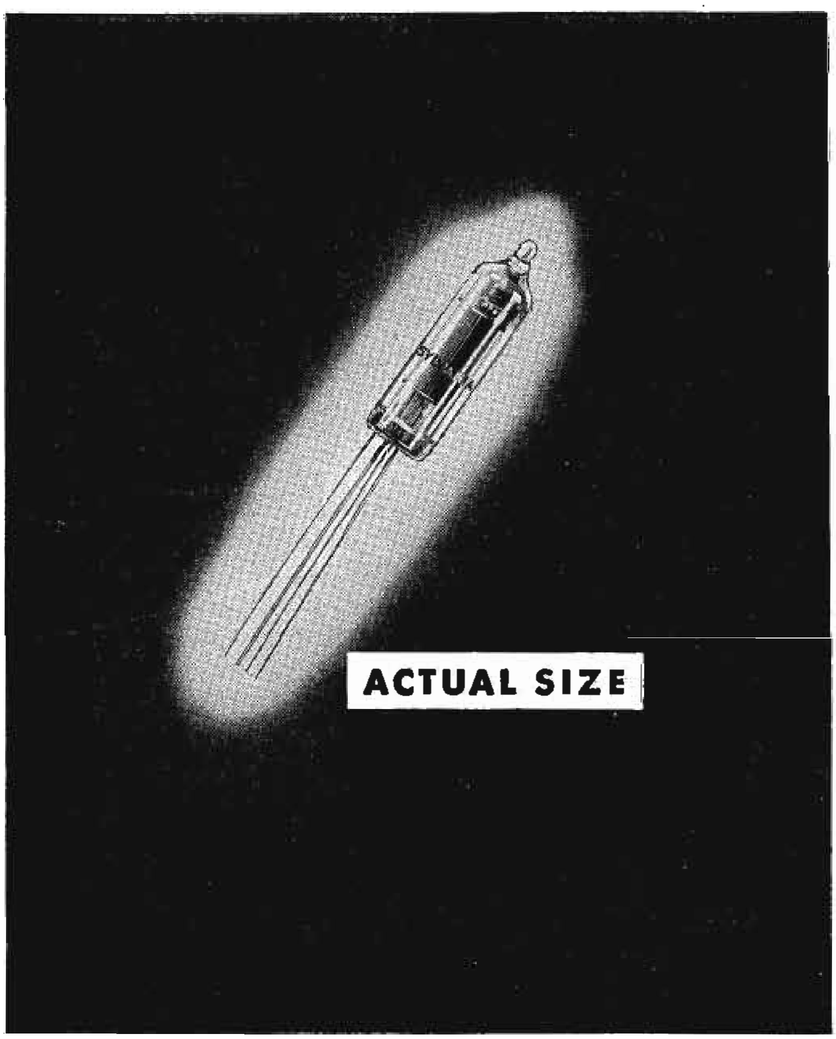
# SYLVANIA NEWS

ELECTRONIC EQUIPMENT EDITION

JAN. *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1946

# NEW T-3 TUBE FILLS NEED FOR SMALLER UNIT IN TINY BROADCAST RECEIVERS




*For any further details, or questions you may want answered about this tiny, sturdy vacuum tube, do not hesitate to write or call Sylvania Electric Products Inc., Emporium, Pa.*

## *Commercial Version of Proximity Fuze Tube Is Rugged, Has Long Life*

Following Sylvania Electric's recent announcement about the sensationally small vacuum tube—originally developed for the now-famous proximity fuze transceiver—have come many inquiries concerning this super-midget.

### SET MAKERS ESPECIALLY INTERESTED

Since the commercial version of the "war-baby" is being produced, many set manufacturers are extremely interested in its qualities — with a view toward making radios about the size of the average wallet or package of cigarettes, miniature walkie-talkie sets and other units.

This new tube, then, is being made in a low-drain filament type and is able to operate at 1.25 volts. This takes advantage of a new, small battery developed during the war which, of course, is a further aid in the manufacture of remarkably small radio sets.

### WILL BE AVAILABLE FOR ALL TYPES

Future designs of this versatile tube can be incorporated in radios ranging in size from tiny pocket sets up to deluxe receivers. It has a life of hundreds of hours, is rugged and exceptionally adaptable to operation at high frequencies.

**SYLVANIA ELECTRIC**

*Emporium, Pa.*

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

# UNEXCELLED FOR HIGH TEMPERATURE APPLICATIONS...

**CAN TYPES 25P**

Two standard types, one for 105° C. and one for 95° C. continuous operation. Other ratings available.

**HERMETICALLY SEALED IN GLASS TUBES**

Famous Sprague glass-to-metal end seals. Extended construction gives maximum flash-over distance between terminals.

## ...*ideal for higher ratings in smaller sizes at lower temperatures*

Sprague Capacitors impregnated with the exclusive VITAMIN Q impregnant make possible the use of much smaller units—with a substantial safety margin—on numerous high-voltage, high temperature applications ranging from transmitting to television. Where high temperature is not a factor, their unique characteristics assure materially higher capacity ratings for a given size.

Type 25 P VITAMIN Q Capacitors operate satisfactorily at thousands of volts at ambient temperature as high as 115° C. Insulation resistance at room temperature is *more than 20,000 megohms per microfarad.* Throughout the temperature range of + 115° C. to — 40° C. they retain all virtues of conventional oil-impregnated capacitors.

**WRITE FOR NEW CATALOG**

Sprague Catalog 20—just off press—brings you details on VITAMIN Q Capacitors in both can and glass tube types as well as dozens of other paper dielectric types for today's exacting uses.

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# SPRAGUE

## VITAMIN "Q" CAPACITORS

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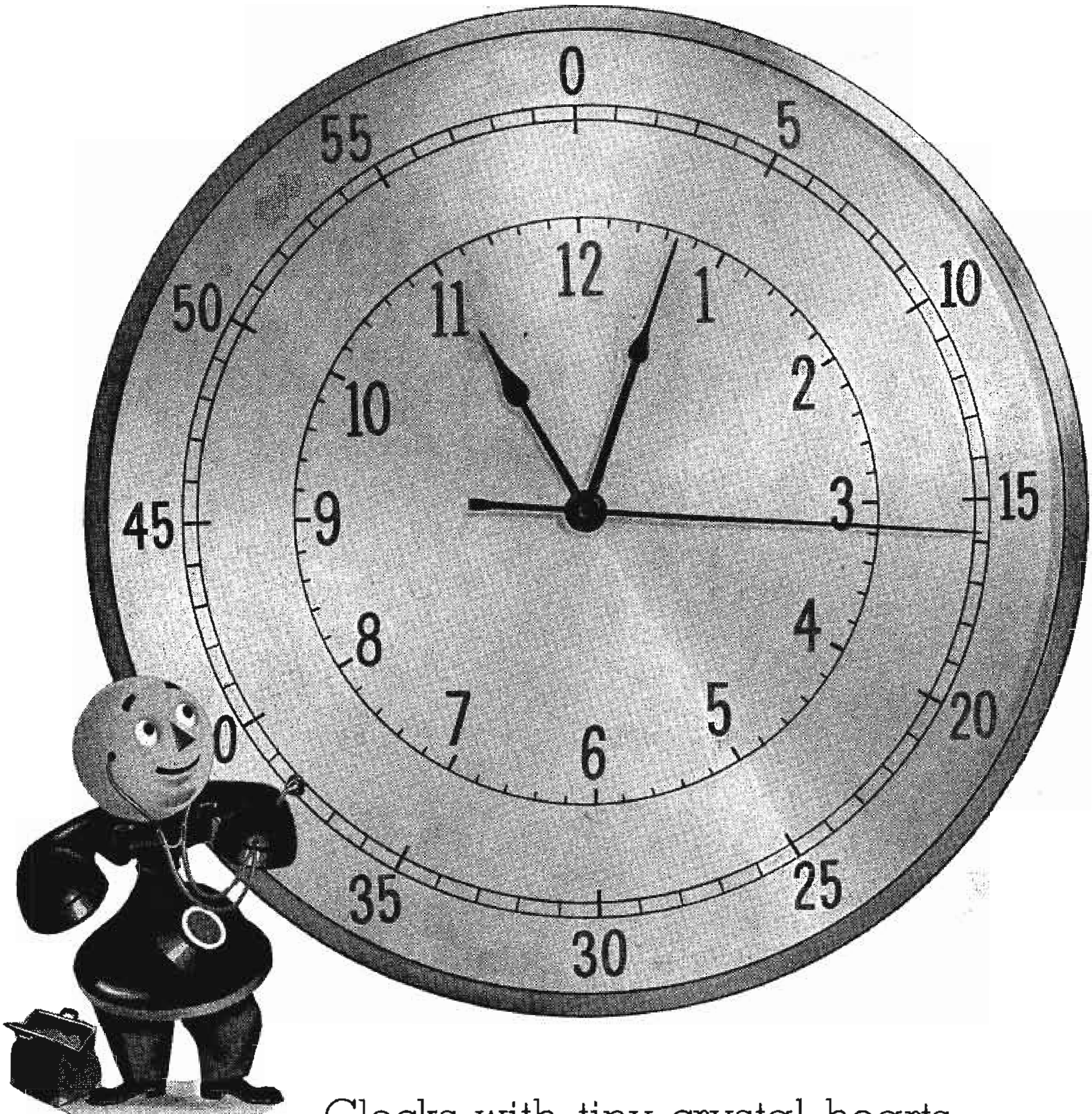


# Clocks with tiny crystal hearts that beat 100,000 times a second.

Crystal Hearts beat time in Bell Telephone Laboratories, and serve as standards in its electronics research. Four crystal clocks, without pendulums or escapements, throb their successive cycles without varying by as much as a second a year.

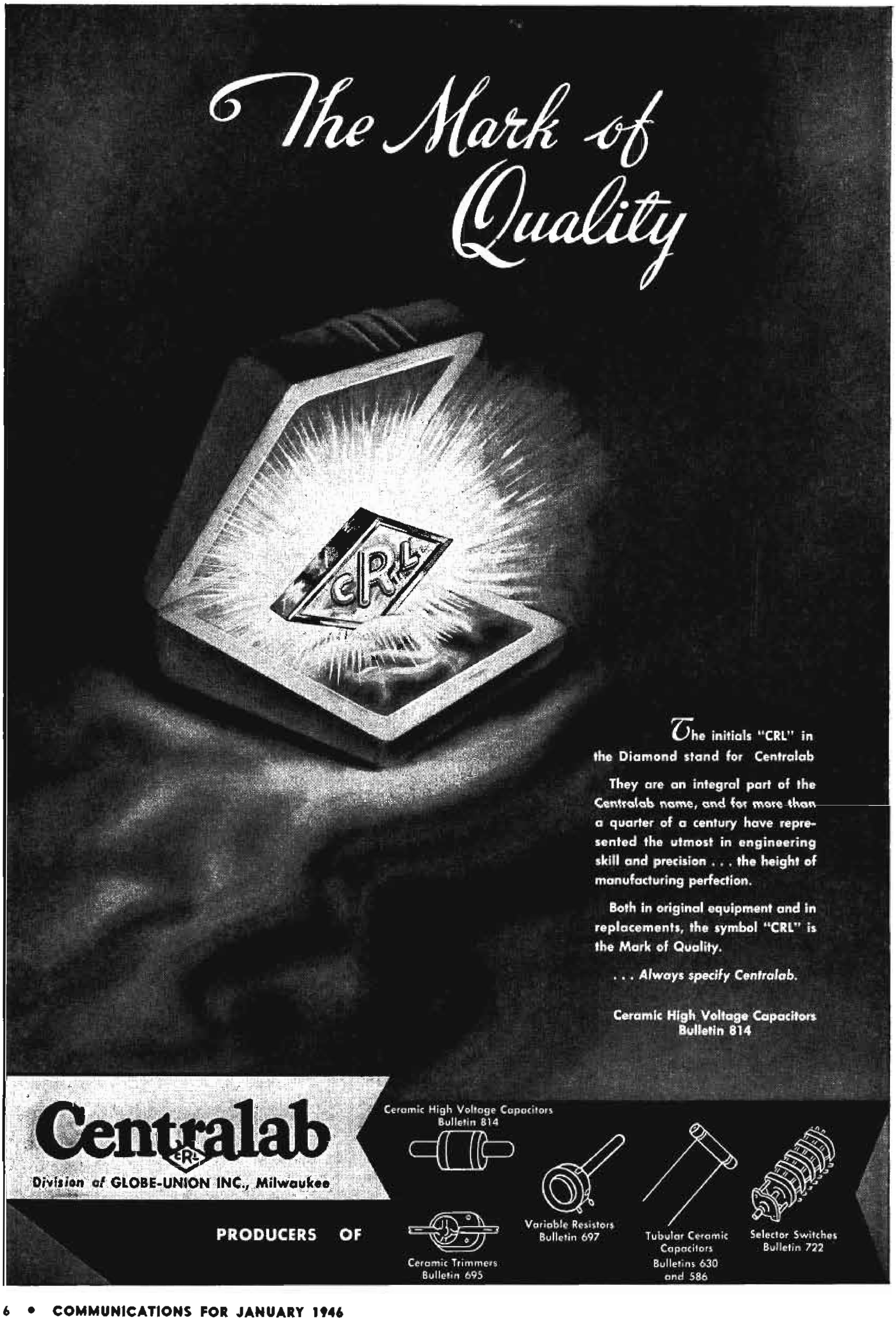
Precise time measurements may seem a far cry from Bell System telephone research, but time is a measure of frequency, and frequency is the foundation of modern communication, whether by land lines, cable, or radio.

These clocks are electronic devices developed by Bell Laboratories, and refined over years of research. Their energy is supplied through vacuum tubes, but the accurate timing, the controlling heart of the clock, is provided by a quartz crystal plate about the size of a postage stamp.

These crystal plates vibrate 100,000 times a second, but their contraction and expansion is submicroscopically small—less than a hundred-thousandth of an inch. They are in sealed boxes to avoid any variation in atmospheric pressure, and their temperatures are controlled to a limit as small as a hundredth of a degree.

Bell Laboratories was one of the first to explore the possibilities of quartz in electrical communication, and its researches over many years enabled it to meet the need for precise crystals when war came. The same character of research is helping to bring ever better and more economical telephone service to the American people.

**BELL TELEPHONE LABORATORIES** *Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.*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Selector Switches Bulletin 722


# RAYTHEON

## IONICALLY HEATED LOW VOLTAGE GAS RECTIFIERS

**A major deterrent to the further size reduction of radio receivers and other equipment designed for universal operation from a standard 117 volt AC or DC line or internal batteries, has been the size and power dissipation associated with the rectifier tube. The advantages of an ionically heated tube for low voltage applications were recognized early by the Raytheon engineers, who have long pioneered in the field of gas tube development. However, considerable research has produced the OY4 and OY4G which start cold from no more than 95 volts DC. High rectification efficiency is realized from the low internal drop and high peak current ratings. Physically these types have the same dimensions as the familiar OZ4G and OZ4.**

**Where size is an important factor, use of the OY4G in place of the 117Z6GT, as extensively employed in the three way receivers, will result in a substantial reduction of the space requirements.**

**Even more important is the differential of approximately eight watts in favor of the OY4 and OY4G because of the ionic heating feature. This saving cuts the input power down by more than 50% for a normal receiver. Consequently, cabinet size can be decreased without danger of excessive heating. Furthermore, the time required for the set to become operative is the same whether on DC, AC or battery — that is, almost instantaneous.**

**These tubes have been engineered to produce a minimum of the radio frequency disturbances associated with a gaseous discharge. The simple filter circuit indicated below will generally reduce such interference to a negligible value.**

**If your product does not call for the ionically heated low voltage gas rectifier, there is a Raytheon type designed for your need. And all Raytheon tubes follow the same rigid pattern of advanced engineering with precision manufacture. To get continuing best results, specify Raytheon High-Fidelity Tubes.**

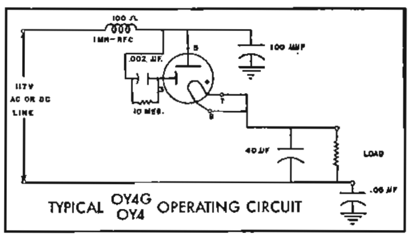
### OY4G AND OY4 RATINGS

Half Wave Rectifier—Condenser Input to Filter*

| | |
|---|---|
| Maximum Inverse Peak Voltage | 300 volts |
| Maximum Peak Current | 500 ma |
| Maximum DC Output Current | 75 ma |
| Minimum DC Output Current | 40 ma |
| Minimum Series Anode Resistance (117V line operation) | 50 ohms |
| Approximate Tube Drop | 12 volts |
| Maximum DC starting Voltage** | 95 volts |

*Pins 7 and 8 must be connected together. Rapid intermittent operation is undesirable.

**With starter anode network as shown in circuit.



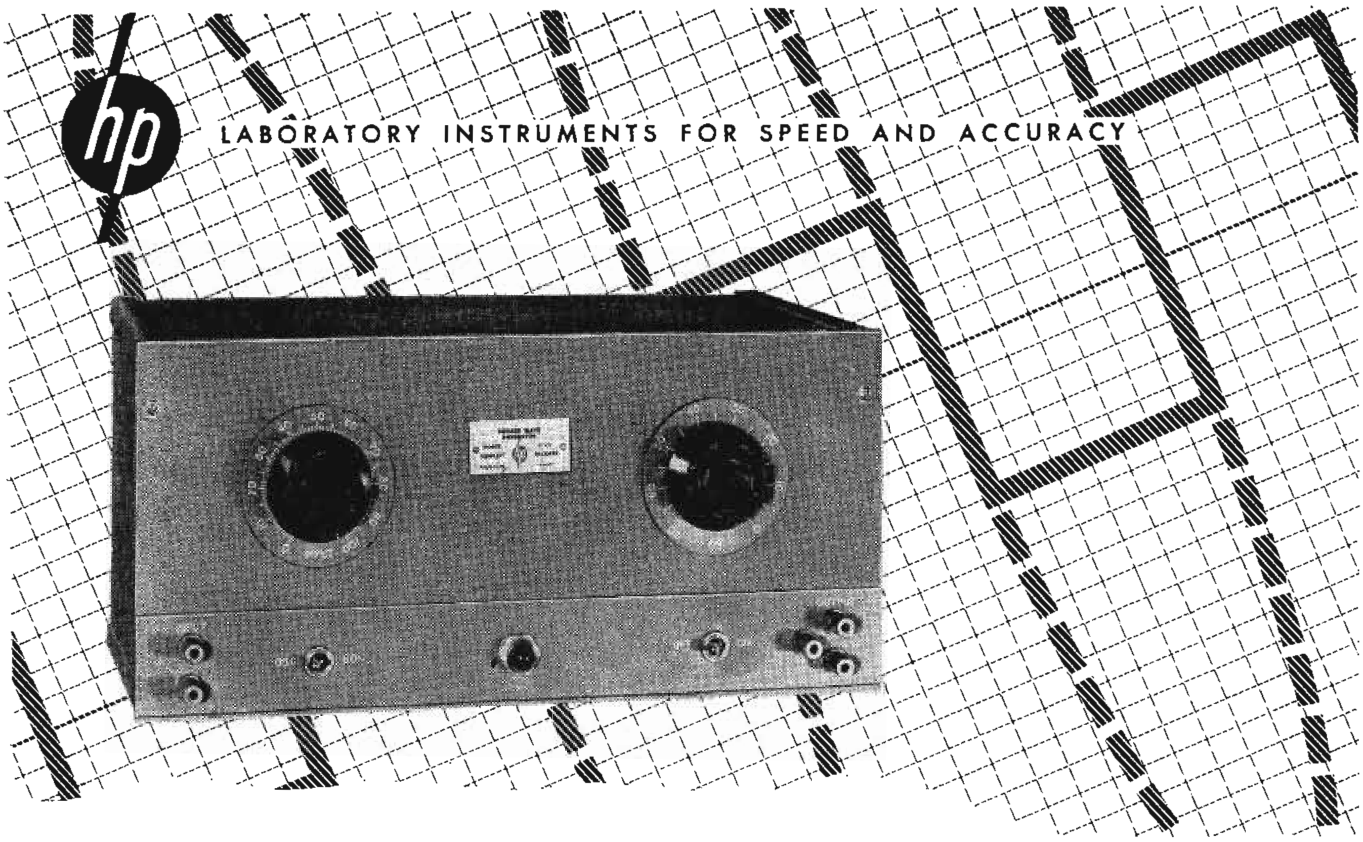

TYPICAL OY4G OY4 OPERATING CIRCUIT

*Radio Receiving Tube Division*

NEWTON, MASSACHUSETTS
NEW YORK • CHICAGO

RAYTHEON MANUFACTURING COMPANY

*Excellence in Electronics*




# TAILOR-MADE WAVES FOR RAPID TESTING

The *-hp-* Model 210A Square Wave Generator is designed to amplify and clip the tops of a sine wave, and thus convert it into a wave which has vertical sides and a flat top. When the square wave voltage is applied to the amplifier or network under test, the shape of the output wave immediately shows up any distortion.

In production testing, one or two observations with an *-hp-* Square Wave Generator will accurately check the frequency response. In development work, the *-hp-* Model 210A shows up phase shift and transient effects, both of which are difficult to study by other methods.

In practice, a wave which appears to be perfectly square will contain 30 or more harmonics; and when the amplitude or phase relation of the harmonics is disturbed, the square wave will be distorted. (See Fig. 1.) Thus the application of a square wave to a circuit shows up any irregularities in amplitude or phase transmission of that circuit, not only at the square wave frequency, but also at frequencies far removed from the test point. These characteristics are particularly important in television video amplifier work.

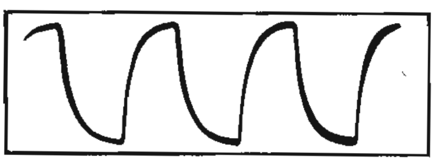


*Fig. 1—Shows the square wave distortion caused by poor high frequency response*

The output of the generator is square within 1 percent over the frequency range from 20 cps to 10,000 cps; a relatively square wave can be obtained even at 100 kc. The frequency response of the attenuator is sufficiently wide so that the output wave shape is not affected even at the highest frequencies. Once proper criteria have been established, the *-hp-* Model 210A Square Wave Generator is the modern, rapid means of production testing, with the speed and accuracy which are characteristic of all *-hp-* instruments.

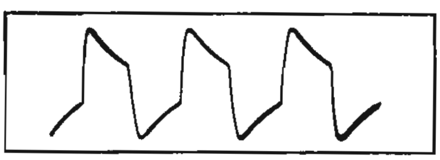


*Fig. 2—Low frequency phase distortion serious in television video circuits*

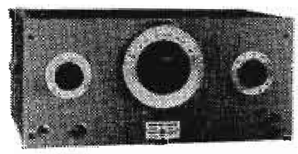
Write for complete details on the Model 210A. Ask for *-hp-* Catalog No. 17B, which includes much valuable information on development and measurements.

## HEWLETT-PACKARD COMPANY

**BOX 1134E • STATION A • PALO ALTO, CALIFORNIA**

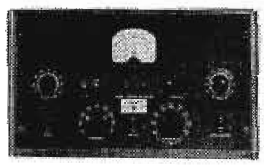
*Audio Frequency Oscillators    Signal Generators    Vacuum Tube Voltmeters*
*Noise and Distortion Analyzers    Wave Analyzers    Frequency Meters*
*Square Wave Generators    Frequency Standards    Attenuators    Electronic Tachometers*

## OTHER -hp- INSTRUMENTS



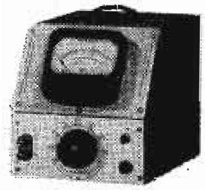
**RESISTANCE-TUNED AUDIO OSCILLATORS**

Require no zero setting . . . Several models available to cover frequency ranges from 2 cps to 200 kc.



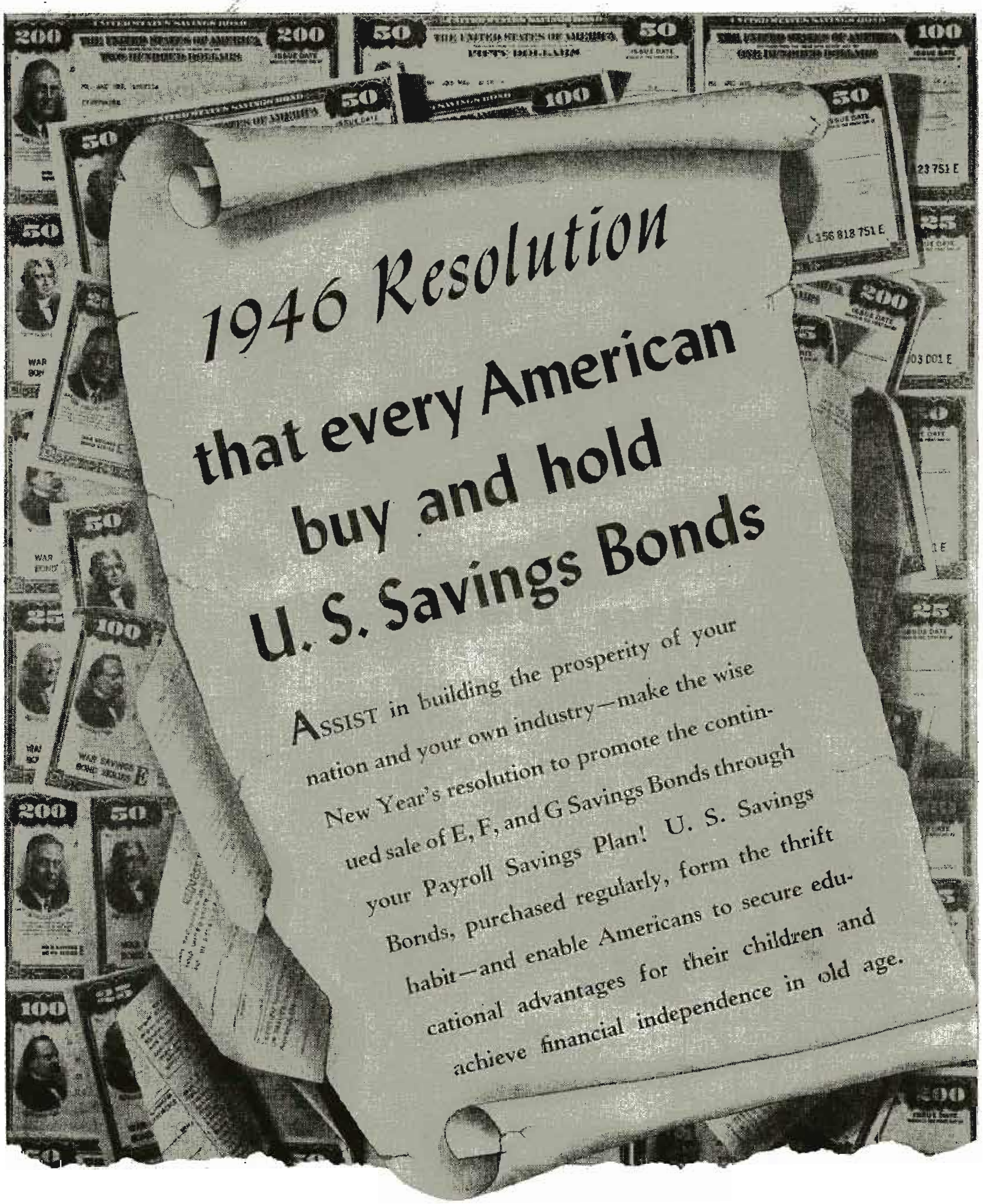
**NOISE AND DISTORTION ANALYZER MODEL 325B**

Combines a vacuum-tube voltmeter with a set of fundamental elimination filters for general purpose measurements of total harmonic distortion, noise and voltage level.



**VACUUM TUBE VOLTMETER MODEL 400A**

Makes accurate voltage measurements from 10 cycles to 1 megacycle, covers nine ranges, (.03 volts to 300 volts) with full scale sensitivity.




*The Treasury Department acknowledges with appreciation the publication of this message by*

**COMMUNICATIONS**

*This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and War Advertising Council*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"Super-Pro
1—FULL COVERAGE
2—VARIABLE CRYSTAL SELECTIVITY
3—VARIABLE I.F. SELECTIVITY
4—FULL BAND SPREAD
5—IMPROVED NOISE LIMITER 6—ADJUSTABLE S METER
FULL COVERAGE .54—30 MC.
Greatly Improved Performance
This is the greatest "Super-Pro" ever offered to the professional or amateur operator. Your new 400 Series "Super-Pro" covers the broadcast band as well as the 10 meter amateur band and its performance is greatly stepped-up through war-time developments.
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MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

# COMMUNICATIONS

LEWIS WINNER, Editor

* * JANUARY, 1946 * *


Figures 1 (below), 2 (right, top) and 3 (right)
Figure 1. Radio-equipped crash truck linked to Martin network.
Figure 2. Hangar control tower used to handle aircraft marine traffic. Figure 3. H-F transmitter and receiver installation on yacht Glenmar IV for patrol of take-off and landing areas.

# THE MARTIN AIRCRAFT H-F TEST NETWORK

## Fixed and Mobile Land, Air and Marine Stations Provide Aircraft Equipment Checks and Traffic Control for Seaplanes and Landplanes During Ground and Air Tests


by FRITZ ALBRECHT

Electrical Tool Engineer, The Glenn L. Martin Co.


WHEN aircraft traffic during tests, regular liner schedules and military take-off flights began to increase daily just prior to the war and then crowd the sky during the war, the development of a radio network at Middle River, Maryland, solved a truly major problem. For with this system, it was possible to expedite plane production and eliminate all airlane schedule bottlenecks. The system also provided for equipment checks on new aircraft and damaged warplanes.

***Development Program***

The factory's location several miles from the take-off of seaplanes area dictated radio control to handle traffic through the restricted approaches. Long before the war a small-scale network was established. This consisted of one radiotelephone transmitter in the factory, on a service boat and on a seaplane tender, operating on 2,612 kc for seaplane traffic control. Simultaneously, it was found necessary to establish direct radio contact with the shore station system of Bell Telephone.

Accordingly, the seaplane tender was equipped with a transmitter capable of contacting any telephone shore station between Boston and Miami. This development was followed by an expansion program for the manufacture of land planes, requiring construc-

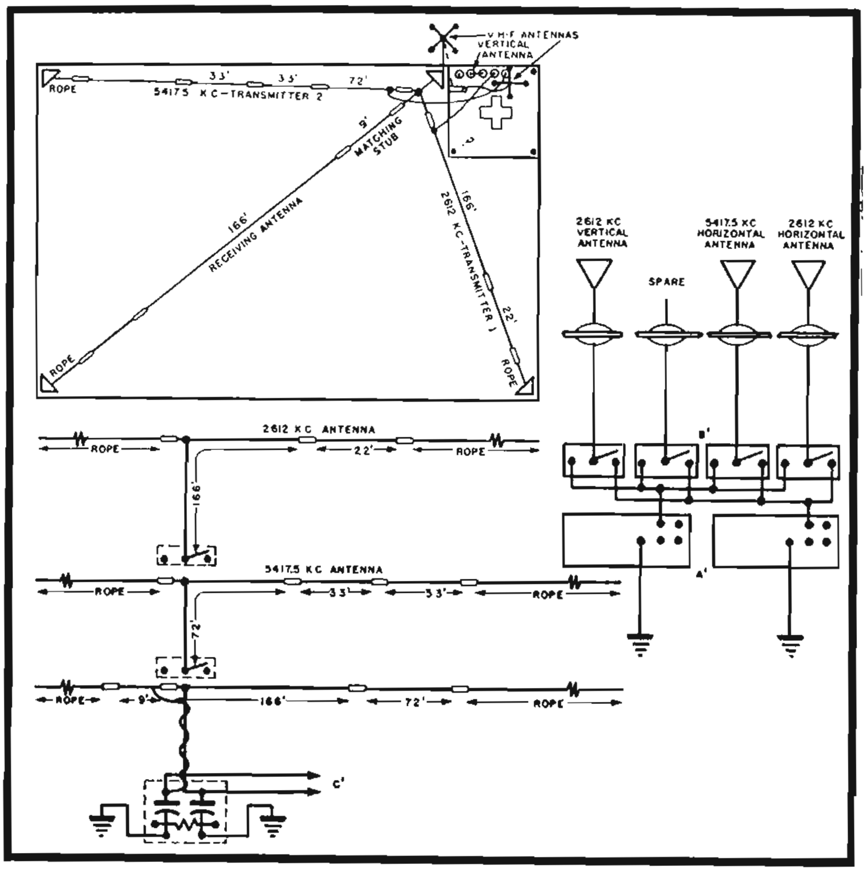



Figure 4

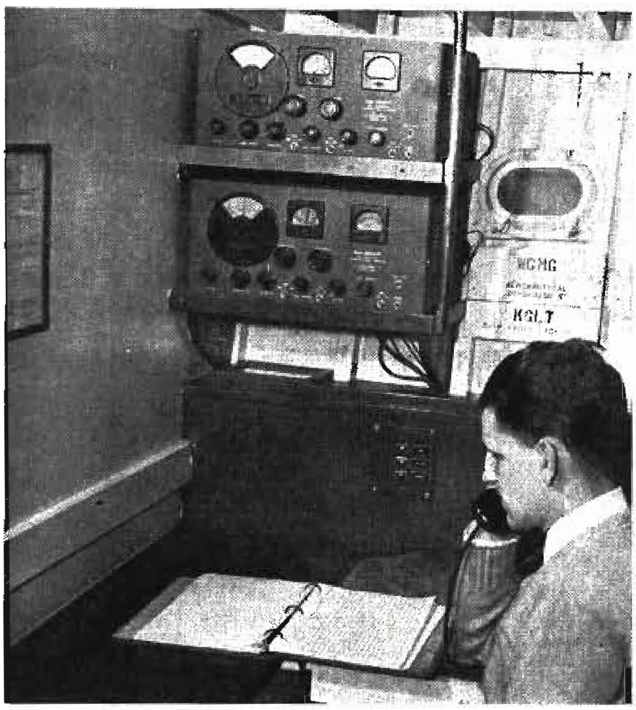
Antennas used at control tower of delivery hangar. *A'*, marine transmitters; *B'*, s-p-d-t knife switch; *C'*, leads to antenna posts on receivers.

tion of an up-to-date airport and control tower necessitating extension of the network. While the land plane development was under way, the seaplane picture did not remain static. Acceleration of production of the Martin Mariner called for expansion of the marine facilities and previous adequate taxi control operations had to be supplemented by radio control of take-offs and landings.

Three radio equipped boats and a marine control tower at the factory launching ramp were added. Shortly before this country entered the war, a second type land plane was produced at a high rate, so that three types of planes were in production. The large number of flights in the immediate vicinity of the plant required close scheduling of land and seaplane operations, augmented by an ever-increasing amount of itinerant traffic. As the factory facilities became crowded, a new seaplane hangar was built with its own control tower, in a relatively ice-free location.

While in terms of commercial airports the amount of traffic handled was not extraordinarily large, it must be remembered that all flights were made by ships fresh off the production line, often requiring landing permission on short notice and preflight taxi tests on the airport's runways or, in the case of seaplanes, in the take-off area. An increasing number of ships were lined up on the parking strips in ground test status requiring radio checks and any one of these ships could be reported ready for flight at any moment.

Thus, traffic control had to be designed for the frequent peak loads in which radio contact and radio checks had to be maintained with up to 30 ships within a 50-mile radius, while giving landing, take-off and taxiing instructions to ships on the ground within the airport and take-off areas. A further burden was the control of ships moving to the airport from two factories on runways crossing arterial highways. At the height of the war seaplane production imposed a severe task on marine facilities. This, in addition to the delivery of battle-damaged seaplanes returned for urgent repairs, required the services of about 28 engineers, operators and maintenance




Figures 5 (left) and 6 (below)

Figure 5. Operating position on the yacht Glenmar III, showing receivers used to guard seaplane frequency and monitor airport control tower frequency. Figure 6. Network monitoring station.

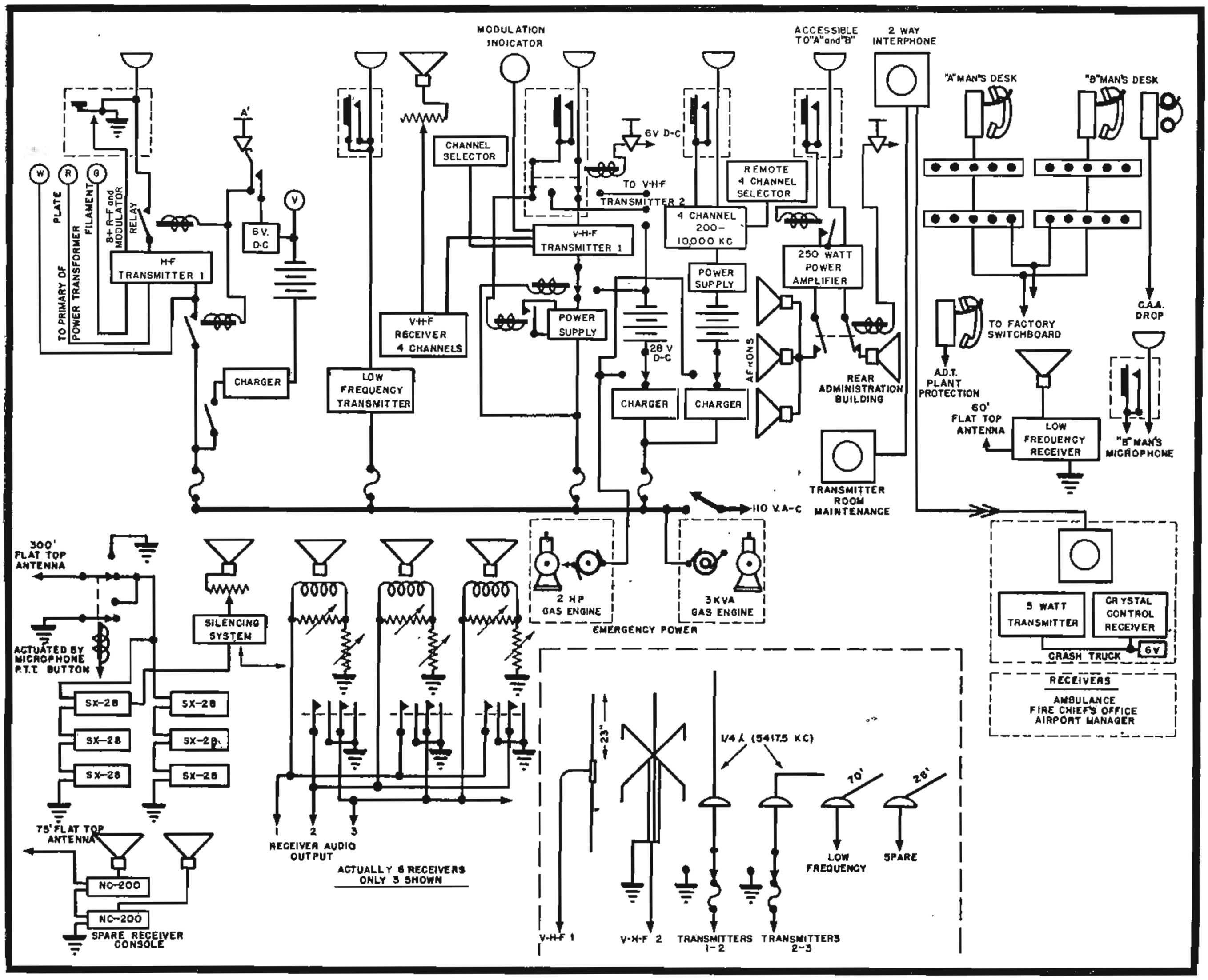



Figure 7
Basic functional diagram of Martin airport control tower. Three transmitters can be operated simultaneously, *A'*. Insert shows types of antennas used for the transmitters.

men for communications purposes exclusively.

In traffic control, two different take-off areas in close proximity must be controlled so as to avoid interference of operations. In addition to production planes, either area must sustain non-scheduled itinerent military and civilian traffic. The urgent need for coordination of all traffic movement was solved by assigning overall control to an *airport control tower.*

Located but a few yards from the final assembly lines is the *ramp control tower* situated immediately at the edge of deep water at the launching ramp. Seaplane movements were controlled initially from this tower, coordinating the launching, beaching and taxiing through restricted waters to the take-off area, about three miles distant from the tower. The airport control tower, about one mile distant, obtained information on ramp tower activities by monitoring the ramp tower frequency, using a direct telephone line for additional information. As the seaplane area was not visible from either tower, information from the seaplane take-off area as to weather, water conditions, ice, landings and take-offs were forwarded on the ramp tower frequency from a service boat in this area. When the seaplane reached the take-off area, it requested and obtained take-off permission from the airport control tower. All CAA system contacts are handled through the airport control tower only to avoid conflictions or duplications.

This coordination permits the airport control tower to closely coordinate all sea and land plane movements in its vicinity. Another control tower at the seaplane hangar about two miles from either of the other two towers, functions in essentially the same manner as the ramp control tower in coordinating the movements of seaplanes in its immediate vicinity.

All land plane operations are controlled directly from the airport control tower.

Itinerant craft, sea or land planes,

Figure 8
Two-way radiotelephone system in cockpit of speedboat for seaplane take-off and landing patrol.

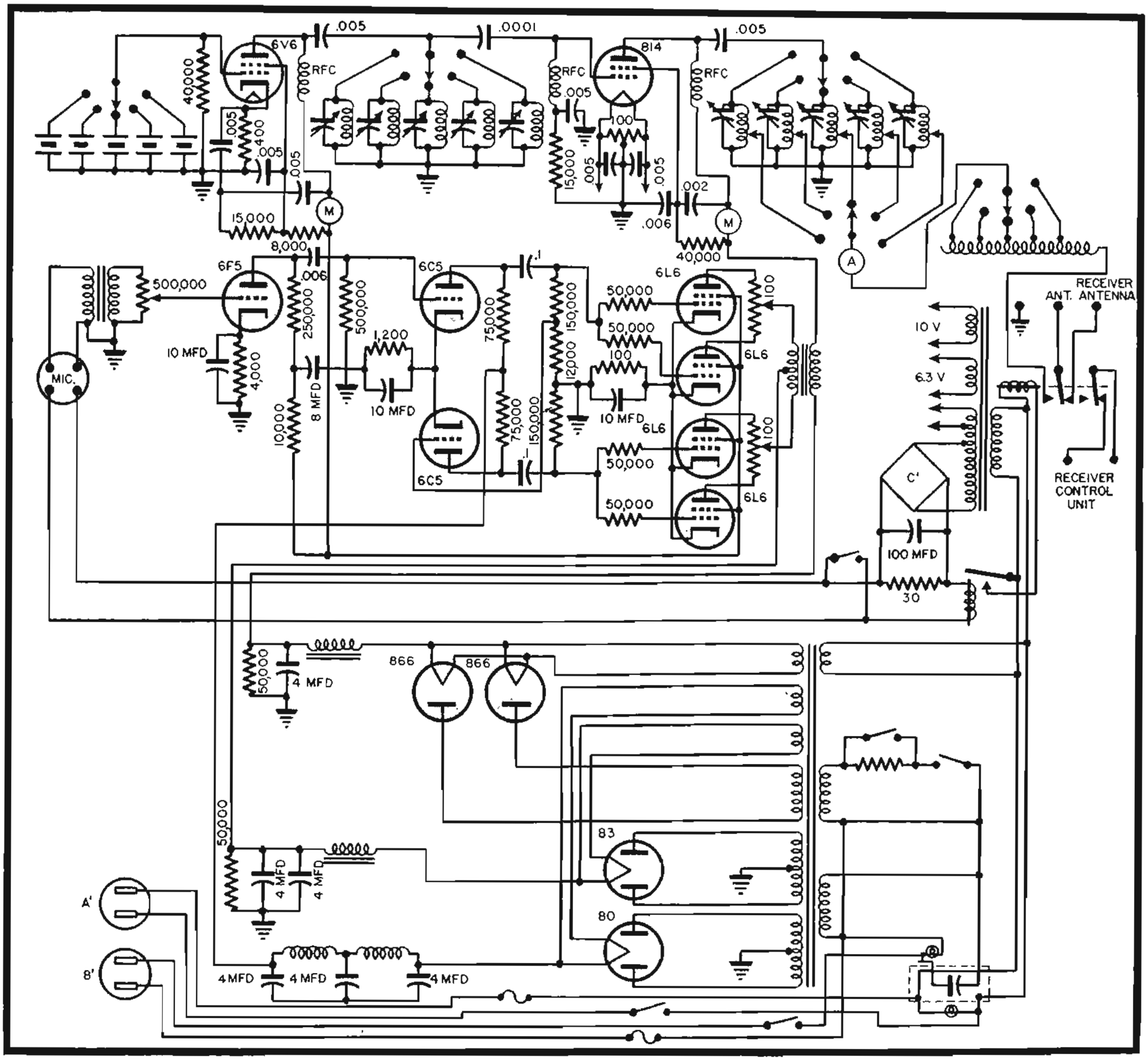



Figure 9
Circuit of 75-watt marine transmitter used aboard ice-breaker. Boat clears away ice-packed areas for take-off. *A'* and *B'* feed to dynamotors. *C'* is a selenium rectifier.

are controlled in all cases from the airport control tower. This tower, however, will delegate control to the ramp or seaplane hangar tower immediately after landing of the craft so that these towers have complete control over taxiing operation within their respective areas.

### Check-Out Facilities

Contractual obligations require that a manufacturer check out all radio equipment before and in flight. For this purpose test calls from the flight line and ships in flight are made to the towers which report back to the ship the quality of the signal. The inspector, from this information, determined if the ship was ready for flight, and in case of a ship in flight, whether it was acceptable for delivery. This involved a close coordination between the tower operations, ground crews, pilots and inspectors, in accordance with checking out procedures developed by the factory tool organization of the company.

### Equipment

The basic idea developed in this network was to provide one frequency for seaplane and another for land plane operations, with the central control point, the airport control tower, monitoring both systems. The airport control tower served in a dual capacity of coordinating the system as a whole and taking care of its own airport traffic.

Thus all towers, seaplane tenders, work-boats, ice-breakers and seaplanes in test or customer flight operate on 2612 kc. All land planes, the airport control tower, ambulance, crash truck and fire chief monitor use 5,417.5 kc for airport land-plane operation. Frequently it was found necessary to assign additional frequencies to test ships or to certain airplane models. However, regardless of the assignment of special frequency, each land plane is able to communicate on 5,417.5 kc. Itinerant planes of either type use commercial and military frequencies in communications with the control tower. Provision was made, therefore, to take care of communications with the small private craft, commercial liner or any of the diversified types which frequent this airport, including foreign military craft.

The airport control tower guards the entire spectrum from the commercial low frequencies to the military v-h frequencies. Transmitting equipment consists of a 50-watt low-frequency transmitter, four 80-watt multichannel h-f transmitters, and three 25-

watt multi-channel v-h-f transmitters. In case of power failure both h-f and v-h-f units can be operated instantaneously by storage battery operated equipment. One *all-wave* tuneable, six h-f tuneable receivers and three four-channel v-h-f crystal-controlled receivers are in operation in addition to spares. Transmitter and receiver controls were designed so that the traffic dispatcher need not move from his position.

#### Receiver Features

A silencing switch was incorporated to silence all receiver loudspeakers, except the one on which the operated switch is located. Thus, if trouble arose on one channel, or if very weak signals were received, complete attention could be focused on the selected channel. Modulation indicators were installed on v-h-f frequencies to permit close control of the tower transmission, which formed the basis upon which inspectors and pilots may accept or reject an airplane. For the purpose of evaluating plane transmission quality all h-f receivers feed individual *S* meters on the tower operator's main desk. The direction finder equipment at the airport control tower is of the *all-wave* military ground-station type. While valuable in cases of low visibility, one of its incidental functions is to ascertain the location of transmitters which due to careless or faulty operation might be *on* and *jam* operations. Considering the large number of airplanes in ground test status in the immediate vicinity of the tower, this condition caused considerable disturbance and at times made for hazardous conditions. Quick spotting of the offending ship by telescope mounted on the direction finder and informing the ground crew by a 250-watt loudspeaker system minimized hazards.

Contact with the crash truck is maintained by an interphone system which disconnects itself as soon as the crash truck leaves its station, when a low-power radiotelephone transmitter-receiver retains contact with the airport control tower and also monitors 5,417.5 kc. Receivers monitoring the tower frequency were installed in the chief pilot's office, and in the fire chief's office and in the offices of key personnel. Monitoring of the control tower permitted emergency facilities to start operations immediately upon detection of dangerous conditions which in cases saved valuable time by anticipating direct alarms. The ambulance carries its own radio equipment to permit contact with the airport control tower.

The hangar control tower equipment is similar to the airport control tower, except that no low-frequency equipment is provided and only two each of the h-f and v-h-f transmitters are operated. On power failure a gasoline driven generator furnishes power automatically with a maximum interruption of 5 seconds. Airport and hangar towers have complete meteorological facilities. Telephone connections include normal and emergency private phone lines to the factory switchboard, and interphone systems to the office concerned with plane movements and CAA.

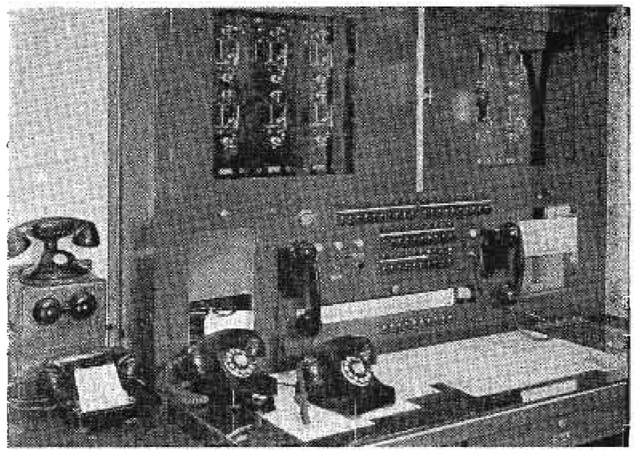


Figure 10
Control board of police and fire-alarm radio communications system.

The ramp tower, located in the factory area, has two h-f transmitters only, as it is primarily concerned with launching and beaching of aircraft. The ramp tower and the hangar tower each contact beaching personnel and anchored seaplanes by means of rotatable directional *bullhorns* fed from a 200-watt amplifier. By this means, the beaching crews are informed of traffic conditions which permit them to prepare the beaching gear and schedule beachings and launchings. The beaching personnel in turn has direct access to the tower by means of interphone communication systems.

#### Marine Services

The operation of a large number of seaplanes requires floating equipment to patrol take-off and landing areas, to transfer passengers and personnel, tools, parts, stores, etc., to and from ships operating in the bay area up to 15 miles distant from the ramps. As the waters from the bay up to the ramp were restricted, all seaplanes had to be escorted, and in winter a path had to be broken through the ice.

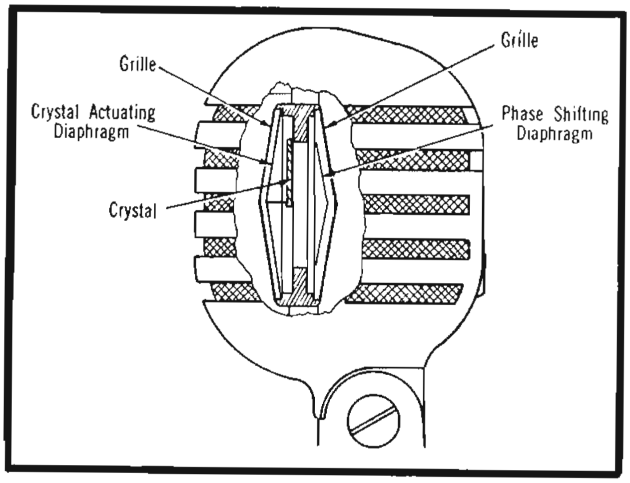
One 100′ diesel-powered seaplane tender was equipped with a h-f radio telephone unit capable of communicating with airplanes, towers, service boats and the Bell Telephone station at any point on the Atlantic seaboard. To round out its deep-sea equipment the tender was equipped with a direction finder.

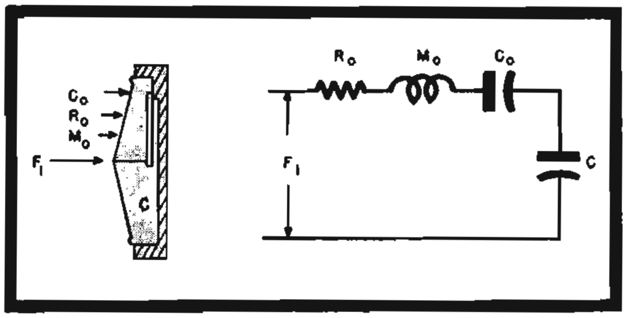
The *workhorses* of the Martin navy are three 50′ heavy duty, high-speed cruisers which have 80-watt systems on three h-f channels to maintain contact with the entire system. The radio equipment on these ships is fed normally from a self-contained power system charged by the main engine generators. Ship's storage batteries may be substituted for radio batteries or vice versa in case of an emergency. All batteries are charged overnight at the dock, but in service a self-contained gasoline-engine driven generator charges the radio batteries if they fall below normal operating level. Duplicate control stations are provided to operate all radio equipment from either the radio room or the bridge. This includes remote control of cranking, choking and stopping of the gasoline driven chargers. The above vessels monitor the airport control tower in addition to their seaplane operation frequencies. For personnel transfers and light tasks three medium-speed and one high-speed work boats with single channel 25-watt h-f radiotelephone equipment, are available.

Another specially designed marine vessel, the ice-breaker, *Ice-Guard,* is available for the purpose of providing a path clear of heavy ice from the ramp to the edge of the ice. This ice is usually near the shore line and fills the arms of the bay, leaving the take-off areas clear. This boat is equipped with a 75-watt, 6-channel h-f radio-telephone transmitter and receiver. One of the channels integrates this vessel into an Army ordnance network for coordination of tests of turrets.

In designing the marine equipment much stress has been laid on interchangeability of transmitters and receivers. As a result, all equipment is 110-volts, 60-cycle a-c operated, power being furnished by battery-driven motor generators. Primary power capacity of one generator supplies receiver and transmitter filament power for 12 hours standby. Then the plate generator is cut in for a total of about

(*Continued on page* 45)




**Figures 1 (above) and 1a (left)**
Figure 1. Pressure microphone and its equivalent mechanical circuit.
Figure 1a. Cross-sectional view of unidirectional crystal microphone.

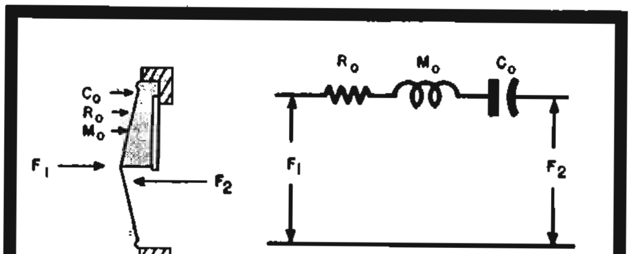
# A UNIDIRECTIONAL

**An Analysis of a Single Transducer Unidirectional Microphone, Employing the Mechanophase Principle, Which Combines Some of the Characteristics of a Pressure Gradient Microphone with Other Characteristics of a Pressure Microphone to Produce Unidirectivity.**


**by A. M. WIGGINS**

**Research Director, Electro-Voice, Inc.**


UNIDIRECTIONAL microphones have long been used satisfactorily to reduce noise, feedback, and reverberation. The first unidirectional microphones combined a bidirectional pressure gradient unit with a non-directional pressure unit to produce unidirectivity. Many of these combinations have been in use employing ribbon[1], dynamic[2], crystal[3], and condenser[4] types. A unidirectional microphone using only one transducer and employing an acoustic phase-shifting network was introduced by Bauer[5] which considerably simplified the construction of unidirectional microphones. In this design the back of the moving element is open to the atmosphere through an acoustical phase-shifting network This is a type of pressure gradient microphone, and the force available for actuating the moving element is proportional to frequency.

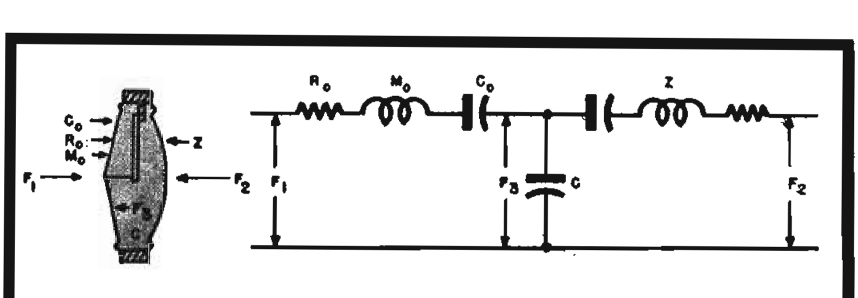



Figures 2 (left) and 3 (below)
Figure 2. Bidirectional pressure gradient microphone and its mechanical circuit. Figures 3, Unidirectional microphone and its equivalent mechanical circuit.

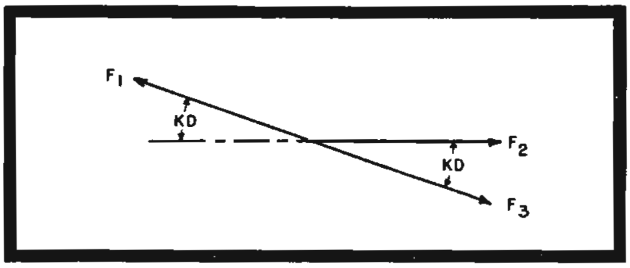
### *Pressure Gradient Microphones*

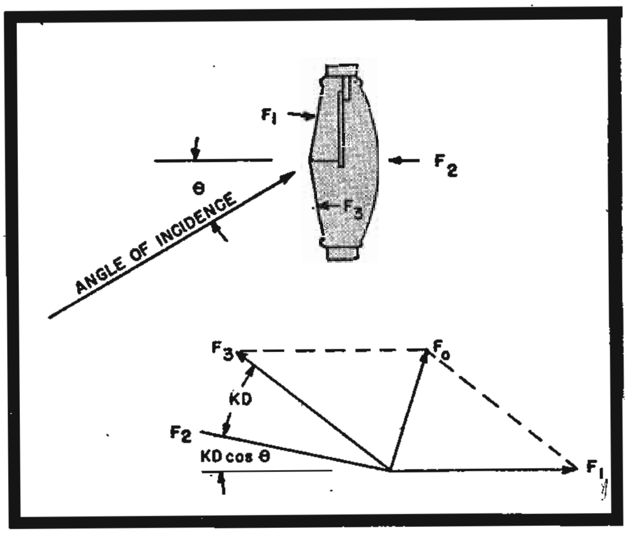
A pressure microphone is one which has its back completely enclosed and is nondirectional. In Figure 1 is shown a pressure crystal microphone and its equivalent mechanical circuit. $R_o$ is the resistance associated with the diaphragm and crystal, $M_o$ the effective mass of the diaphragm and crystal, $C_o$ the compliance of the diaphragm and crystal, and $C$ the compliance of the volume of air back of the diaphragm. The back of the case presents an infinite impedance to sound. In this microphone the force on the diaphragm is independent of frequency. A pressure gradient bidirectional microphone and its mechanical circuit appears in Figure 2. Here the back of the diaphragm is open, presenting zero impedance to sound, so that the microphone responds to a difference of pressure between the front and back of the diaphragm and is thus bidirectional. The resultant force in this case is proportional to frequency.

If, instead of a pressure microphone with an infinite impedance leading to the back of the diaphragm or a pres-




[1]Weinberger, Olson and Massa, *Journal of the Acoustical Society*; October 1933
[2]Marshall and Harry, *Journal of the Acoustical Society*; April 1941
[3]Patent 2,184,247
[4]Patents 2,093,664, 2,126,437
[5]Bauer, *Journal of the Acoustical Society*; July 1941




Figures 4 (above) and 5 (right)
Figure 4. Vector diagram of forces of sound arriving on the axis from the rear. Figure 5. Vector diagram of forces for any angle of incidence.

# CRYSTAL MICROPHONE

sure gradient with zero impedance leading to the back, we have a microphone with the back covered with a mechanical impedance of the right value, the combined characteristics of pressure and pressure gradient microphones will prevail; that is, it will be unidirectional. This is accomplished by placing a damped dead diaphragm over the back of the microphone case. At the low frequencies the stiffness of the dead diaphragm is the controlling factor producing a high mechanical impedance. Therefore the microphone operates as a pressure microphone and is nondirectional. The force on the diaphragm at low frequencies is independent of frequency, while at higher frequencies it operates as a pressure gradient microphone and becomes unidirectional if the mechanical impedance of the dead diaphragm is of the right value. This allows the microphone to sacrifice unidirectivity at the low frequencies for increased level at these frequencies.[1]

A microphone with a damped dead diaphragm and its mechanical circuit is shown in Figure 3. $F_1$ is the force on the front of the live diaphragm, $F_2$ the force on the front of the dead diaphragm, and $F_3$ the force on the back of the live diaphragm. $F_2$ is displaced in phase from $F_1$ by an angle $KD \cos \Theta$ (Figure 4) and is in the opposite direction where $K$ is $2\pi/\lambda$, $D$ is the acoustic distance between the front and back diaphragms, $\lambda$ is the wave length and $\Theta$ is the angle of incidence. $Z_o$ is the mechanical impedance of the live diaphragm and crystal, $Z$ the mechanical impedance of the dead diaphragm, and $C$ the mechanical compliance of the volume of air between the two diaphragms.

[1](*A curve of both the front and back response is shown in Figure 7. There is still some unidirectivity even at a frequency as low as* 100 *cps.*)

### Calculation of Dead Diaphragm Mass and Resistance

To calculate the characteristics of the dead diaphragm which will produce unidirectivity, the mechanical circuit shown in Figure 3 is applied. The dead diaphragm must have a mass, $M$, and a mechanical resistance, $R$, so that for sounds arriving from the rear along with the axis, the force on the back of the live diaphragm will be equal and opposite to the force on the front of the live diaphragm.

In Figure 4 we have a vector diagram of the forces acting on the microphone for sounds arriving from the rear along the axis. $F_2$ is the force acting on the front of the dead diaphragm, $F_1$ the force acting on the front of the live diaphragm displaced by an angle, $KD$, from $F_2$, and $F_3$ the force acting on the back of the live diaphragm. The force actuating the live diaphragm is $F_1 + F_3$ which in this case, for sound arriving from the rear along the axis, is zero. For this condition the velocity of the diaphragm is zero. Then

$$\frac{F_2}{F_3} = \frac{Z + X_c}{X_c} \qquad (1)$$

The phase displacement between $F_1$ and $F_2$ is $KD$.

Assuming $F_3 = -F_1$, then $F_2 = F_3 e^{jKD}$ (2)

$$\text{and } \frac{F_3 e^{jKD}}{F_3} = \frac{Z + X_c}{X_c} \qquad (3)$$

If we neglect the stiffness of the dead diaphragm, then

$$C^{jKD} = \frac{R + j\omega M - \dfrac{j}{\omega C_M}}{-j/\omega C_M} \qquad (4)$$

The acoustic capacitance of the volume between the two diaphragms is

$$C_A = \frac{V}{\rho c^2}$$

where $V$ is the volume, $\rho$ the density of air, and $c$ the velocity of sound. The value of the mechanical compliance of this volume is

$$C_M = \frac{V}{\rho c^2 A^2}$$

where $A$ is the area of the diaphragms. By substituting this in equation (4) and writing the unit vector in a different form, the equation becomes

$$\cos KD + j \sin KD = 1 - \frac{\omega^2 MV}{\rho c^2 A^2} + j \frac{\omega R V}{\rho c^2 A^2} \qquad (5)$$

By separating real from imaginary quantities, two equations are obtained:

$$\cos KD = 1 - \frac{\omega^2 MV}{\rho c^2 A^2} \qquad (6)$$

$$\sin KD = \frac{\omega R V}{\rho c^2 A^2} \qquad (7)$$

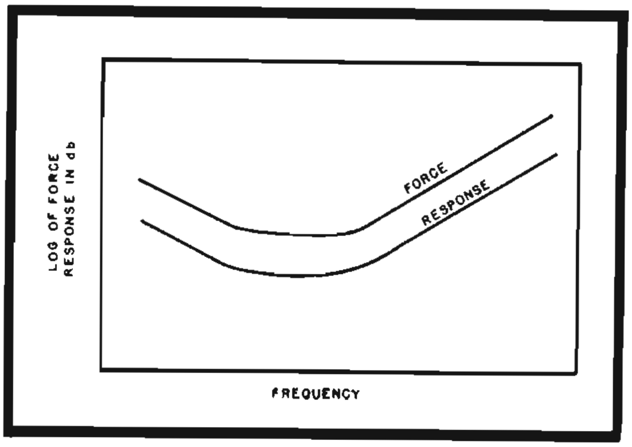



Figure 6

Variation of force and response with frequency. Since the voltage of a crystal microphone is proportional to displacement, and it is stiffness controlled, the frequency response will follow the curve of force, as we see in this plot.

For small angles sin KD = KD and since $K = \omega/c$

$$\frac{\omega D}{c} = \frac{\omega R V}{\rho c^2 A^2} \qquad (8)$$

From this equation the mechanical resistance of the diaphragm must be

$$R = \frac{D \rho c A^2}{V} \qquad (9)$$

for unidirectional action of the microphone.

If $KD << 1$, the cosine of the angle $KD$ may be written

$$\cos KD = 1 - \frac{(KD)^2}{2}$$

$$= 1 - \frac{\omega^2 D^2}{2 c^2} \qquad (10)$$

From equation (6) the cosine of the angle may also be written

$$\cos KD = 1 - \frac{\omega^2 M V}{\rho c^2 A^2}$$

$$= 1 - \frac{\omega^2 D^2}{2 c^2} \qquad (11)$$

From this equation the mass of the dead diaphragm must be

$$M = \frac{D^2 \rho A^2}{2V} \qquad (12)$$

for unidirectional action of the microphone.

#### Aluminum Diaphragms

A diaphragm with a mass of the correct value may be obtained by using an aluminum diaphragm with an effective mass equal to the desired value. A resistance of the right value may be obtained by damping the diaphragm either with a perforated shield over which is cemented a piece of cloth or by placing a piece of sponge rubber between the shield and the diaphragm. It may be noticed that the mechanical impedance of the live diaphragm or the crystal has nothing to do with the unidirectional action of the microphone.

#### Polar Response

A diagram of the microphone, with a more generalized vector diagram for any angle of incidence, is shown in Figure 5. $F_1$ is the force on the front of the live diaphragm, and $F_2$ is the force on the front of the dead diaphragm which is displaced by an angle KD cos $\theta$, where $\theta$ is the angle of incidence of the sound. $F_3$ is the force on the back of the live diaphragm which is always displaced by an angle KD from $F_2$ due to the action of the mechanical impedance of the dead diaphragm. The vectorial sum of the forces acting on the front and back of the live diaphragm is equal to the resultant force, $F_o$, on the diaphragm. The equation for the phase relation of the force on the back of the diaphragm to the force on the front may be written:

$$F_3 = -F_1 e^{-j(KD + KD \cos\theta)};$$

then

$$F_o = F_1 + F_3 = F_1 - F_1 e^{-j(KD + KD \cos\theta)}$$

#### Force on Diaphragm

For small angles of $KD$ the force on the diaphragm is

$$F_o = KD\, F_1 (1 + \cos\theta)$$

This equation shows that the force on the diaphragm is proportional to frequency and the polar response is a cardioid. Owing to the effect of stiffness in the dead diaphragm, its impedance increases at the very low frequencies causing the microphone to act as a pressure microphone at these frequencies, and the force on the diaphragm is then independent of frequency. A curve showing the force on the diaphragm versus frequency is shown in Figure 6.

#### Frequency Response and Force

Since the voltage of a crystal microphone is proportional to displacement, and it is stiffness controlled, the frequency response will follow the curve of force, as we see in Figure 6. Compensation must be used in the microphone to level the response at the point it becomes a pressure gradient microphone and the response starts to rise. Since the response is rising 6 db per octave at the higher frequencies, a simple $RC$ filter, with the opposite characteristics of the microphone, is used to give a flat response. Since filtering action need not start until the response starts to rise with frequency, it is possible to obtain a higher level than would be possible with a strictly pressure gradient unidirectional microphone.

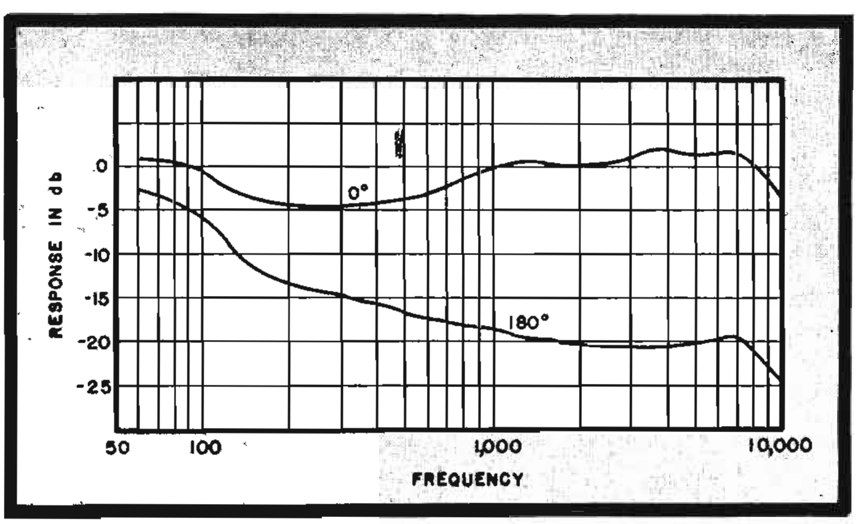



Figure 7

Front and back response. Note that there is some unidirectivity even at a frequency as low as 100 cps.

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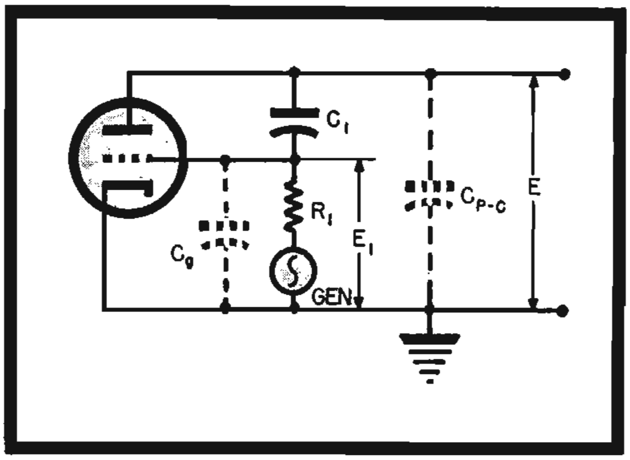



Figure 1
Fundamental reactance circuit. The output capacity $C_{p\text{-}c}$ is quite important, because the injected reactance shows across this capacity, and the final total reactance obtained is limited by the magnitude of this fixed parallel reactance.

# WIDE-ELECTRONIC

## Variable Frequency 500-kc to 110-mc Test Unit Developed For Television Receiver Alignment and Generator Calibration

by A. D. SMITH, JR.

Senior Engineer, U. S. Television Mfg. Corp.

IN the design and development of various kinds of amplifiers, with frequency ranges of from a few cycles to several hundred megacycles, it has been found necessary to use a variety of test equipment for alignment and general servicing. It was found that no one unit would do more than a very limited amount of the testing that was actually required. A project of designing a radar receiver several years ago in which the i-f was 15 mc emphasized this problem. At the beginning of the project ordinary calibrated signal generators were used. These necessitated making many band-width measurements by the cumbersome and outdated point-to-point method. After struggling with this procedure for a short time, a search was made for a sweeper that would give a picture of the overall band-pass characteristic at a glance. It was discovered that there was none available, in spite of the fact that some had been made before the war for alignment of television i-f and r-f amplifers. It seems that production on all of these equipments had been discontinued. Accordingly a study was made of the method of using a reactance-tube modulator to cause an oscillator to sweep a band of frequencies. As a result of this analysis, a fixed-frequency (15 mc) electronic sweeper was developed. The unit provided a ±2½-mc sweep giving a total swept bandwidth of 5 mc. For the work at hand this instrument proved to be entirely satisfactory, but the need for a variable frequency instrument soon became evident when the section of the radar project was considered. To meet this condition, the harmonic output of the 15-mc sweeper was used.

At the conclusion of the war, when civilian equipment design activities were initiated, the test equipment problem appeared again. This was particularly true in a television-receiver project assigned to the writer. The test unit had to be flexible, stable and portable. There was nothing available, in a size that could be called portable, which would sweep a sufficient bandwidth and which would also cover all of the portion of the frequency spectrum used for television. It was thus necessary to develop one. The frequencies required were the complete range between 60 cps and 110 mc. However, as it turned out, the lower frequency portion had to be omitted. The final instrument covered the 500 kc to 110 mc range.

### Design Problems

Sweepers used on various occasions had several disadvantages such as instability, no output attenuator, etc. An attempt was made to overcome all of these problems. There are no doubt some disadvantages in the instrument finally developed, but there is a finite limit to the amount of work that can be done in a certain amount of space, and the compactness and portability

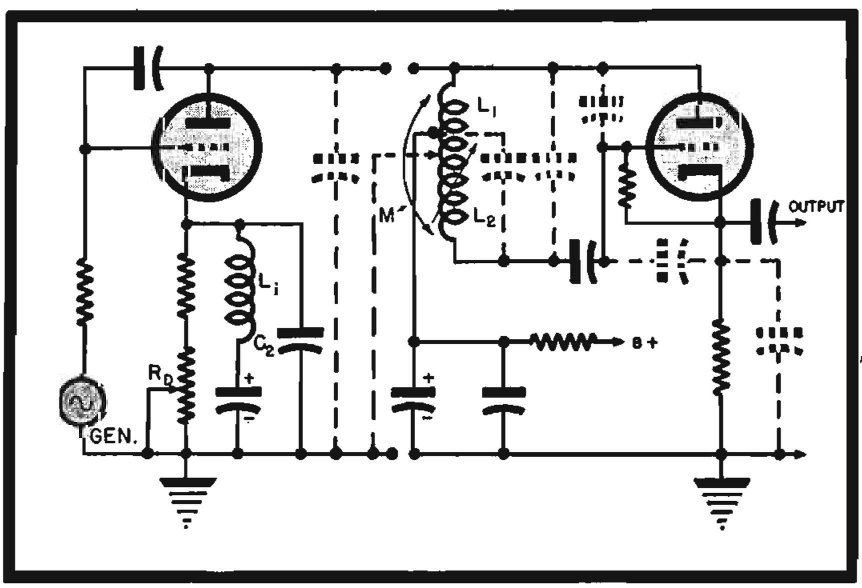



Figure 2
Overall reactance oscillator circuit. It will be noted that the greater portion of the reactance in the grid circuit has been eliminated.

# RANGE SWEEPER

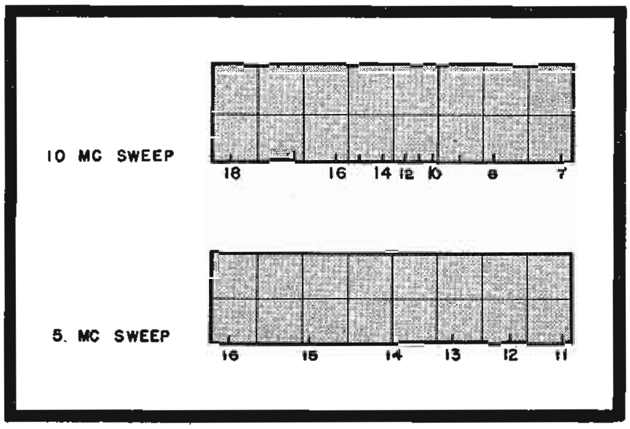



Figure 3
Linearity characteristics of the electronic sweeper. It will be noted that then sweeping the wider range (11 mc), a portion of the overall characteristic is crowded as compared to both sides of the region. The reactance tube bias adjustment is used to set this narrower position near the center of the overall sweep.

more than compensate for any trivial disadvantages.

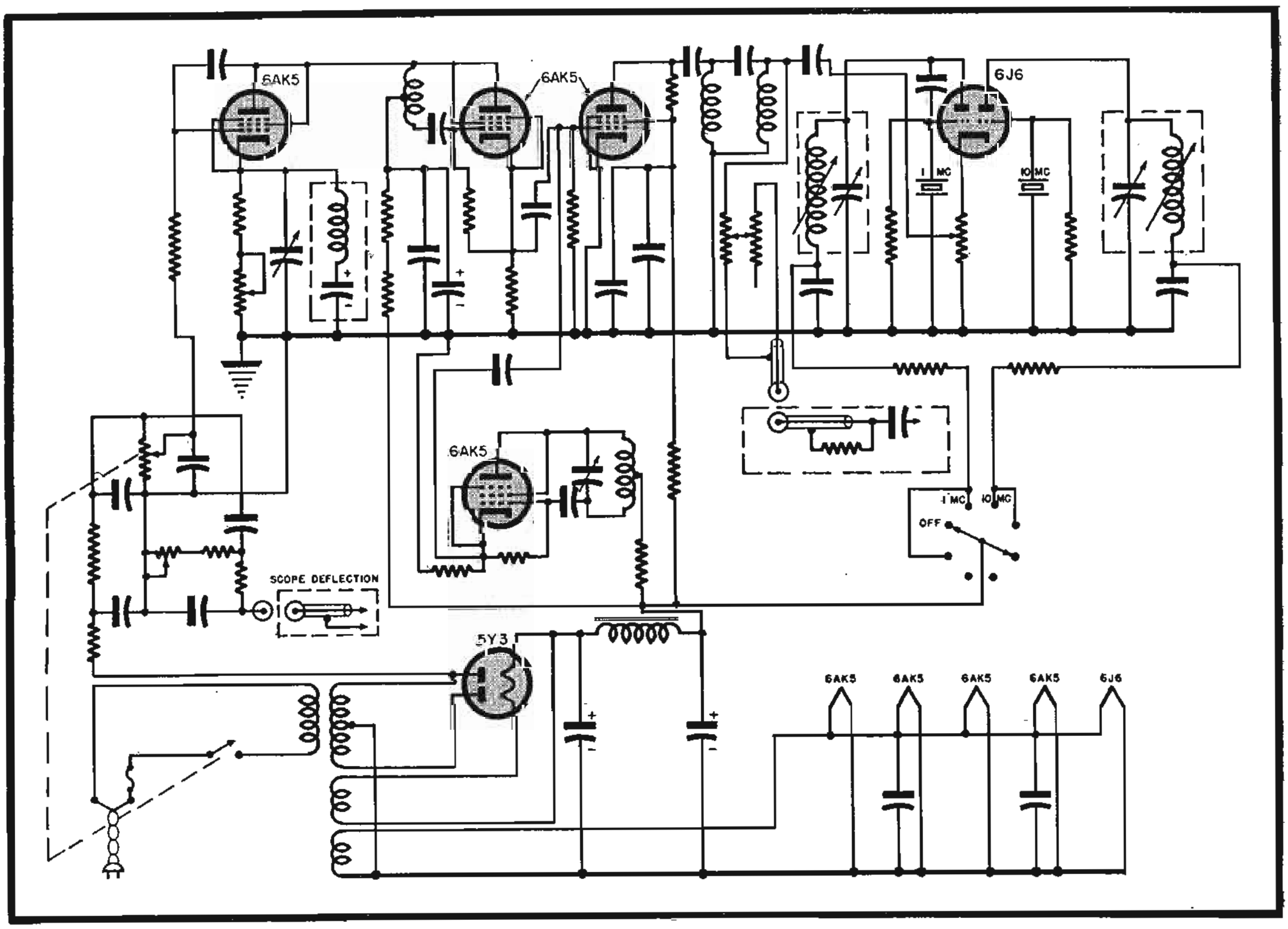
One of the principal objections to present wide-band sweepers is that, inasmuch as they use some form of mechanical or electromechanical frequency modulator, they are subject to vibration, particularly when their frequency modulation is small. In this instrument as in any other, the stability is still a function of the bandwidth swept, but the initial stability is sufficiently great so that the most narrow bands are swept without appreciable *jitter* due to mechanical vibration.

### Instrument Requirements

In designing the sweep, six factors were considered: (*1*)—The r-f band to be covered was to be as low a frequency as possible (which turned out to be 500 kc to 110 mc); (*2*)—the sweep width at any point in this band was to be a minimum of 8 mc (which turned out to be 10 mc) and adjustable down to something under 100 kc (which turned out to be about 5 kc) for alignment of narrow band receivers; (*3*)—the output over the swept band at any frequency was to be constant within ±10%; (*4*)—the output was to be 100 ohms resistive; (*5*)—size was to be kept to minimum; and (*6*)—all equipment and functions necessary to the operation of the instrument (such as power supply, cables, cable terminations, oscilliscope horizontal deflection, etc.) were to be self-contained.

The first consideration was a choice of tubes for the reactance tube (in some applications called *quadrature* tube) and the reactance oscillator tube. It is necessary to use an oscillator tube

Figure 3a
Circuit of the electronic sweeper. A limiter stage has been included to maintain a satisfactory constant output over the 10-mc sweep range at any frequency.



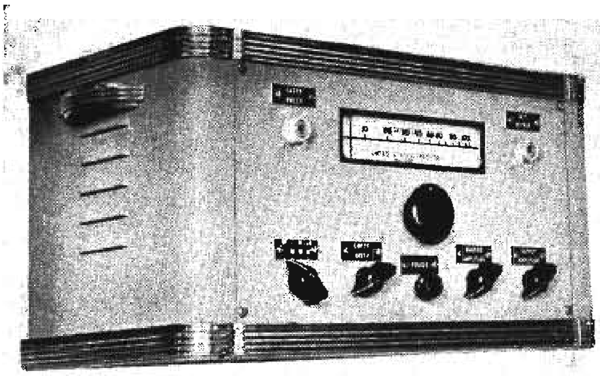


Figure 4
The final laboratory model of the electronic sweeper. The main tuning dial is calibrated in megacycles with marks at 10-mc points. This procedure was adopted because two crystal-marker oscillators operating at 1 and 10 mc are used in the unit.

which operates well at high frequencies, that is, frequencies above 100 mc and up to 200 mc or slightly higher. The 9002 is a very good tube for this range, as is the 1201 or 6J4. There are other tubes, such as the 446 or 717, which operate well at the frequencies required, but these tubes all require circuits which are physically cumbersome. In the present case it was considered best to try the 6AK5, due to its high $G_m$ and also because its output capacity is fairly low. This tube is a sharp cut-off tube with a little higher output capacity than the 6AG5, which, in turn, has a little higher input conductance than the 6AK5. As a matter of fact, the 6AG5 was chosen for the reactance tube for these reasons.

#### Reactance Tube Selection

In the choice of a reactance tube, high dynamic value of $G_m$ is an important factor. This is necessary because the grid voltage, which is normally low, (being phased by a phase shifting network from the reactance oscillator itself) must cause as high an out of phase injection to the oscillator, as possible.

The linearity of the tube should be good over the entire range from near zero bias to cut-off, in order that the amount of swing on each side of the unmodulated dynamic operating point be linear and equal in both directions.

Inasmuch as it is the magnitude of the plate current of the reactance tube which causes the frequency deviation of the oscillator, the reactance tube chosen should also have good power amplification. Besides these considerations it is necessary that the tube used have low inter-electrode capacities because the operating frequency is rather high. One important capacity in the fundamental circuit, Figure 1, is the output capacity $C_{p-c}$, because the injected reactance shows across this capacity, and the final total reactance obtained is limited by the magnitude of this fixed parallel reactance. The same reasoning applies in the reverse direction to the grid (input) capacity $C_g$. In this case, the phase shift impressed upon the grid would be limited by the fixed parallel reactance of the grid itself.

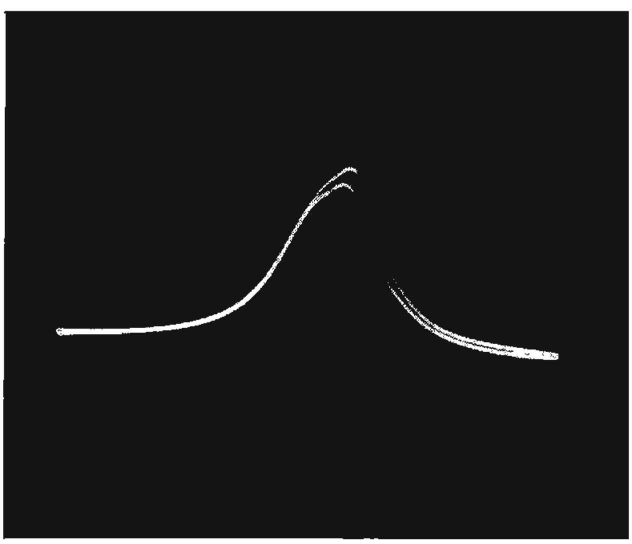
In the reactance circuit finally adopted, Figure 2, the greater portion of the reactance in the grid circuit was eliminated. A tuned circuit was inserted in the cathode to change the reactance to ohmic resistance. This tuned circuit consists of an inductance, $L_1$ (placed in series with the low-frequency bypass capacitor), which is resonated by the cathode capacity of the tube. So that a sweep-width adjustment would be available for production setting at slightly over 10 mc this inductance was made to be slightly smaller than necessary to resonate only the tube capacity. A small trimmer capacitor, $C_2$, was placed across it for an internal sweep-width adjustment. It should be pointed out that the circuit used is by no means limited to a sweep width of 10 mc. During the preliminary stages of construction sweep widths of over 20 mc were obtained. However, a sweep width of 10 mc is ample for television and f-m work, and thus the instrument is adjusted for this width in production.

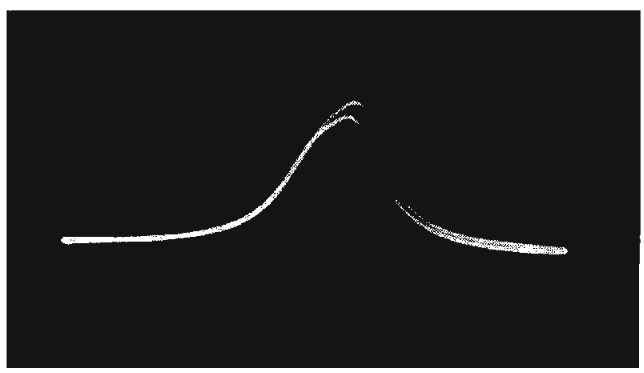
Inasmuch as the mathematical analysis of reactance tubes becomes rather lengthy, and since space is limited, the exact formulas will not be examined here. For reference, the writer recommends August Hund's book *Frequency Modulation*.

So that the reactance modulator tube can operate over the most linear portion of its characteristic, bias must be used. In the present case, cathode bias was used, and the cathode resistor bypassed. Thus the 60-cycle component could be used most efficiently for deviating the frequency of the oscillator. The low-frequency bypass capacitor must be placed in series with the inductance to resonate the cathode circuit at or near the carrier frequency. A potentiometer, $R_p$, was inserted for bias control on the reactance tube.

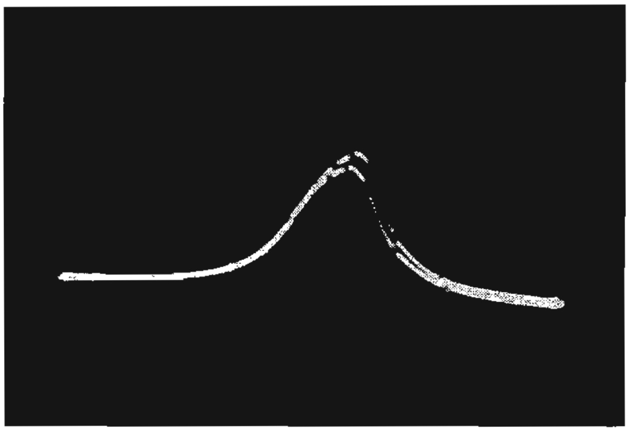
Since the potentiometer has a rather high capacity between either side and ground, a fixed resistor, $R_c$, was inserted between the potentiometer and the cathode so as not to short circuit this capacity. This fixed resistor is also used for the purpose of maintaining a rated minimum bias on the tube regardless of the setting of the potentiometer.

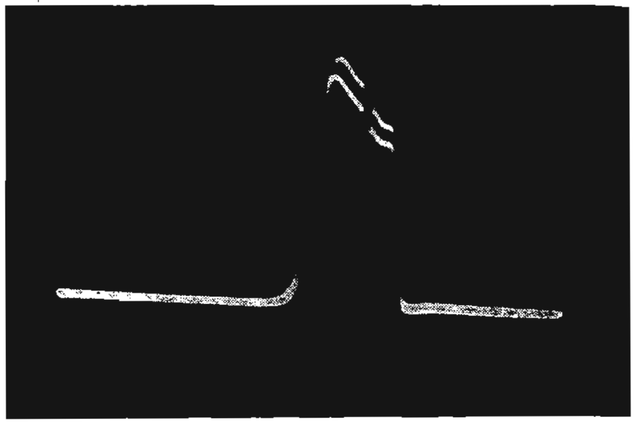
The chart, Figure 3, shows the linearity characteristic of the sweeper. It can be seen that when sweeping the wider range (in this case, 11 mc) a





Figures 5 (left) and 6 (above)
Figure 5. Trace of the last i-f stage of a television receiver with the sweeper connected to the grid of the last amplifier tube, and an oscillograph connected to the output of a diode detector. Figure 6. The same trace with the 10-mc mark turned on.





Figures 7 (left above) and 8 (right above)

Figure 7. The same trace shown in Figure 6, but with 1-mc markers turned on; this trace was used to plot the chart of Figure 3. Figure 8. The overall response characteristic of the same receiver used in making the previous traces.

portion of the overall characteristic is crowded as compared to the sweep on both sides of this region. The reactance tube bias adjustment is used to set this narrower portion near the center of the overall sweep. The crowding disappears when sweep widths of the order of 5 or 6 mc are used, because the reactance tube is not being driven beyond its most linear characteristic. This can also be seen in the same chart. Before leaving the reactance modulator and oscillator circuit, one other detail should be observed. To keep the efficiency high the center tap on the oscillator tank circuit, $L_1$ $L_2$, must be exactly positioned. Ordinarily, this tap might not have to be bypassed to ground. However, for frequency deviation, some point on the tank circuit must be solidly grounded for both the modulation frequency and the carrier frequency. If this were not done, the deviation would be accomplished in series with one of the tube electrode capacities to ground. Although the oscillator would still function satisfactorily, the deviation would be very limited.

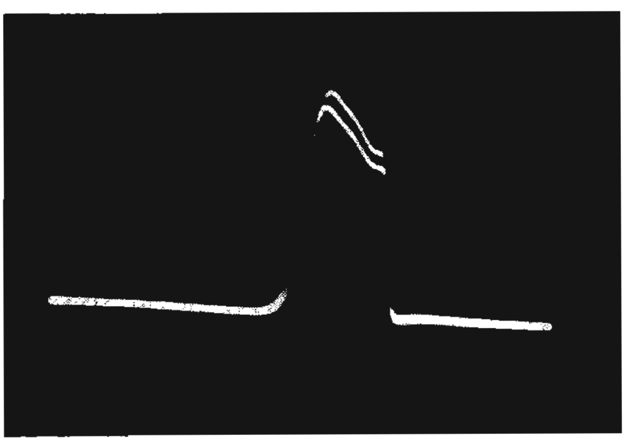
We previously stated that the reactance modulator and oscillator tubes should be selected for high-frequency operation. This is necessary because the bandwidth to be covered, 500 kc to 110 mc, which is an inductive or capacitive change of 14.3 to 1, immediately prohibits the use of fundamental operation and convenient methods of inductive tuning, such as slug adjustment. Fundamental operation and tuning by means of a variable capacitor is prohibited because the tuning capacity would be shunting the injected reactance, and as capacity is added, the deviation would become less. It therefore becomes evident that the reactance oscillator and associated circuits should be fixed at a frequency somewhat above the highest frequency output of the instrument. The frequency chosen was 135 mc. Using this frequency for the reactance oscillator, an adjustable frequency oscillator can be made to operate over the 135 mc to 135-mc range plus 110 mc, or from 135 to 245 mc. This necessitates the use of the heterodyne principle and some kind of mixer.

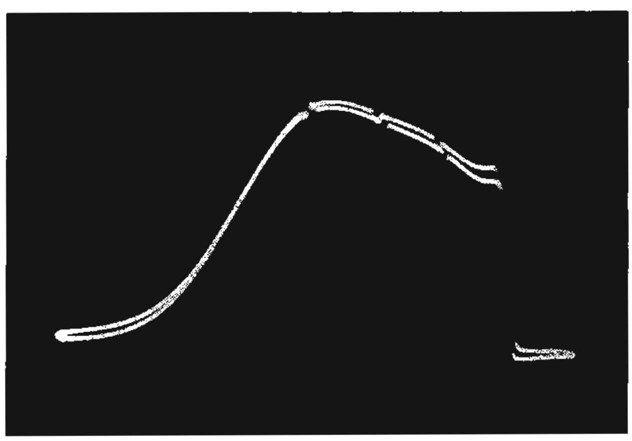
A convenient method of mixing would be the use of a high-frequency dual triode type of tube in which a signal is fed to each grid, the resultant signal being taken from the parallel plates. In this instrument, it was thought advisable to include a limiter stage to maintain as constant an output as possible over the 10-mc sweep range at any frequency. Triodes are inherently not as sharp cut-off tubes as pentodes, and so the choice of one combination pentode mixer and limiter tube was made, rather than two pentode tubes. The mixing is accomplished by the normal grid-leak method, and the limiting is caused by driving the grid from zero bias to beyond cut-off. As an aid to the limiting action the screen and plate voltages are run somewhat below their normal ratings, which gives a lowered output, but an output which is reasonably constant in any one sweeping position. As the output frequency is changed by means of the variable oscillator, the output amplitude changes somewhat because the gain of the mixer-limiter tube changes somewhat. The outputs from the two oscillators are taken from their cathodes to add as little capacity as possible to either of the tank circuits, and also to help the stability of the overall output with regard to frequency drift. Due to the above method of limiting, good harmonic output is produced. This makes the instrument thoroughly satisfactory for use up to 220 mc.

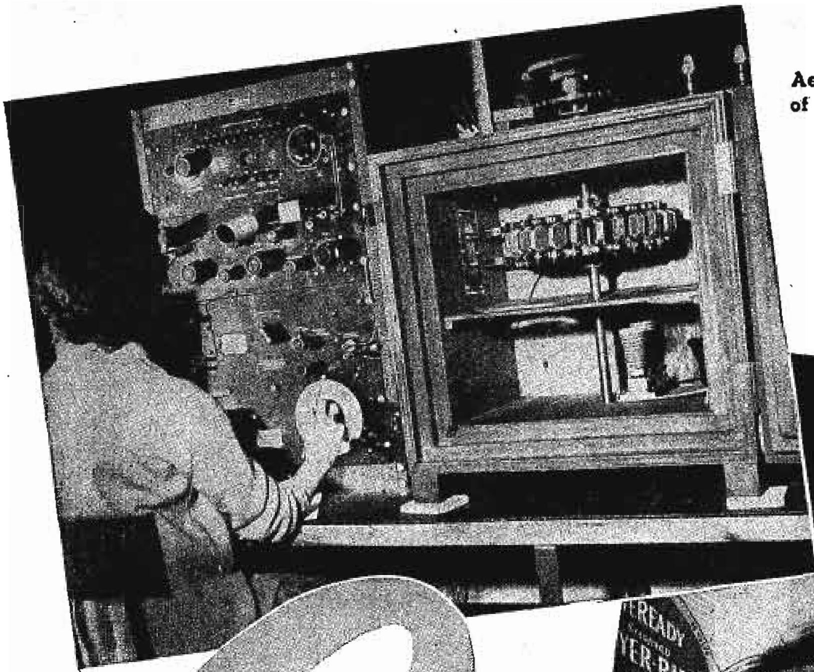
To avoid power supply ripple (or inversely, a large power supply) being superimposed upon the output of the

Figures 9 (left below) and 10 (right below)

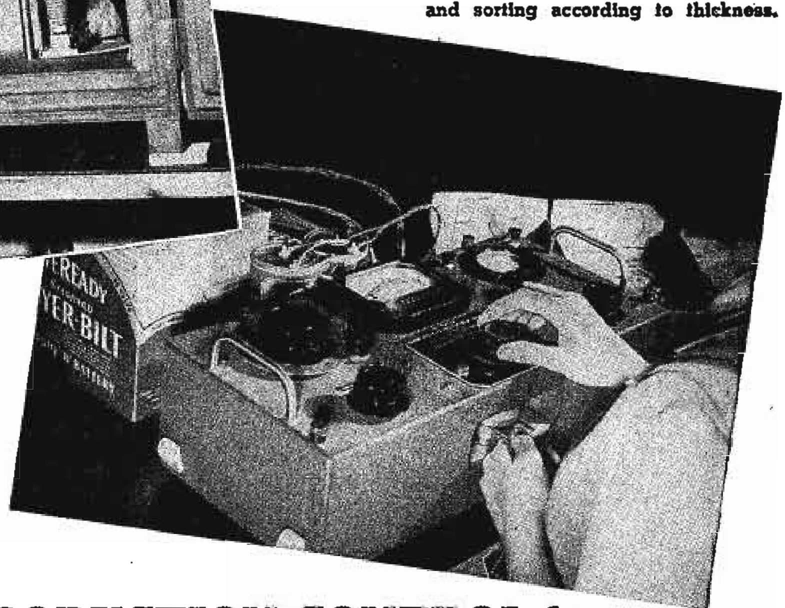
Figure 9. Overall response characteristic of the receiver used in making the traces, but with the 10-mc marker turned on. Figure 10 shows a trace that results when the sweep width has been decreased and the sweeper is sweeping a band just wide enough for a clear interpretation of the trace, with a 1-mc marker turned on.







Aerovox high-frequency capacitance bridge test of mica capacitors in heat chamber at right.



Block mica check for power factor. Every piece is checked before splitting and sorting according to thickness.

# QUALITY PRODUCTION CONTROL from Alpha to Omega . . . step by step . . . with nothing taken for granted or left to chance . . . spells

# AEROVOX MICA CAPACITOR *Craftsmanship*

• Mica capacitors are usually precision units. Capacitance tolerances may be tight. But even more important, critical characteristics such as power factor and "Q" must be met.

AEROVOX QUALITY CONTROL is exercised at every step in production. Incoming block mica is checked piece by piece for power factor and "Q." This proved invaluable during the wartime mica shortage when new sources of supply had to be used. A spot check simply would not do.

Split micas are checked—electrically, visually, micrometrically. Mica assemblies are checked. Completed mica units are checked on the Q-meter. And since operating characteristics may change with operating temperatures, such units are checked at given temperatures, by means of precision instruments of recognized accuracy, including Aerovox-designed and -built instruments.

It is this kind of production inspection, along with skilled craftsmanship and engineering "know-how," that accounts for the enviable reputation enjoyed by Aerovox mica capacitors.

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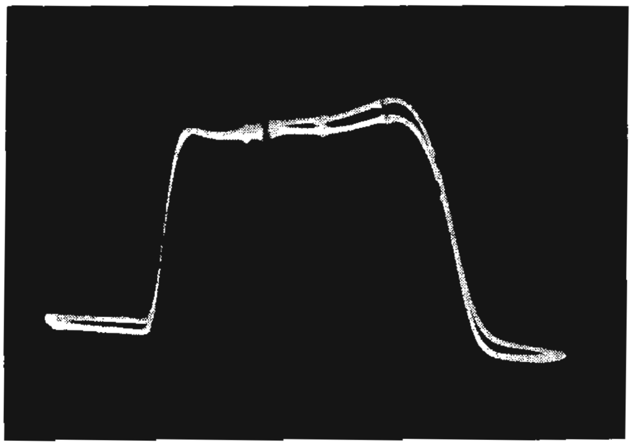


Figure 11
Signal-generator calibration test signal. Shown is the over-all band-pass characteristic of a television receiver with the sweeper output connected to the antenna input with the 1-mc markers on.

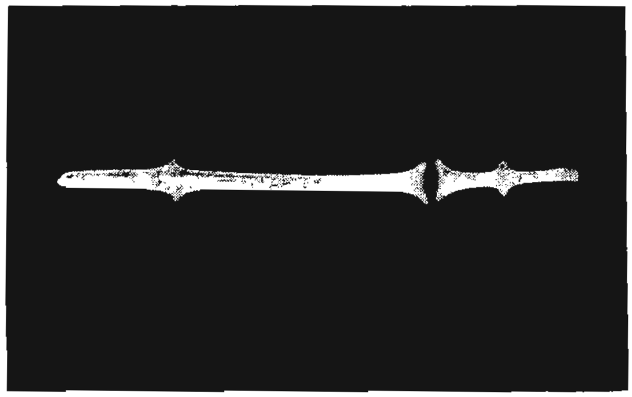


Figure 12
Here we see the same 1-mc marks of Figure 11, but the sweep width has been adjusted to slightly over 1 mc.

instrument, a high-pass filter was inserted between the output of the limiter tube and the attenuator. This filter is designed for a 100-ohm line, and a 100-ohm L-pad attenuator is used. No attempt was made to calibrate this attenuator, as the actual measurement of sensitivity of equipments can be more accurately made by using unmodulated carrier inputs, or at least by using inputs that are not frequency modulated. However, a scale is used for all the knobs. Thus the instrument may be roughly calibrated, if desired.

### Production Problems

Having worked out the details of the operation of the instrument, consideration had to be given as to whether or not it was suitable for production. A major problem in an equipment operating at frequencies of the order of 100 mc or higher is the manufacture of the tank-circuit constants which must be sufficiently exact. As has been said, trimmer capacitances cannot be used in the tank circuit of the reactance portion of the instrument or the frequency deviation will be reduced. Hence, adjustment of the inductance is necessary. The tank circuit coil forms are of ceramic, slotted to accept the wire. Powdered iron slugs, designed to operate at the proper frequency are used to make the initial inductive adjustments. These slugs have a sufficiently high $Q$ so that the overall operation is not affected. In the case of the reactance oscillator circuit, which is a tapped inductance, a special precaution was taken to provide a slightly smaller inductance on the side of the coil into which the slug enters, so that an average adjustment of the slug would create the proper position for the tap.

### 1- and 10-Mc Marker Crystals

In Figure 4 appears a view of the final laboratory model. In this illustration it will be seen that the main tuning dial is calibrated in megacycles with marks at 10-mc points only. This procedure was adopted because two crystal-marker oscillators operating at 1 and 10 mc are incorporated in the instrument. These can be turned off or on separately or together. Harmonics of these crystal oscillators appear throughout the entire frequency range, and their amplitude is adjustable because toward the lower frequencies their output is nearer the fundamental and therefore stronger. The control which adjusts the amplitude of the marks is a carbon potentiometer, the output of which is combined with the sweeper output signal ahead of the sweeper output amplitude control, so that the percentage of marker to signal remains constant with adjustment of the sweeper output control. If, for instance, the dial reading is near 30 mc and the 10-mc marker is turned on and appears near the center of the oscillograph trace of an amplifier characteristic, the mark seen must be the 30-mc mark, not 20 or 40 mc. Knowing this, the 1-mc markers can be turned on and frequencies on either side of the 10-mc mark can be counted as far on either side of the 10-mc mark as the amplifier characteristic will pass them.

### Trace Data

Figure 5 shows the trace of the last intermediate frequency stage of a television receiver, with the sweeper connected to the grid of the last amplifier tube and an oscillograph connected to the output of a diode detector. (These pictures are actual photographs of the traces.) In Figure 6 we have the same trace with the 10-mc marker turned on. Figure 7 is the same but with the 1-mc markers turned on. (This picture, incidentally, is the one that was used to plot the chart of Figure 3.) Figures 8 and 9 show the overall i-f response characteristic of the same receiver, Figure 9 showing the 10-mc mark again. In Figure 10 the sweep width has been decreased (by means of the control identified in Figure 4) and the sweeper is sweeping a band just wide enough for a clear interpretation of this trace, with the 1-mc markers.

The method of using the sweeper with its internal crystals for calibrating other generators is shown in Figures 11 and 12. Figure 11 shows the overall band-pass characteristic of a television receiver with the sweeper output connected to the antenna input

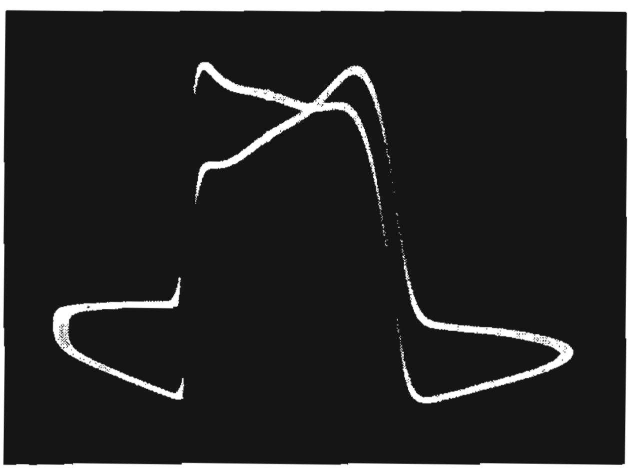
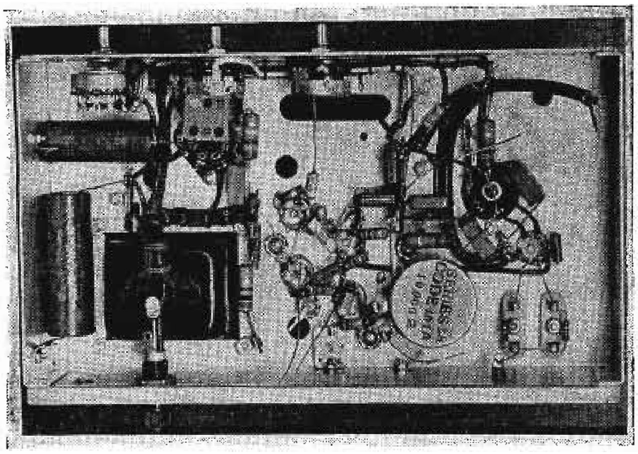
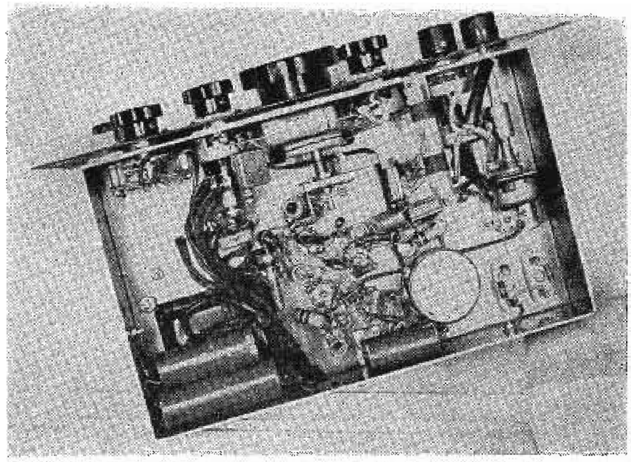


Figure 13
Response characteristic shown in Figure 11, except that the markers are turned off. A small amount of i-f distortion has been introduced and the trace produced shows the usual attenuated i-f square-wave pattern.





Figures 14 (above left) and 15 (above right)

Figure 14. A production line sweeper. In Figure 15 appears the underside view of the first laboratory model of the sweeper, with the power supply at the extreme left, r-f section in the center and the crystal marker circuits at the extreme right.

of the receiver and with the 1-mc markers turned on. Another signal generator was also set up for this test, the output of which was also fed to the antenna input of the receiver. The mark produced by this external generator can be seen between the 1-mc marks just to the left of the center of the top portion of the pass-band. This mark can be moved back and forth across the characteristic by varying the frequency of the external generator. Figure 12 shows the same 1-mc marks on the characteristic shown in Figure 11, but the sweep width of the sweeper is now adjusted to only slightly over 1 mc, and the frequency of the external generator has been shifted slightly to show its mark moved to the right. With the sweeper adjusted in this manner the external generator can be tuned so that zero beat is produced between it and the 1-mc crystals, the external generator's dial being calibrated in both positions. It should be noted that any of the 1-mc marks can be used for this purpose, the only requirement being that they show in the overall band-pass characteristic. In this way the most inaccurate of generators can be calibrated every 1 mc, to provide quite accurate readings between the 1-mc points. The markers chosen for inclusion in the sweeper were chosen with this in mind. It can readily be understood that it would be impossible to include all the markers which might be required for the different purposes for which the instrument will be used.

#### Alignment Uses

Another use for the sweeper is in the overall alignment of television receivers to judge the low-frequency response characteristic. To align the very low-frequency end of a video equipment 60-cycle square waves are usually used.

Figure 13 shows the same response characteristic as Figure 11, except that the markers are turned off. A small amount of low-frequency distortion has been introduced, and the trace produced shows the usual attenuated low-frequency square-wave pattern which gives a slope toward the axis as the square wave passes through the loss circuit. In this case the loss is produced by a network consisting of a .01-mfd capacitor followed by a 330,000-ohm resistor.

#### Constructional Changes

Figure 14 shows one of the units which has been taken at random from the production line. Figure 15 shows the under side of the chassis of the first laboratory model, with the power supply section at the extreme left, the r-f section in the center, and the crystal marker circuits at the extreme right. Figure 16 shows the top of the chassis of the first laboratory model.

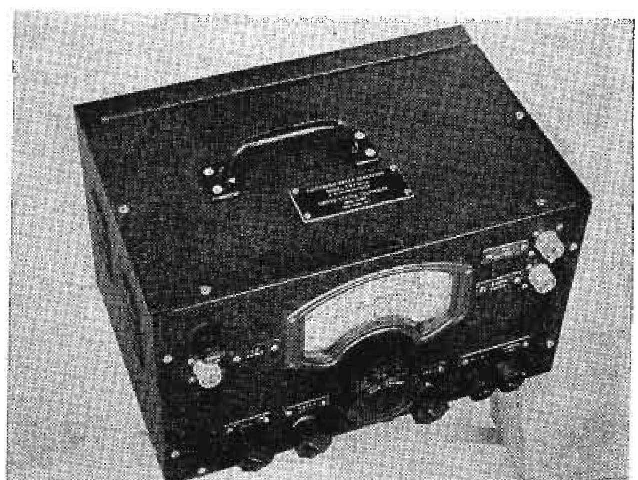
#### Instrument Range

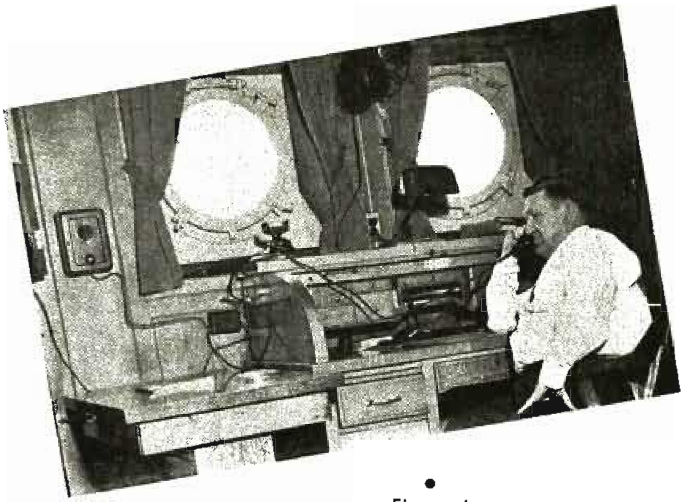
The writer has not had occasion to test the instrument at frequencies higher than its fundamental range, but from his experience with other instruments and from the design of this one, it can be said with a reasonable amount of certainty that the harmonic output will be sufficient to test all of the present commercial television and f-m bands up to 220 mc.

#### Credits

In conclusion the writer wishes to express his thanks to senior engineer M. Soja for his fine work on the details of the physical construction of the instrument and to A. D. Heller of the Trigon Company for his excellent overall design work.

Figure 16
First laboratory model of the electronic sweeper.





# THREE-CHANNEL SYSTEM FOR


—by D. A. HEISNER—

**Chief Engineer**
**The Lorain County Radio Corporation**


Figure 1
Great Lakes radio communications system in operation. In this installation the cradle-type telephone instrument is linked to the system.

Figure 2
Great Lakes heavy craft radio communications installation, where the telephone instrument and dial system, and miniature speaker are combined in one unit.

WITHIN the past ten years, radiotelephone service on the Great Lakes has expanded from a few experimental installations to a complete and reliable service which is used by practically all of the larger ships. The expansion of this service has been mostly in the field of bulk freight.

### *Ship to Barge Communications*

The lake freighters, most of them about 600 feet long, have adopted radiotelephone communications almost unanimously; and most of the traffic, at the present time, is concerned with the movement and business of these large ships.

In the development of this service, there have been a number of side issues which have been only partially considered. These concern the need for communications between the larger ships and barges which they may be towing. When the large ships are approaching the various harbors, they occasionally have need for communications with the towing tugs that meet them and shift them about inside the ports. There are numerous supply vessels on the Great Lakes whose business it is to ride alongside the large freighters for the purpose of supplying food, mail, magazines and general merchandise. Communications between these service ships and the large vessels are also desirable.

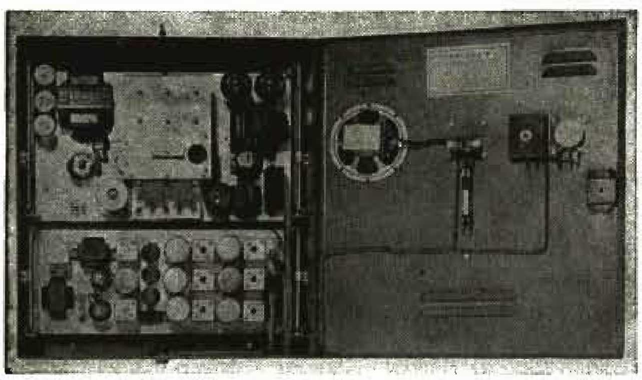


Figure 3
Interior of transmitter-receiver 3-channel unit developed for smaller craft use on the Great Lakes.

### *Auxiliary Fleet Requirements*

This auxiliary fleet is chiefly concerned with ship-to-ship communications between themselves and the large freighters. The vessels are, for the most part, small and space is at a premium. Consideration must be given to power consumption on most of these

# 25-WATT RADIOTELEPHONE

# SHIP-TO-SHORE

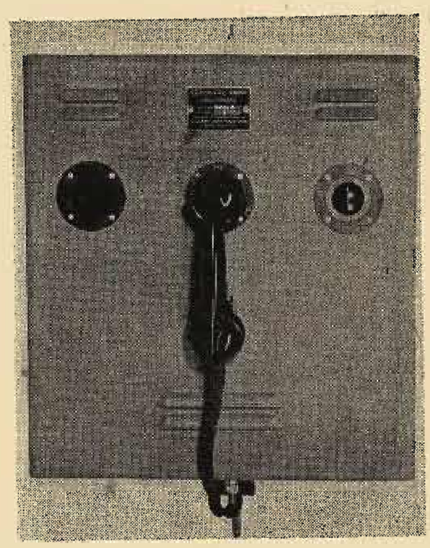


Figure 4
Front panel view of 25-watt radiotelephone unit. Channel selector control is behind handset at top.

smaller ships because they do not, as a rule, have electric power available from a generator, except at night. Radiotelephone equipment for use on these auxiliary ships must be easy to operate.

To meet these requirements a small radiotelephone unit has been developed.

### *Transmitter Characteristics*

The transmitter delivers 25 watts, carrier, to a suitable antenna on any one of three pre-determined frequencies, which are controlled by quartz crystals.

The transmitter is voice controlled, which means that no push-to-talk operation is necessary for its use.

Frequencies covered are: 2,182 kc (channel 51), 2,738 kc (channel 40) and 2,118 (channel 39). On channel 39, 2,154 kc is also used for receiving.

The telephone instrument employed is a standard cradle-type microphone and the shipboard operator simply picks it up and talks into it as he would in using an ordinary land telephone.

### *Voice Control Operation*

Voice control operation is obtained by the simple expedient of using a copper-oxide rectifier to rectify a portion of speech energy in the speech amplifier output. The rectified speech is filtered and used to operate a sensitive relay which, in turn, controls oscilla-

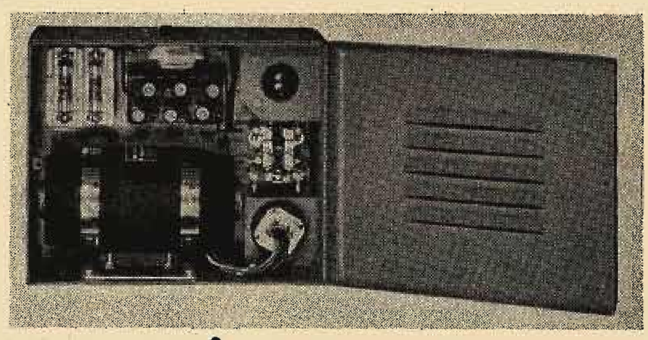
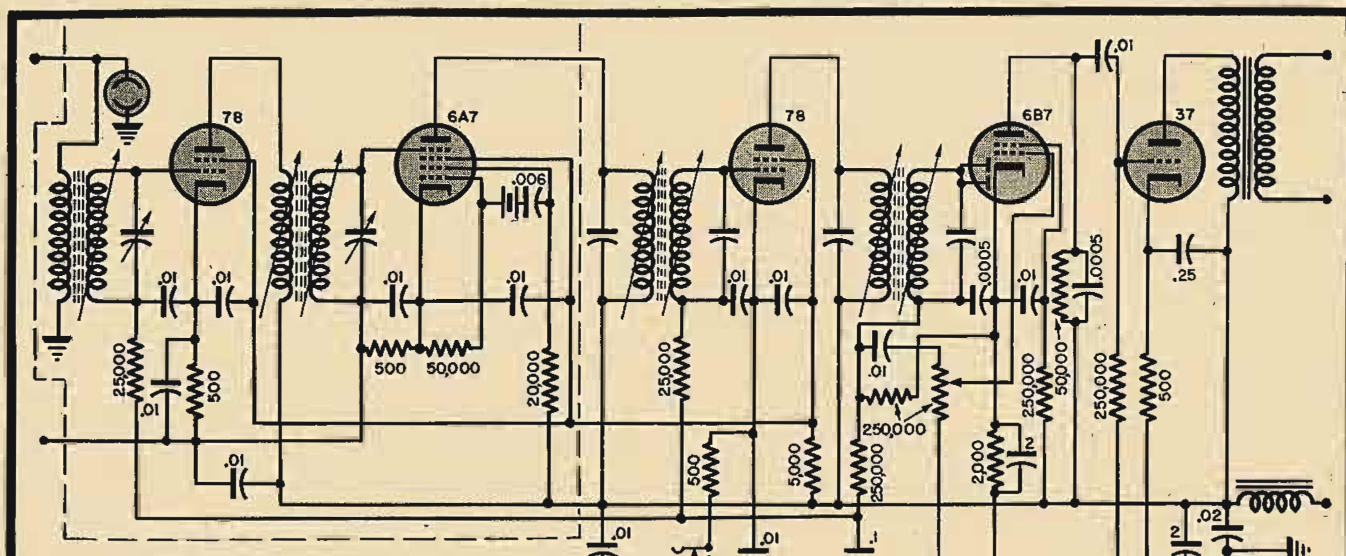
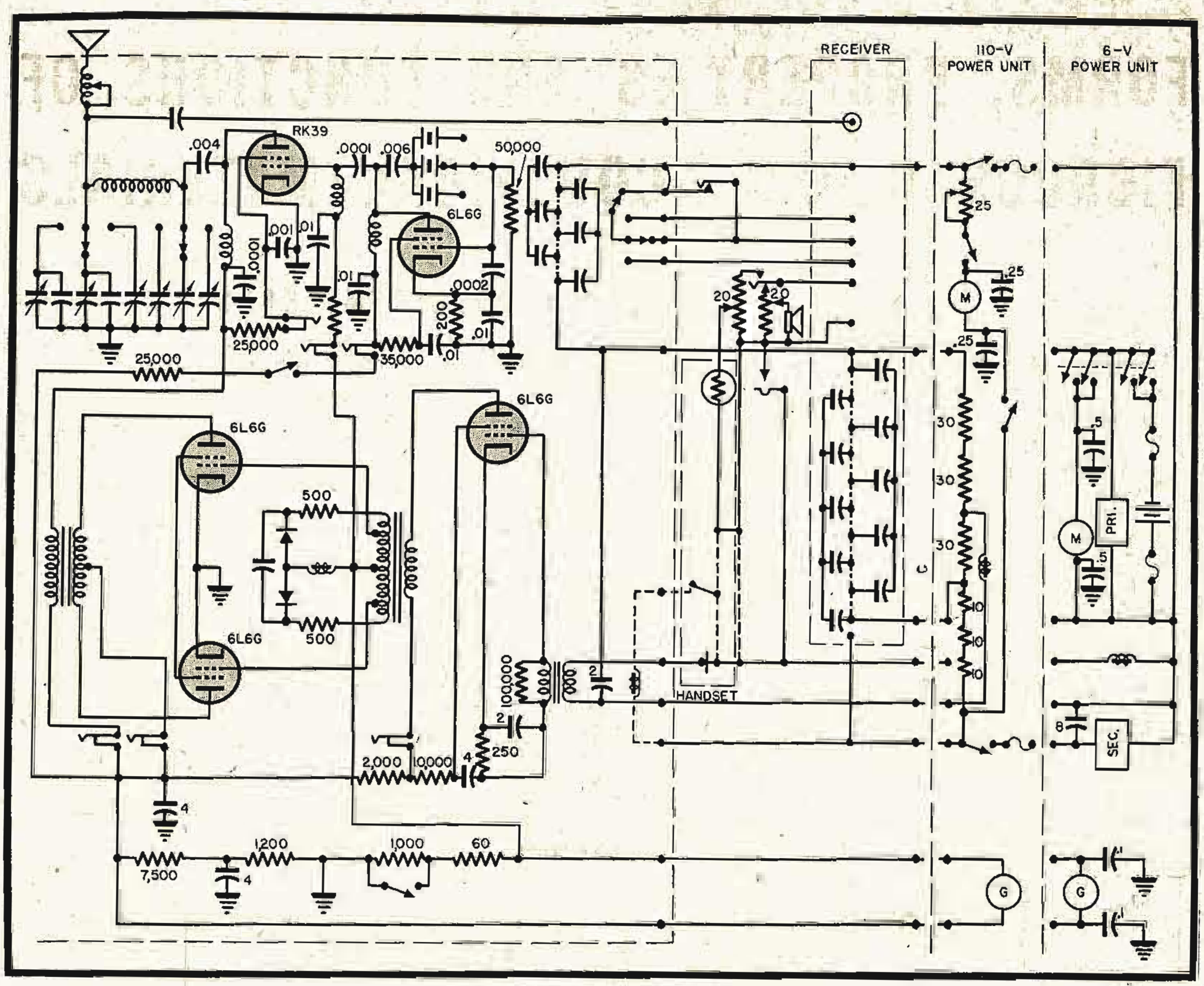


Figure 5
Power supply unit, housed in a 12" x 10" x 7" cabinet. Power system for 6, 12, 32 or 110-volt sources is available.

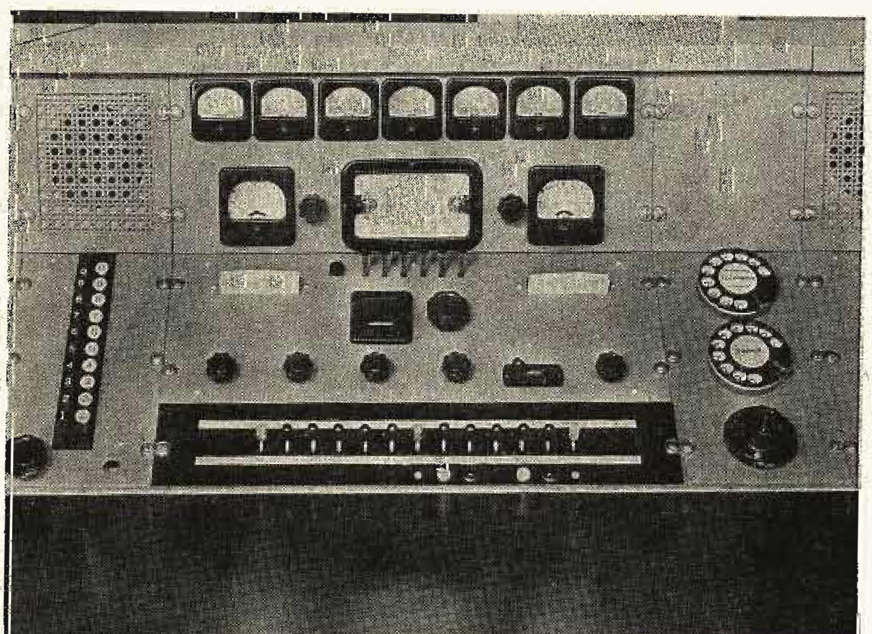
Figure 6
Receiver for ship-to-shore system. To facilitate frequency changing, three separate amplifiers are provided for the radio frequencies involved, with a separate mixer and crystal oscillator for each channel. A series-parallel plug is provided for filament control, *A*. Neon limiter is used in antenna circuit.






Figures 6 (top) and 7 (below)

Transmitter circuit. A Pierce crystal-controlled master oscillator power amplifier is used. A RK39 is used in the power amplifier, with a $\pi$ network for its output circuit. For short antennas used on the smaller craft, a loading coil is provided. The dotted wiring indicates the push-to-talk circuits. Two of the 6L6Gs serve as modulators, while another is used as a speech amplifier. Figure 7 illustrates the control board at the main receiving station of the Lorain Great Lakes system, where it is possible to route calls locally as well as via long-distance lines throughout the nation.



tor plate voltage for the transmitter. This means that whenever speech is present, the transmitter oscillator will be supplied with plate voltage and a modulated carrier will be transmitted. In the absence of speech at the speech amplifier, the relay returns to normal and the receiver is allowed to operate.

### Transmitter Features

The transmitter features a Pierce crystal - controlled master - oscillator power amplifier. The power amplifier uses a single RK39 with a $\pi$ network for its output circuit. An antenna loading coil is provided for use with the short antennas which necessarily must be used on the smaller ships.

### Frequency Changing

This circuit arrangement provides the minimum number of circuits to be

(*Continued on page* 44)

# FORMS, PROPERTIES AND FUNCTIONS OF FIBROUS GLASS ACOUSTICAL MATERIALS

by WILLIS M. REES

Acoustical Specialist
Owens-Corning Fiberglas Corporation

OVER-ALL sound control may require not only control of airborne sound within an enclosed space, but exclusion of sound from the space, and the minimizing of sound at its source. The minimizing of sound at its source is not a function of sound-control materials except as it may be used as lining for ducts or plenum chambers in air conditioning equipment, etc., to quiet machinery noise where such quieting can be accomplished by absorption of airborne sound.

Except in aircraft applications, the exclusion of outside sound is a function of sound-control materials to only a limited degree. In building construction of all types, exclusion of sound depends primarily upon the ability of walls, floors and ceiling to resist vibration. This, in turn, depends chiefly upon their weight and rigidity.

Efficient sound exclusion can be obtained only by great weight in single construction, or by the use of double construction. In double-wall construction, the efficiency depends partly upon weight and rigidity, and to a large extent upon the degree of structural isolation between the two walls. Even a single nail driven through both sides of a double wall greatly reduces efficiency by conducting vibration across the air space. This also applies to floors and ceilings.

The volume of an enclosed space, and the reflecting or absorbing power of the surfaces, determines the length of time a sound originating within the space will be prolonged, the amount of sound overlapping, and, as a result, the hearing conditions within the space. The more reflective the surfaces, the longer a sound will rever-

Table A

Sound absorption coefficients of fibrous glass materials, from tests made in accordance with the Acoustical Materials Association methods.

**Insulating Wool**

| Thickness | Density lbs./cu. ft. | Coefficients N.R.[a] | 128 | 256 | 512 | 1024 | 2048 | 4096 | lbs./sq. ft.[b] | Facing[c] | Mounting[d] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1" | 2 | .55 | .24 | .30 | .57 | .69 | .70 | .. | .17 | Metal lath | 4 |
| 1" | 3 | .65 | .27 | .35 | .68 | .77 | .76 | .71 | .25 | Perforated metal[1] | 4 |
| 1" | 4 | .75 | .33 | .45 | .81 | .88 | .78 | .. | .33 | Metal lath | 4 |
| 1" | 4 | .70 | .33 | .40 | .76 | .91 | .77 | .73 | .33 | Perforated Metal[1] | 4 |
| 1" | 6 | .80 | .35 | .51 | .89 | .93 | .87 | .. | .50 | Metal lath | 4 |
| 2" | 2 | .75 | .38 | .49 | .84 | .91 | .76 | .. | .33 | Metal lath | 4 |
| 2" | 3 | .80 | .44 | .61 | .96 | .93 | .77 | .86 | .50 | Perforated metal[1] | 4 |
| 2" | 4 | .90 | .54 | .60 | .99 | .99 | .88 | .. | .67 | Metal lath | 4 |
| 2" | 4 | .90 | .62 | .85 | .99 | .99 | .86 | .. | .67 | Muslin | 4 |
| 2" | 6 | .90 | .55 | .79 | .99 | .99 | .91 | .. | 1.00 | Metal lath | 4 |
| 2½" | 2 | .80 | .50 | .60 | .93 | .90 | .81 | .87 | .42 | Metal lath and 10-mil bonded mat[2] | 4 |
| 2½" | 2 | .85 | .48 | .59 | .98 | .94 | .85 | .78 | .42 | Same as above—painted[3] | 4 |
| 2½" | 2 | .85 | .47 | .64 | .99 | .99 | .76 | .59 | .42 | Metal lath and 40 natural kraft paper | 4 |
| 3" | 2 | .85 | .55 | .68 | .95 | .90 | .79 | .80 | .50 | Perforated metal[1] | 4 |
| 3" | 3 | .90 | .68 | .78 | .99 | .94 | .86 | .80 | .75 | Perforated metal[1] | 4 |
| 3" | 4 | .95 | .69 | .91 | .99 | .99 | .91 | .82 | 1.00 | Perforated metal[1] | 4 |

**Board-Type Insulation**

| Thickness | Density lbs./cu. ft. | N.R. | 128 | 256 | 512 | 1024 | 2048 | 4096 | lbs./sq. ft. | Facing | Mounting |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1" | 2½ | .60 | .24 | .32 | .65 | .77 | .73 | .81 | .21 | Bare | 2 |
| 1" | 4¼ | .70 | .20 | .41 | .75 | .87 | .86 | .82 | .35 | Bare | 2 |
| 1" | 6 | .75 | .25 | .41 | .86 | .94 | .84 | .81 | .50 | Bare | 2 |
| 1" | 6 | .70 | .18 | .33 | .75 | .95 | .84 | .77 | .50 | Creped kraft paper | 2 |
| 1" | 9 | .75 | .22 | .46 | .97 | .90 | .68 | .52 | .75 | Painted | 2 |
| 2" | 4¼ | .85 | .41 | .60 | .99 | .99 | .84 | .85 | .71 | Bare | 2 |

**Notes**

[a] N.R.—Noise Reduction Coefficient—The average of the coefficients at frequencies of 256, 512, 1024 and 2048 cycles, given to the nearest 5%. This average coefficient is recommended for use in comparing materials for noise-quieting purposes as in offices, corridors, etc.

[b] Weight of material only. For estimating weight of metal mesh and sewn blankets. Add weight of facing materials to these figures.

[c] Facing or confining materials which may be used without appreciable acoustical affect upon materials covered:

| | |
|---|---|
| Fiberglas 10 mil bonded mat | .009 lbs./sq. ft. |
| Expanded metal lath | .278 lbs./sq. ft. |
| ⅜" Hi-rib lath | .444 lbs./sq. ft. |
| Hexagonal wire mesh | .109 lbs./sq. ft. |
| Flameproofed muslin | .017 lbs./sq. ft. |
| Kraft paper | .026 lbs./sq. ft. |
| Glass cloth | .011 lbs./sq. ft. |

Perforated materials such as metal, hardboard, cement asbestos board, plywood, etc.

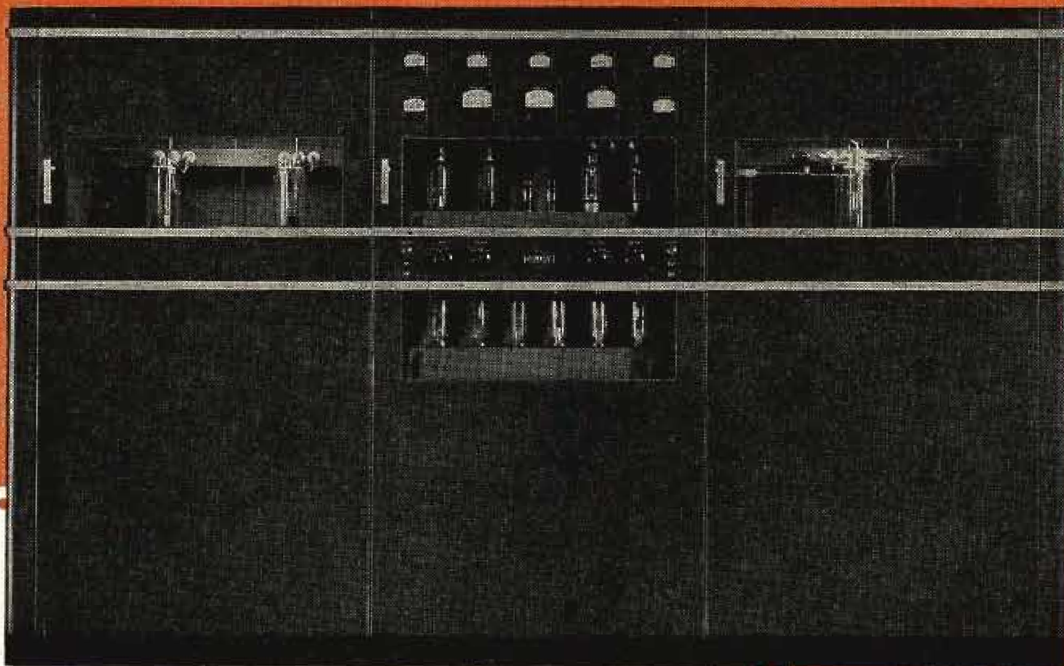
[d] Mounting 4 is laid on laboratory floor. Mounting 2 is nailed to 1" x 2" wood furring 12" OC.

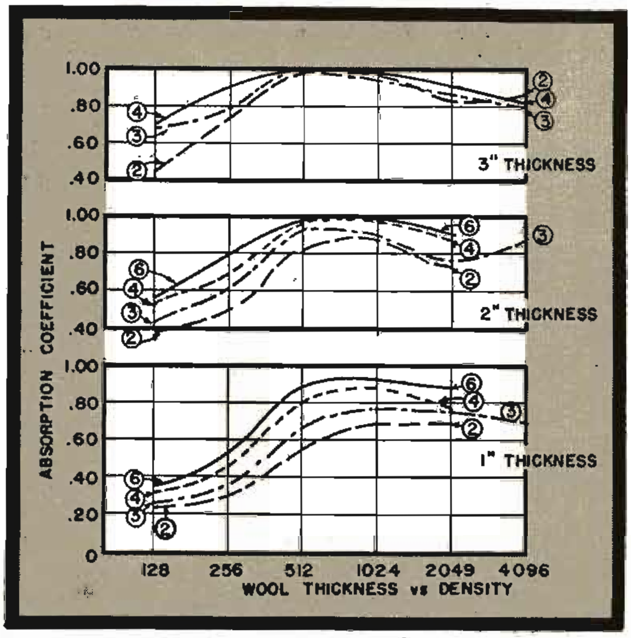
[1] Perforated metal, 26 gage .076" holes, .176" on center.

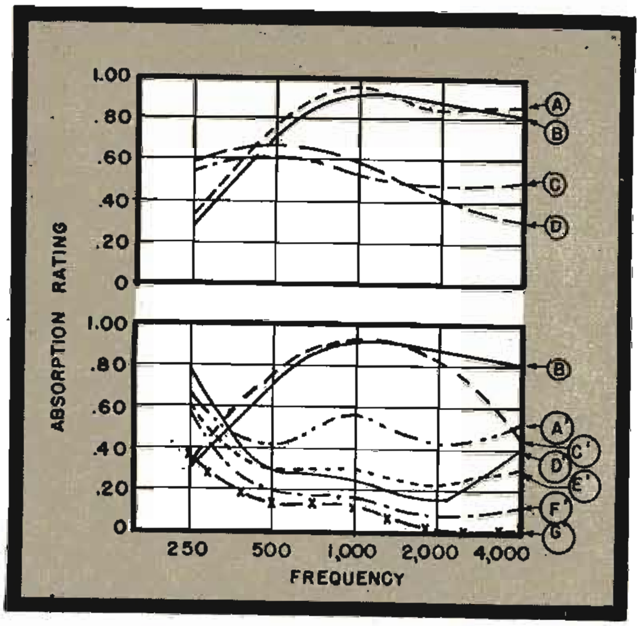
[2] Fiberglas 10-mil bonded mat type 10.

[3] Spray painted with cold water paint.

[4] Weight includes glass cloth facings.






Figures 1 (left above) and 2 (right above) Figure 1. Apparent effect of thickness and density upon sound absorption values of wool-like materials. Figure 2. Apparent effect of surface films on board materials. *A*, one coat casein paint; *B*, plain bare board; *C*, two coats casein paint; *D*, one coat lead and oil paint; *A'*, loose cellophane wrapped; *B* (lower plot), plain bare board; *C'*, cellophane cemented to surface; *D'*, four coats of casein paint; *E'*, two coats of lead and oil paint; *F'*, three coats of lead and oil paint; *G'*, solid 26 gage sheet metal, unperforated.

berate; the more absorptive the surfaces, the shorter the time of reverberation. The chief function of sound-control materials in building construction is the control of sound originating within an enclosed space, by absorbing the airborne sound waves and preventing that prolongation and overlapping which results in a confused jumble.

#### Properties of Fibrous Glass Materials

Use of fibrous glass sound-control materials by the armed forces was based primarily upon their acoustical efficiency, but was also influenced to a large degree by their incombustibility, non-moisture absorptive and rot-proof characteristics, and their light weight. The fact that the materials combine high thermal insulating efficiency with high acoustical efficiency was also a major consideration.

In determining acoustical requirements of such spaces as auditoriums, it is common practice to consider reverberation at the one frequency of 512 vibrations per second. Spaces requiring critical analysis, in which the acoustical treatment must provide most of the sound absorption, may show excessive reverberation at low frequencies even though conditions may be satisfactory at 512 cycles. Because fibrous-glass materials usually provide exceptionally high absorption at low frequencies it appears to be particularly well suited for use in radio studios and other spaces requiring *straight-line* absorption for effective results.

#### Forms of Glass-Fibre Materials

The plain white, wool-like *fiberglas*, which is produced in bat, roll and blanket forms, is known as *TW-F wool*. The same material is bonded with a thermosetting resin and produced in board-like forms. These are known as *PF* materials. The average diameter of the glass fibers ranges from 0.00055″ to 0.00005″.

The bats, rolls and most of the blankets have a natural density of 1½ pounds per cubic foot, but being resilient, may be compressed to greater densities. Predetermined thicknesses of the boards range from 1″ to 4″; predetermined densities range from 2½ to 9 pounds per cubic foot.

Table A offers sound absorption data for the wool-like glass fibrous material and board types in several densities and thicknesses.

Figure 1 shows the apparent effect of thickness and density upon sound absorption values of the wool-like materials. In a material 1″ thick, the absorption at all frequencies increases with little change in the shape of the curve as the density increases. As no tests have been made for densities over 6 pounds, it is not apparent what the optimum density would be for 1″ material. The 2‴ thicknesses curves show increased absorption at all frequencies, with little advantage for 6-pound material over 4-pound material at middle and high frequencies. In the 3″ thickness curves it would appear that density is of little consequence for frequencies of 512 and up, although higher densities improve low frequency values.

Figure 2 shows the apparent effect of various surface films on board materials. The curve for bare board is typical of many materials. The upper set of curves shows that one coat of casein paint has no appreciable effect on sound absorption. But with either two coats of casein paint or one coat of lead and oil, the curve is completely altered, both surfaces giving substantially the same characteristics. The test with two coats of casein, in particular, gives an extremely flat curve.

In the lower set of curves in Figure 2, the effect of additional paint coats is shown. Two and three coats of lead and oil, and four coats of casein all show very similar curves. Cellophane cemented to the board surface, and even solid unperforated 26-gage sheet steel surfacings, show similar curves. A loose cellophane wrapping shows little change as compared with the curve for the bare board, except for a reduction at 4000 cycles.

Just how a material absorbs sound is still not fully understood, but it has been stated that friction of the pulsating air molecules against the interstices of porous materials transforms sound energy into heat, and that it is in this way that most sound absorption is provided. If this theory is correct it follows that, within limitations, by increasing the total surface area provided by a material, the noise absorption value can be increased.

Total surface area of a porous fibrous material can be increased by decreasing the diameter of the fibers that make up the material. Further research may demonstrate that acoustical values are functions of fiber diameter, and of the surface area of the fibers. This theory would account for the performance of *fiberglas* as an acoustical material.

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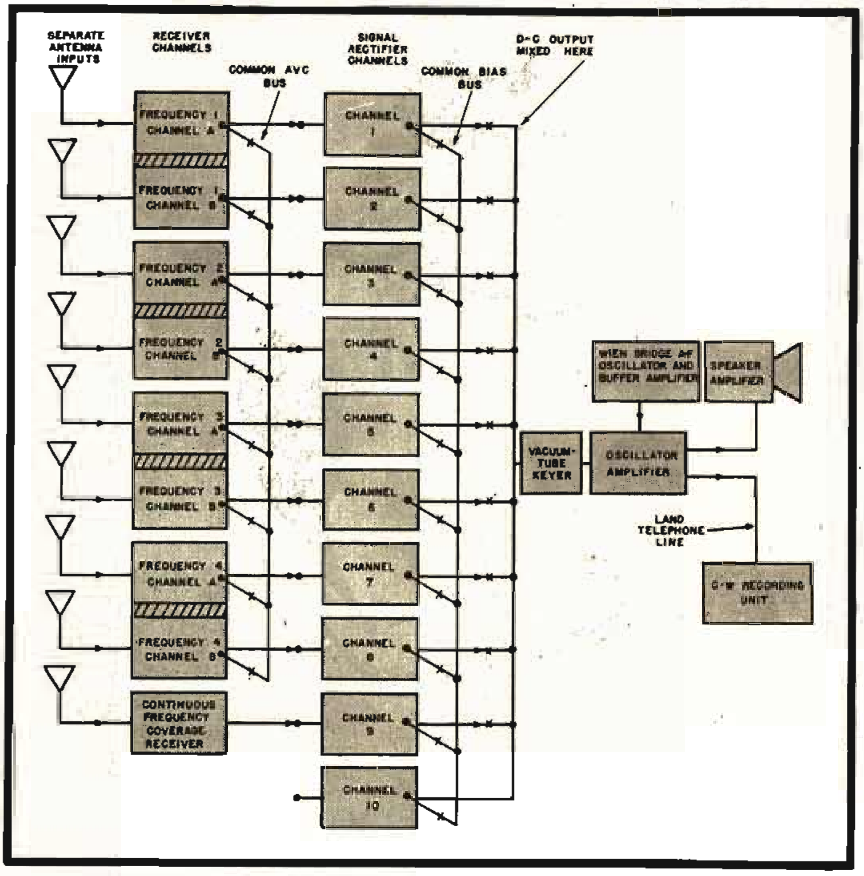
# CAA ALASKAN DIVERSITY





by

**JACK IVERS**

**Chief Electrical Engineer**
**National Company**


Figure 1

Block diagram of the 8-channel diversity system used by CAA communications stations in Alaska. A common receiver avc bus and common signal-rectifier bias bus serves to cause decreased sensitivity of channels with weak signal input or no signal input when strong signals are picked up by any of the other channels. A continuous frequency coverage receiver is included as a ninth channel, or as a spare or emergency channel. There are ten signal rectifier channels available in cases of emergency or for maintenance purposes.

DURING the war, a dependable and foolproof communications network was required between this country and the Alaskan regions. Because of the particularly bad atmospherics and erratic fading and skip conditions, it was found necessary to use diversity-type receivers with a variety of special polar-country features.

The receivers had to provide reliable high-speed c-w circuits comparable to land-line continuity. In addition the equipment had to meet the day and night coverage characteristics common to northern regions. In the temperate and equatorial regions high frequencies are useful for long range daytime communications; medium frequencies are useful for nighttime communications; and low frequencies are useful for both day and nighttime communications. In polar regions, however, the most satisfactory communications frequency may be predicted for very short time intervals only.

To cope with this problem, the Civil Aeronautics Administration, who were in charge of the project, requested the development of a special system, to be carried out jointly by a CAA and National group.

The *diversity* receiving system designed countered the polar atmospheric conditions by simultaneous pickup of c-w signals with eight separate receiving channels having eight separate antennas as feeders. Four different frequencies were used with two receiving channels per frequency. These frequences ranged from 100 kc to 20 mc.

With all eight channels feeding a high-speed recorder simultaneously, signals have been accurately received at all times. Space diversity was used on each of the four frequencies to minimize the deleterious effect of short temporary fades occurring at any one or more frequencies. Frequency diversity was also included to minimize the effects of longer time fades and erratic and unpredictable frequency-range performance at any time of the day or night.

### *Diversity System Features*

Figure 1 shows a block diagram of the diversity system developed. In operation, simultaneous keying of four transmitters on frequencies such as 150 kc, 4000 kc, 8100 kc, and 12,200 kc is picked up at the receiving station by nine diversity antennas. One of the nine antennas is connected to a continuous frequency coverage type of receiver, and this channel is usually operated as a spare, emergency, or searching channel. In the eight diversity-operated channels the signals are amplified by a sensitive superheterodyne receiver in each channel and then combined with a stable b-f-o signal to develop an a-f voltage of approximately 1500 cycles in the second detector. This a-f voltage is amplified and fed to signal rectifiers. Here the 1500-cycle signal is rectified and the d-c developed at the output of each signal rectifier is combined in shunt.

A local a-f oscillator is keyed by the d-c developed by the signal rectifiers, following the received c-w transmissions. A vacuum-tube keyer is operated so that the local oscillator's amplifier is biased to cut-off when no d-c is impressed at the input terminals of the keyer. When the rectified d-c, following the received c-w signal, is applied to the input of the keyer the bias of the oscillator's amplifier is restored to normal and the amplifier operates properly as long as the d-c is maintained at the keyer input.

The keyed tone is fed to a speaker amplifier for aural monitoring and via land telephone line to a c-w recording

# RECEIVING SYSTEM

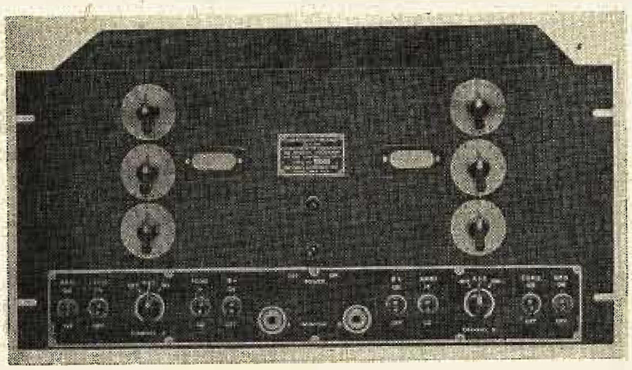


Figure 2
Front view of one of the four dual-channel receivers. Each dual channel receiver operates on one frequency for both channels.

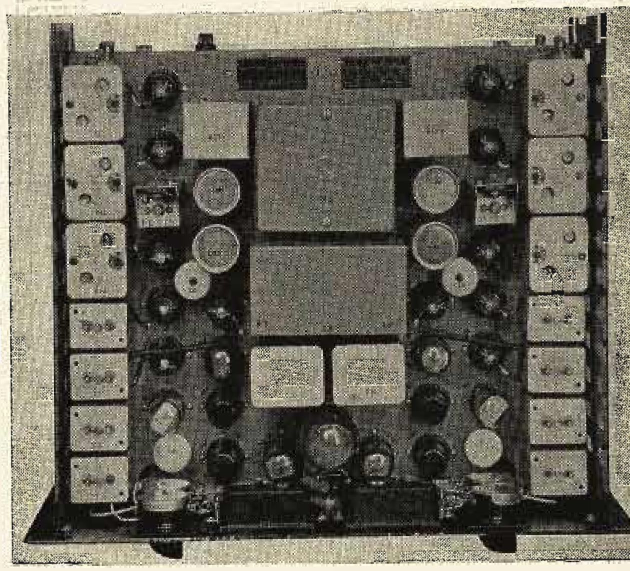


Figure 3
Top view of one of four dual-channel receivers. Common power supply occupies center of chassis.

device. The recording device is usually located several miles away from the diversity receiving room.

The system provides high-speed automatic tape recording up to 250 words per minute, radio signal relays, or aural reception.

The choice of four spaced frequencies and the use of two channels per frequency solved some of the atmospheric problems. However, interference between channels and noise pick-up by a receiver channel, when its signal input was below the threshold of usability, had to be eliminated or minimized.

One interesting contribution to the solution of this problem permitted the interconnection of all the avc voltages to form a common bus. Large signal strengths in channel *1*, for example, could serve to decrease the gain of all the other channels connected to the avc bus by virtue of the large avc voltage developed by channel *1*. Thus, noise interference normally received through high-gain low-signal-strength channels may be decreased.

A three-position control for each channel, seen in Figure 2, may be set to short circuit each individual channel's avc voltage to ground, or to confine the avc voltage to act within its own channel, or to connect the channel's avc voltage to the common avc bus to be used in full diversity operation.

### The Circuit

*(In the following circuit-diagram discussion, Figure 4, attention has been focussed on channel A. Channel B is a mirror image of channel A, identical to it in all respects within a single dual-channel chassis.)*

In this figure $L_2$ is a broadly self-resonant 455-kc coil. It therefore makes an effective load for the pentode amplifier section of the 6B8, which serves as the avc amplifier and rectifier. A delaying bias is used on the diode rectifier portion of the 6B8.

It is necessary that the bias interconnections forming the avc bus must not increase the diode loads to such a point as to render the available avc bias insufficient for interchannel noise suppression. A .1-megohm unit serves as an isolating resistance to avoid the unwanted loading of the diode load, .5 megohm. With all eight channels operating in diversity the maximum avc voltage decrease is less than 20% as compared with the avc voltage developed in one channel disconnected from the avc bus, illustrating effective isolation of the individual channel avc diode loads.

The avc sensitivity of each channel is designed to meet the following specification: With a change of r-f input from 10 microvolts to .1 volt, the change in power output is not more than 20 db, using a 30% modulated r-f signal input.

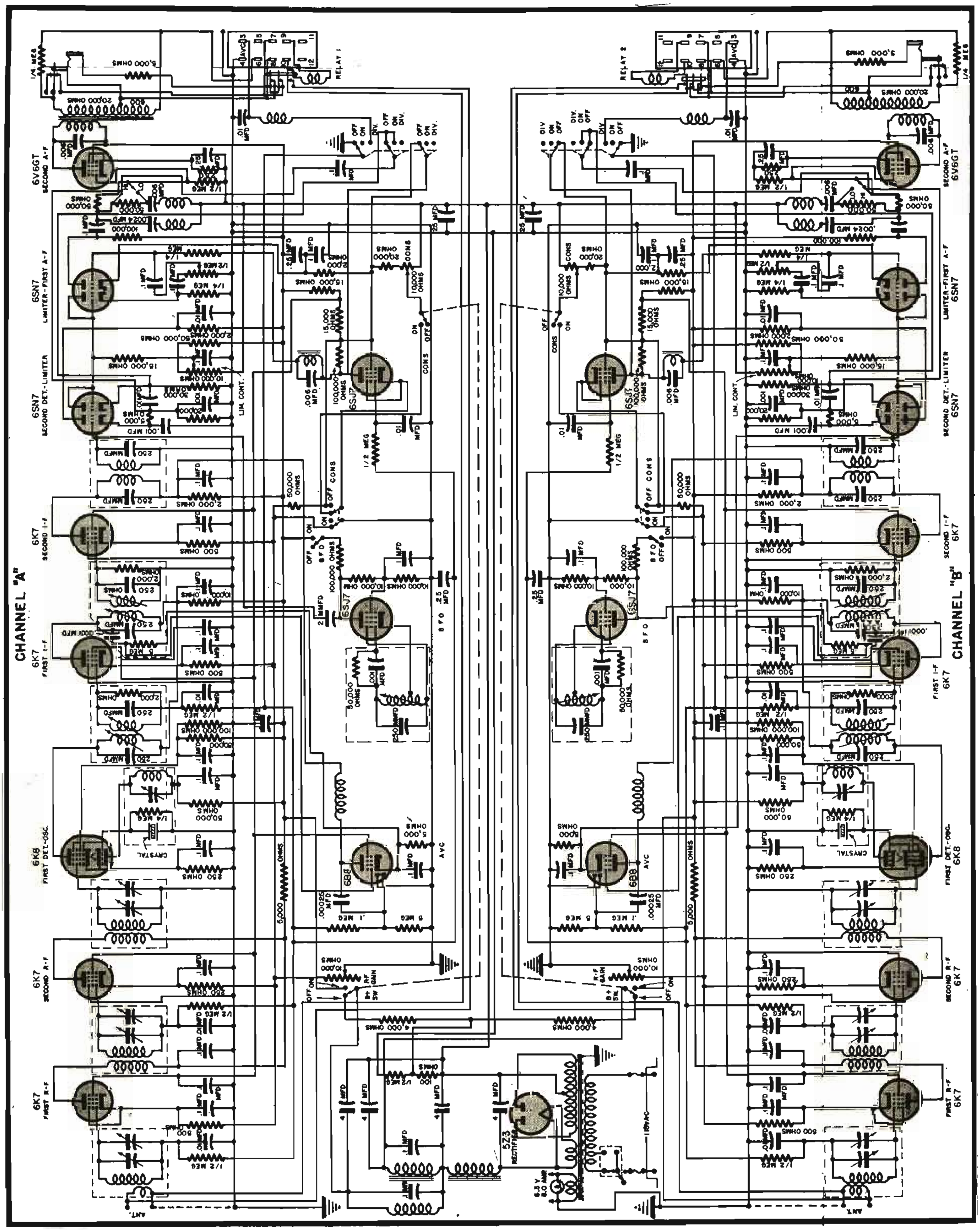
The r-f sensitivity of the receiver in each channel is such that 1 microvolt r-f input delivers sufficient output signal with a very large margin f safety.

Another aid to noise suppression is the series type diode noise limiter. With this noise limiter the output power level can be controlled between the limits of 1 milliwatt and 2 watts. The amount of limiting action is controlled by a 10,000-ohm unit, which provides the voltage applied to the diode plates of the limiters. The diodes are made up of a triode section of each of two 6SN7s with grid and plate tied together.

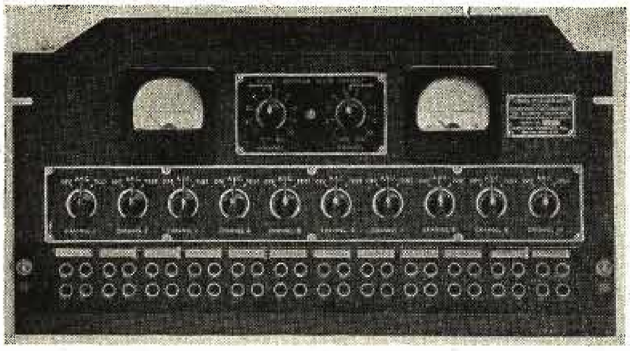
C-O-N-S circuits (carrier-off-noise-suppressed) are used in each receiver channel. These are audio squelch circuits actuated by the avc voltage for unsquelching. When the receiving system is being used in diversity, with all eight channels, the reception of one strong signal unsquelches all eight receiver channels. In a receiving channel set for avc action within its own channel only, the c-o-n-s circuit using a 6SJ7 d-c amplifier may be effective in noise reduction with very weak signals.

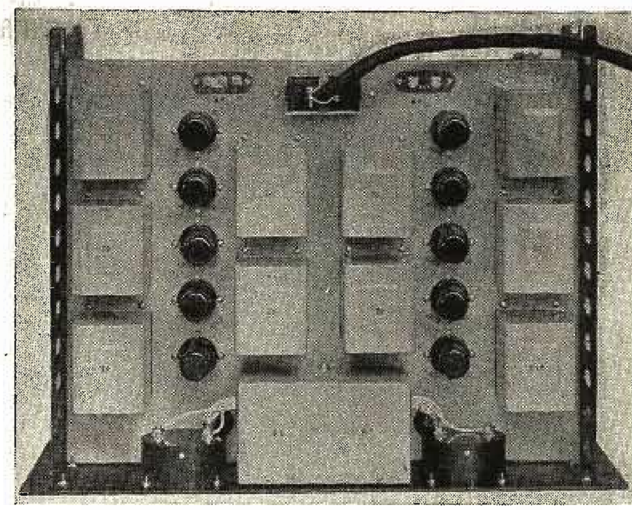
To insure good frequency stability of the local heterodyning oscillator of each receiver channel a low-frequency temperature-coefficient crystal is used as a frequency control. The crystal oscillator circuit is the simple plate-tuned circuit resembling the t-p-t-g oscillator where the grid tank circuit is replaced by the crystal oscillator plate. A 6K8 is used as the mixer-local oscillator; its conversion transconductance is quite high.

For frequencies above 10 mc the crystal can be operated as a mechanical harmonic oscillator with no circuit changes. To derive a 12,200-kc signal, for example, a crystal with a fundamental thickness-shear resonant frequency of 4,066.667 kc may be used, with the plate tank circuit tuned to 12,200 kc. The crystal will oscillate at its third mechanical harmonic and that will be the only signal developed. The frequency-temperature coefficient at third harmonic operation is the same value as for fundamental frequency operation. Thus the same


CHANNEL "A"
CHANNEL "B"
6V6GT SECOND A-F
6SN7 LIMITER-FIRST A-F
6SN7 SECOND DET.-LIMITER
6K7 SECOND I-F
6K7 FIRST I-F
6K8 FIRST DET.-OSC.
6K7 SECOND R-F
6K7 FIRST R-F
6SJ7
6B8
5Z3 RECTIFIER
RELAY 1
RELAY 2
CRYSTAL
ANT.
BFO
AVC
LIM. CONT.
R-F GAIN
115 V AC
6.3 V 8.0 AMP





**Figures 5 (above) and 6 (right)**

**Figure 5. Front view of the signal rectifier unit. Each channel of the four dual-channel receivers feeds a separate signal rectifier and the signals are mixed as d-c after rectification. Figure 6. Top view of the signal rectifier unit. Its power is derived from the power supply on the keyer-oscillator chassis.**

order of frequency stability is possible.

Adequate isolation of the fields of each crystal oscillator in any one dual channel chassis is another circuit feature. Since both channels receive the same frequency signals there must be no interaction between local oscillators. Undesirable beats and spurious frequencies may result from local oscillator coupling. The isolation is such that the spurious signals are at least 40 db below the desired signal.

The i-f system of this receiver is set nominally at 455 kc. The actual frequency is determined by the frequency error of the local heterodyning oscillator and is aligned at the factory with the actual operating crystal in the circuit. This error is under 1 kc, and represents the frequency tolerance of the local oscillator crystal.

For signal frequencies above 4000 kc the crystal oscillator frequency is below that of the incoming signal. For signal frequencies below 4000 kc, the crystal oscillator frequency is above that of the incoming signal.

The i-f system has a broad nose characteristic. This is desirable to accommodate frequency drifts of either the transmitting station or of the local oscillator in the receiver. Selectivity curves show that at 6 db down the bandwidth is not less than 4 kc, and at 60 db down the bandwidth is not more than 24 kc.

Each receiver channel employs a b-f-o. A 6SJ7 is used as a Hartley oscillator electron coupled to the plate of the tube.

In the usual communications receiver the use of the b-f-o would decrease the gain of the receiver if avc is used. This decreased gain is caused by the avc developed when the b-f-o signal is picked up by the i-f system. Such a condition must be avoided in a diversity system of the polar type.

**Figure 4 (left)**

**Schematic of one of the four dual-channel receivers. Note that the b-f-o is coupled directly to the grid of the infinite-impedance second detector, and the avc voltage is derived from the plate circuit of the first i-f stage. The avc voltage is then amplified and rectified, and used to control the bias on the first and second r-f stages, and the first r-f stage only.**

The solution of this problem involved several factors. The b-f-o is very carefully shielded to avoid radiation and stray coupling to the i-f system. The b-f-o signal is fed directly to the grid of the second detector. However, the avc amplifier tube is not fed from the load in the second detector, but rather from the plate load of the first i-f stage. The amplified and rectified avc voltage serves as grid bias for only the first and second r-f stages and the first i-f stage. The second i-f stage acts as a buffer, isolating the avc and the b-f-o actions.

A high order of stability of the frequency of the b-f-o is necessary over ambient temperatures from –10° C to + 50° C, and for relative humidities up to 90%. Accordingly, permeability tuning is used in the oscillator tank. The tank coil has especially low temperature-frequency drift characteristics. Negative-temperature coefficient capacitors are used here as well as in the i-f system resonant circuits.

The b-f-o in each receiver is adjusted at the factory with the local crystal oscillator plate, to be used in the field, inserted in place. In the factory tests, the actual signal to be received or an accurate replica of same is tuned by the receiver. The b-f-o is set so that an audio-frequency tone of 1500 cycles is developed at the second detector. Due to receiver and transmitter drift this 1500-cycle tone may vary from 600 cycles to 2400 cycles in actual operation, but with no deleterious effect on c-w recording.

It is true that each transmitter and receiver channel may drift differently. Therefore the 1500-cycle tone set at the factory for each channel may vary in some random manner in field operation. If the output of each receiver were to be combined to mix these nominal 1500-cycle tones the resultant would be a signal of many multiple signals, interference between signals causing fluttering and beats. Aural reception and interpretation of such a signal would be difficult. To derive a satisfactory signal for recording each receiver output is rectified separately and the outputs are combined as direct current. The combined signal is then used to actuate a v-t keyer, which keys a local tone generator.

The second detector used in each channel is one triode section of a 6SN7 connected as an infinite impedance detector. The a-f voltage of approximately 1500 cycles is developed across the cathode load, 20,000 ohms, and then fed to the series limiter circuit.

Remote quieting of any receiver channel may be accomplished by the use of a relay, *1*. This relay short circuits the antenna terminals as well as the output transformer secondary.

By means of patch cords the audio signal output of each receiver channel may be connected to the input of a 10-signal rectifier channel, Figure 7. Here the audio signals are rectified separately and then combined in shunt as d-c. In Figures 5 and 6 appear front and top views of the signal rectifier unit. One 6SC7 is used in each channel as a grid-controlled full-wave rectifier operated at beyond cut-off grid bias. The grids are fed in push-pull and the plates are connected in parallel to effect full-wave rectification. By adjustment of the rectifier bias control, 10,000 ohms, Figure 10, it is possible to eliminate the effect of noise currents in the rectified signal when the desired signal input levels up to 10 volts rms are at least 1 volt rms above any noise or interference levels. Thus signal-to-

(*Continued on page* 46)

## SHIP-TO-SHORE RADIOTELEPHONE

*(Continued from page 35)*

switched for frequency changing, with the most flexible arrangement for loading the modulated amplifier.

The audio portion of the transmitter consists of two 6L6Gs as modulators and one 6L6G speech amplifier. The energy for the voice relay circuit is taken from the input transformer to the modulators.

### Receiver Features

The receiver is of the superheterodyne type, employing one r-f stage, a crystal-controlled mixer, one 465 i-f stage, a diode detector/avc/first audio, and a triode output.

To facilitate frequency changing, three separate amplifiers are provided for the r-f frequencies involved, with a separate mixer and crystal oscillator for each channel. Frequency changing is accomplished by switching the plate voltage to the amplifier and mixer desired. This control is ganged with the transmitter channel shift control so that only one operation is necessary to change frequency.

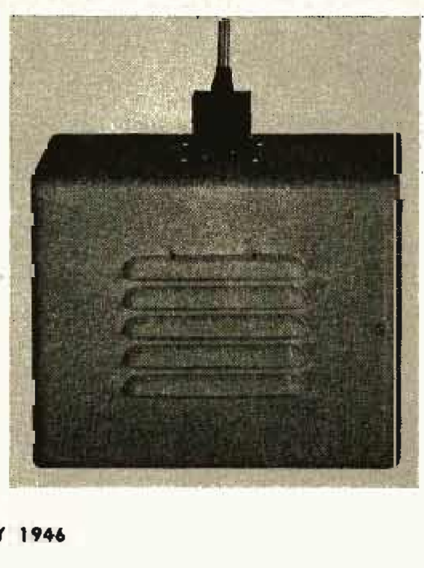
### Receiver Sensitivity

The receiver has an average sensitivity of approximately one microvolt. A high degree of selectivity is obtained by the use of iron-core inductances in all of the tuned circuits.

In previous Great Lakes apparatus design and construction the practice has been to house all equipment in one cabinet. It was felt that on small craft, the installation problem could be simplified if the equipment were built in two pieces. Consequently, this 25-watt transmitter and receiver is housed in a 20" × 18" × 9½" case while the power supply is housed in another cabinet, 12" × 10" × 7". This method of construction permits interchangeability in the power supplies.

The equipment can be supplied for operation on 6, 12, 32 or 110-volt power sources.

Figure 8
Housing for power supply for 25-watt radiotelephone unit designed for smaller craft.





### RADAR COUNTERMEASURE SYSTEMS

PBY patrol bomber with radar countermeasure equipment.
*(Courtesy U. S. Navy)*

## THE MARTIN NETWORK

(*Continued from page* 19)

2 hours with a microphone button. Extensive silencing of all engine ignition and incidental electrical apparatus was necessary to provide undisturbed reception from the relatively weak airplane transmitters on the ships' antennas which do not exceed 12′ length on the large boats and 7′ on the small boats. The physical dimensions of the antennas are dictated by the potential damage the antenna structures could inflict on airplane hulls when operating in rough water close to the hull or under the wings.

A quick release hinge was also provided on small boats. This drops the whip antenna alongside the gunwhale when passengers board from seaplanes in rough water. As all cruisers are equipped with towing bitts, the after end of the horizontal antenna has to be carried on a 45° inclined mast to provide sufficient antenna length and at the same time permit free play to the tow lines.

The constant hazard of *off-frequency* operation was diminished to a negligible amount by the operation of the monitor station. This set-up functions as part of the tool organization's radio laboratory and is manned constantly. One heterodyne-type frequency meter covers the l-f and m-f bands. A harmonic-type signal generator and absorption-type frequency meter is used for checking frequenies up to 700 megacycles. Random checks are made daily in addition to a scheduled monthly check of all transmitters.

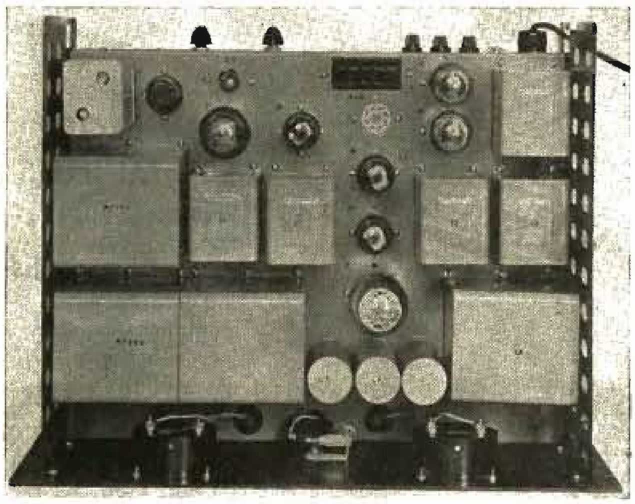
**Organization**

The entire system is administered by two basic organizations, *tool engineering* and *flying branch,* operating through the *plant electrical engineer* and the tower personnel respectively. The plant electrical engineer was responsible for all work until the station was completely engineered and tested. The operating personnel took over only after satisfactory operating tests. One phase of the plant electrical engineer's continued responsibilities was the setting up of preventative maintenance schedules and preparation of maintenance instructions.

The plant electrical engineer is also responsible for proper technical procedure during construction and testing of the airplane radio. The flying branch maintains rigid control over all operational functions. These two organizations so balance the performance of the network that production aspects do not superimpose themselves upon traffic control to the detriment of safety.

# CAA DIVERSITY SYSTEM

(*Continued from page 43*)



Figures 7 (bottom), 8 (left top) and 9 (left center)

Figure 7. Schematic diagram of the signal rectifier unit. Jacks allow for the monitoring of each separate input to the signal rectifier channels.

Figure 8. Front view of the keyer-oscillator unit. This unit feeds the c-w recorder as well as the speaker amplifier monitor.

Figure 9. Top view of the keyer-oscillator unit. This unit also supplies filament and plate power to the signal rectifier unit.

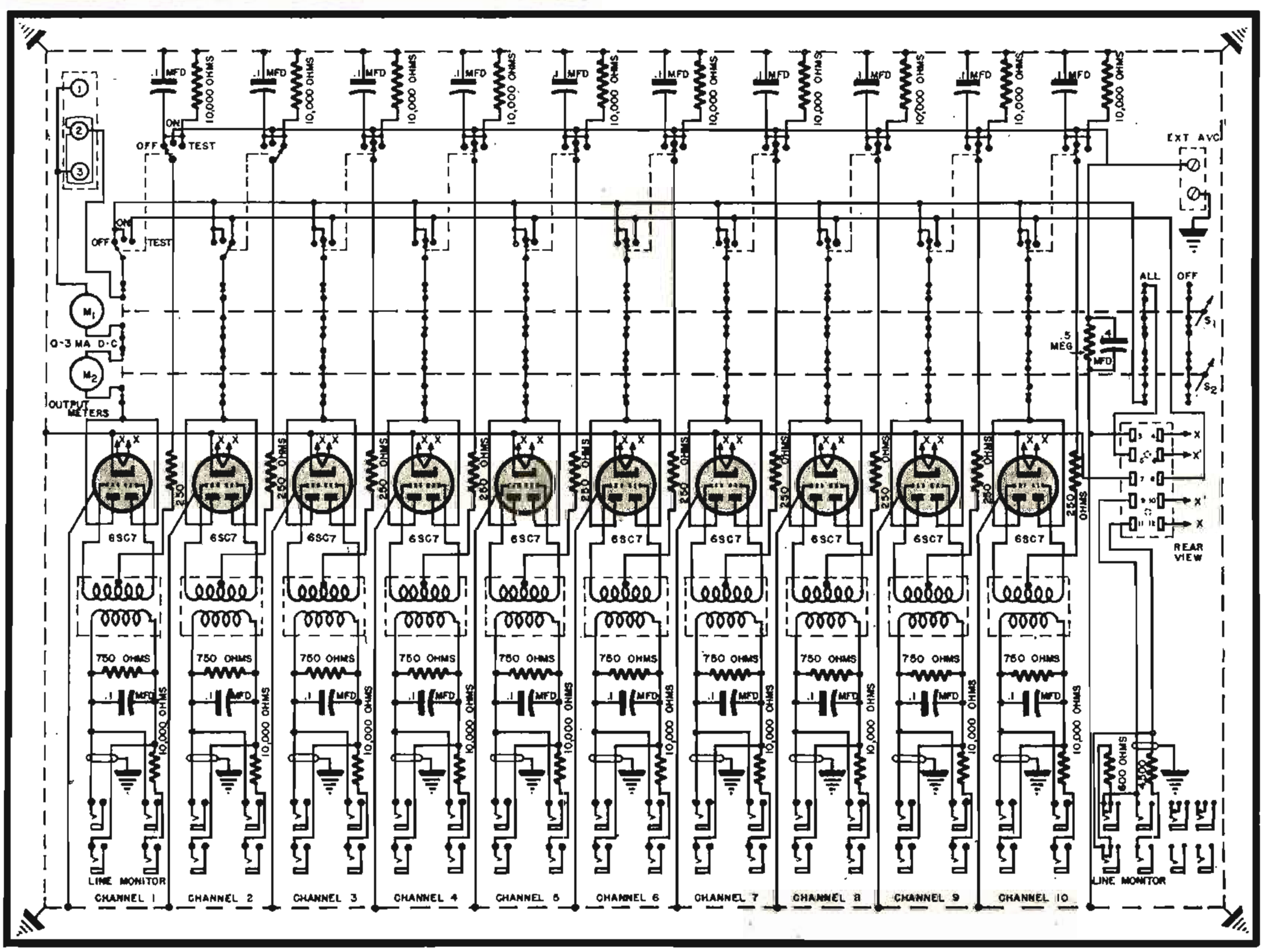
noise discrimination may be made quite high.

Although the plate voltage on the 6SC7's is fairly low some gain is realized in each signal rectifier channel.

Another interesting diversity interconnection is possible in the signal rectifier unit. A grid bias bus is provided so that the bias developed across the .5-megohm resistor and 4-mfd capacitor by incoming signals may be used in common by all channels. When used in this way, avc action is realized, and a strong signal rectified in one channel provides bias to reduce the output of all the other channels. The *IR* drop across the .5-megohm unit is of such polarity as to add to the fixed bias set by the 10,000-ohm resistor. The resistors leading from the center tap of the secondary of each channel's input transformer to the bias bus provide additional bias for each individual channel and serve as isolating resistors when signals are applied to the input of the channel.

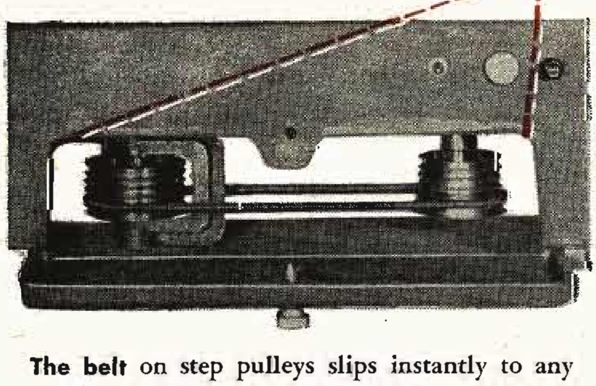
The avc bias developed by the rectifiers is available for external use at a pair of terminals mounted at the rear of the chassis.

***[To be concluded in February]***



# Not jet propelled . . .


# but just as NEW!



PRESTO'S newest *turntable* . . . for highest quality master or instantaneous recordings. The 8-D features instantaneous change of cutting pitch. An improved cutting head provides higher modulation level, more uniform frequency response and retains its calibration under all normal temperature conditions.

The heavy cast-iron turntable and mounting base insure exceptionally low background noise. Adjustable feet permit accurate leveling on bench or stand at a height to suit the operator.

**The belt** on step pulleys slips instantly to any position to set cutting pitch at 96-104-112-120-128 or 136 lines per inch. Other pitches available on special order.

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***Walter P. Downs, Ltd., in Canada***

**WORLD'S LARGEST MANUFACTURER OF INSTANTANEOUS SOUND RECORDING EQUIPMENT AND DISCS**

# VOLTAGE-REGULATED

[Part III]

by G. EDWARD HAMILTON and THEODORE MAIMAN

Senior Engineer
Test Equipment Division
National Union Radio Corp.

Formerly Junior Engineer
National Union Radio Corp.
Now with U. S. Navy

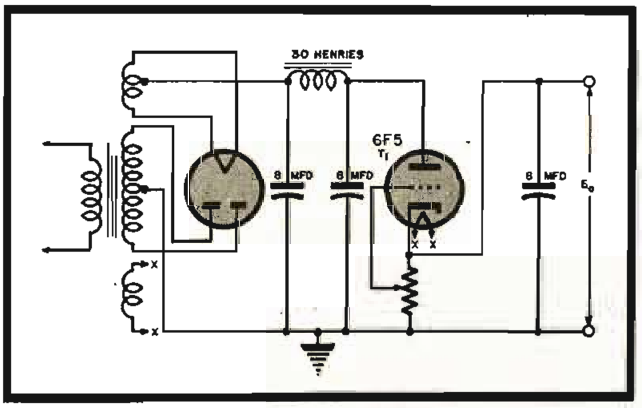



Figure 5 (See Notes on page 49)

Degenerative voltage control system. This regulator compensates for changes in output voltages resulting from both changes of line voltage and varying load current.

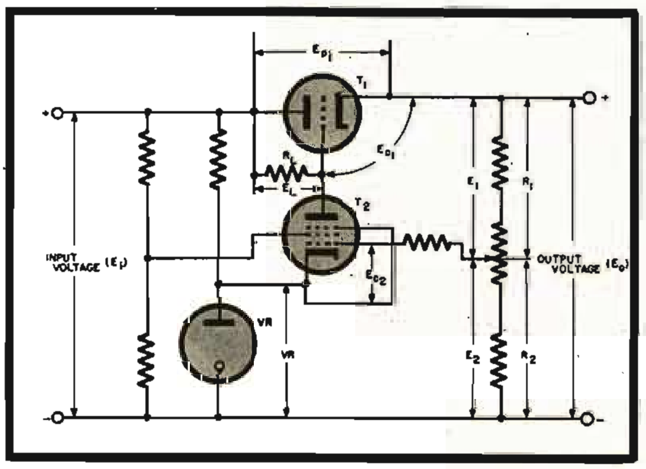



Figure 6 (See Notes on page 49)

Circuit that provides compensation for both changes of input voltage and load current. It also has a low internal impedance between its output terminals.

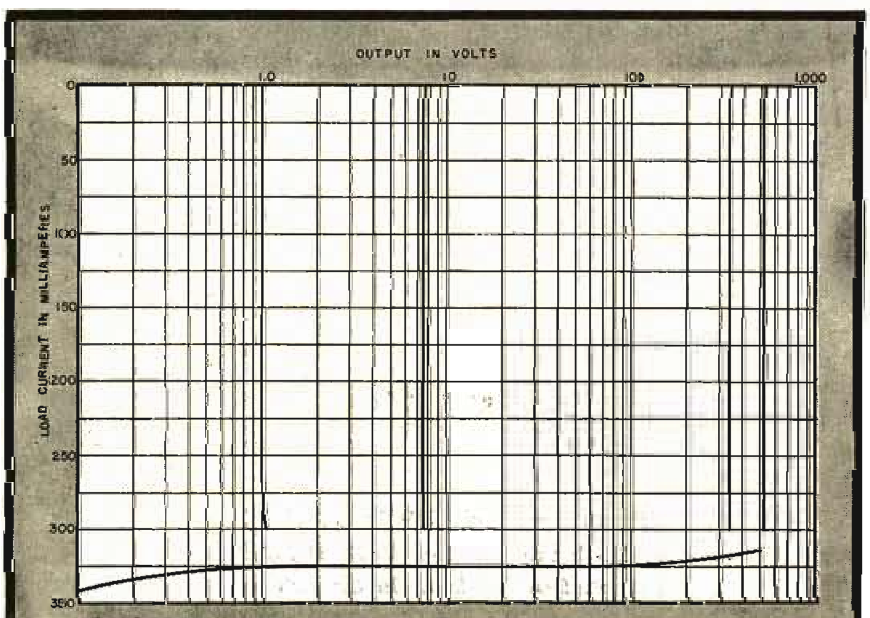



Figure 11

Operating characteristics of 0 to 500-v/300-ma stabilized supply, showing output voltage versus output current. Note good regulation at low voltages.

NORMAL operating potentials appearing in the supply when adjusted to a 400-volt output are shown below. An RCA voltohmyst, jr., was used for the measurements, and all voltages are with respect to the negative output terminal.

| | | |
|---|---|---|
| Plate | of 829Bs | = 650 |
| Plate | of 6SJ7 | = 320 |
| Screen | of 6SJ7 | = –21.5 |
| Cathode | of 6SJ7 | = –145 |
| Cathode | of 829Bs | = 400 |

If only the complete range is desired the 9-megohm shunt control potentiometer may be omitted and the bleeder resistance values changed to $R_A = 35{,}000$ ohms, $R_B = 20{,}000$ ohms, and $R_C = 12{,}700$ ohms. This arrangement does make low-voltage settings critical.

Measured potentiometer resistances for normal operation are:

($R_2$) Screen to cathode = 170,000 ohms
($R_3$) Cathode to negative end of control (bottom) ....... = 3,500 ohms
Cathode to positive end of control (top) .......... = 1,800 ohms

It is to be noted that these values are for a particular supply and choice of different component parts will introduce sufficient variation to make these figures only approximate.

### Appendix: Basic Power Supply Design

#### High Voltage Supply:

Output voltage = 650
Ripple factor (PO) = .01%
$\alpha = 6670 = (W^2LC-1)^n$
$R_t$ (no load) = 20,000 ohms
$R_t$ (full load) = 1,890 ohms

$$L_o \text{ (no load)} = \frac{20{,}000}{1{,}000} = 20 \text{ henries}$$

$$L_o \text{ (full load)} = \frac{1{,}890}{500} = 3.78 \text{ henries}$$

For practical values we should use a

5 - 20 henry swinging input choke.

***For Second Filter Section:***

$$LC = \sqrt{\frac{\alpha + 1}{w^2}} = \frac{6{,}670 + 1}{567{,}913} = 144 \times 10^{-6}$$

It is then necessary to determine $C_1$ for first section using $L_o = 5$ henries as a limiting case.

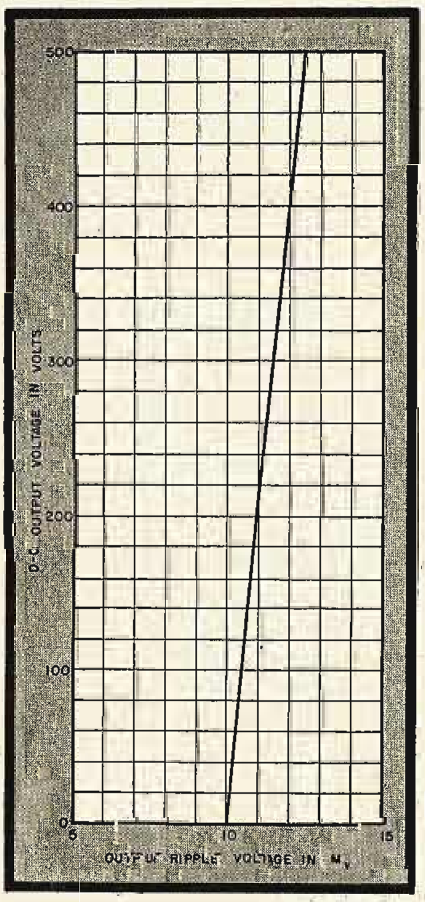
$$C = \frac{144 \times 10^{-6}}{5} = 29 \text{ mfd}$$

or in practical values, a 2 to 80 mfd capacitor can be used in series. We then should determine $L_2$ using an 8 mfd capacitor for $C_2$.

$$L = \frac{144 \times 10^{-6}}{8 \times 10^{-6}} = 18.2\ ;$$

•

Figure 12
Plot of d-c output voltage versus output ripple voltage for a voltage-stabilized power supply. (See page 71, December COMMUNICATIONS for circuit of supply). The supply current was 150 ma.




$L_2$ should then be 20 henries.

***Negative Voltage Supply:***

Output voltage $= -315$

$$\text{Ripple factor} = .005\% = \frac{66.7}{.005} = 13{,}340$$

$R_1$ (constant load) $= 6{,}300$ ohms

$$L_{min} \text{ at rated load}, = \frac{6{,}300}{500}$$
$$= 12.6 \text{ minimum value}$$

$$LC = \frac{\sqrt{\alpha + 1}}{w_2} = \frac{\sqrt{13{,}341}}{567{,}913} = 204 \times 10^{-6}$$

For the first section $L_1$ should equal 20 henries.

$$C_1 = \frac{204 \times 10^{-6}}{20} = 10.02 \text{ mfd}$$

For the second section $L_2$ should equal 20 henries.

$$C_2 = \frac{204 \times 10^{-6}}{20} = 10.02 \text{ mfd}$$

***R Tube Series Resistance:***

$$R = \frac{E_1 - V_R}{I_{VR} + I_L} \quad \text{where:} \quad E_1 = 450 \text{ v}, \quad VR = 315, \quad I_{VR} + I_L = 50 \text{ ma}$$

$$R = \frac{1.35}{.05} = 2{,}700 \text{ ohms}$$

***Notes***

In the November, 1945, discussion we noted that an increase in output voltage causes $E_2$ (Figures 5 and 6) to increase in direct proportion to the change in output voltage ($\Delta E_o$). This increase in $E_2$ results in a decrease of bias voltage on $T_2$, causing the negative bias for $T_3$ to become more positive, which causes an increase in plate current of $T_2$. This causes the plate resistance of $T_3$ to decrease resulting in an increase of negative grid bias on $T_1$ (becomes more negative) which decreases the plate current through $T_1$. This may be considered an automatic resistance element in series with the load, operating in a manner such that an increase in $E_o$ causes more resistance to be included in the circuit, resulting in a regulated output voltage. If the output voltage drops, regulation will be obtained by the reverse process. The minimum output voltage in this system cannot be reduced to zero.

| *Tube Type* | *Voltage* | *Current* |
|---|---|---|
| **VR-150 (a)** | 164 | 0 |
| | 151 | 3.4 |
| | 151 | 4.0 |
| | 152 | 8.0 |
| | 152 | 10.0 |
| | 153 | 20.0 |
| | 156 | 30.0 |
| | 157 | 35.0 |
| **VR-150 (c) (with internal pin)** | 150 | .2 |
| | 155 | 1 |
| | 154 | 2 |
| | 154 | 10 |
| | 152 | 15 |
| | 151 | 20 |
| | 151 | 30 |
| | 151 | 40 |
| **VR-105 (b)** | 124 | 0 |
| | 114 | 1 |
| | 112 | 2 |
| | 112 | 3 |
| | 112 | 9 |
| | 110 | 10 |
| | 110 | 20 |
| | 110 | 30 |
| | 110 | 40 |
| **VR-150 (b) (with internal pin)** | 152 | 0 |
| | 150 | .5 |
| | 154 | 1.0 |
| | 154 | 2.0 |
| | 155 | 4.0 |
| | 159 | 6.0 |
| | 159 | 8.0 |
| | 159 | 10.0 |
| | 159 | 20.0 |
| | 159 | 30.0 |
| | 159 | 35.0 |
| **VR-105 (a)** | 122 | 0 |
| | 112 | 1 |
| | 112 | 2 |
| | 112 | 3 |
| | 111 | 4 |
| | 111 | 6 |
| | 110 | 10 |
| | 110 | 20 |
| | 110 | 30 |
| | 110 | 40 |
| **VR-105 (c)** | 123 | 0 |
| | 114 | 1 |
| | 112 | 2 |
| | 112 | 10 |
| | 111 | 20 |
| | 110 | 30 |
| | 110 | 40 |

Voltage-current characteristics of various types of VR tubes.

# HIGHLIGHTS OF DR. P. C. GOLDMARK'S PAPER ON COLOR TELEVISION

[PRESENTED BEFORE RADIO CLUB OF AMERICA]

BY RALPH G. PETERS

WITH color television interest growing daily and CBS playing an important role in fostering this interest, Dr. Goldmark has offered several color television papers during the past few years analyzing progress of the art. In this R. C. of A. paper he continued these analyses, offering data on the current television developments of the CBS engineering department.

## Baird Systems

Recalling the color television demonstrations of J. L. Baird, in England, in July 1928, he said that the famous Nipkow mechanical scanning disc used had three sets of spirally-disposed holes about its circumference, one set of holes being provided with red filters, the second with blue and the third set with green filters. The system produced approximately 15-line pictures and required a transmission bandwidth of 10 kc.

It wasn't 'till 1938 that color demonstrations were given again. And again Baird did the demonstrating, this time with a 120-line system which employed a 20 facet mirror drum revolving at 6,000 rpm, plus a 2-color filter disc (orange and blue-green) revolving at 500 rpm, all in conjunction with an optical lens system and a photocell arrangement.

In 1941 Baird demonstrated a 600-line color-television system using a dual cathode-ray tube scanning arrangement plus a rotating 2-color filter disc. The two sets of images were made to register on a common screen through an optical system. This was an extremely difficult problem because alignment of the images had to be exact to within 1/2000 of the picture height if a good resultant image was to be obtained.

In 1944 Baird announced a different 2-color television system wherein no moving mechanical parts were employed. This system made use of a special cathode-ray tube having two electron gun structures and a special translucent target which was scanned on one side with one electron gun, and had red flourescent material on the target. It was scanned on the other side with the other electron gun, with a blue-green target material.

## Color Photography and Television

Dr. Goldmark explained that in color photography additive color methods are used on the taking end and subtractive methods are used on the reproducing end. A three-layer film composed of magenta (which is red plus blue, or minus green), cyan (which is blue plus green, or minus red) and yellow (which is red plus green, or minus blue) is used to achieve the subtractive process.

Dr. Goldmark was of the opinion that a subtractive process was out of the question for color television, because of the technical difficulties involved in the way of the amount of light available, exposure time, and the rapidity with which the chemical color changing process could be made to progress or retrogress. As a consequence, additive methods must be considered, and these are of two basic types:

(1)—A 3-channel simultaneous method, which imposes virtually impossible registering requirements.

(2)—The sequential scanning method,



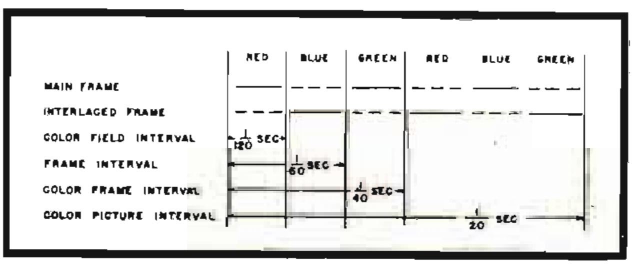



Figure 1
Picture frame intervals for color television, discussed by Dr. P. C. Goldmark.

which is quite feasible and is used in the present CBS color television system.

Dr. Goldmark discussed the Maxwellian *color triangle*[1], and showed how closely the present-day color photography art has succeeded in approaching with the synthetic means that had been devised. He then compared this optimum synthetically produced triangle with the one which represents CBS's color television system, and pointed out that the television system came close to duplicating the color values which are possible with the optimum photographic process.

#### Present CBS System

The present CBS color television standards call for a 525-line system utilizing a 10-mc wide transmission band. Equal horizontal and vertical definition were said to be obtainable with this arrangement. According to Dr. Goldmark, the CBS television system will transmit on a carrier frequency of 485 to 500 mc. Their experimental receivers use 105-mc i-fs, 10-mc wide, with either color drums or color discs to effect sequential scanning. Each color field interval is 1/120 second, whereas the frame interval (normal plus interlaced) is 1/60 second. A complete color frame (3 color) is thus scanned in 1/40 second, whereas a complete color picture is obtained in 1/20 second, Figure 1.

Color *phasing* of the receiver disc is automatically insured by transmission of synchronizing pulses every 1/40 second so that the quality of the image is high.

Sound is transmitted in the form of *bursts* of frequency modulation of the picture carrier, these bursts of modulation being introduced only during the flyback time of the horizontal traces. This effectively gives a time-division multiplexing action, which therefore permits the use of the same amplifier tubes, power and wide-band antenna for both the picture and the sound. The picture or video modulation is of the single sideband amplitude type.

[1]May, 1944, COMMUNICATIONS.

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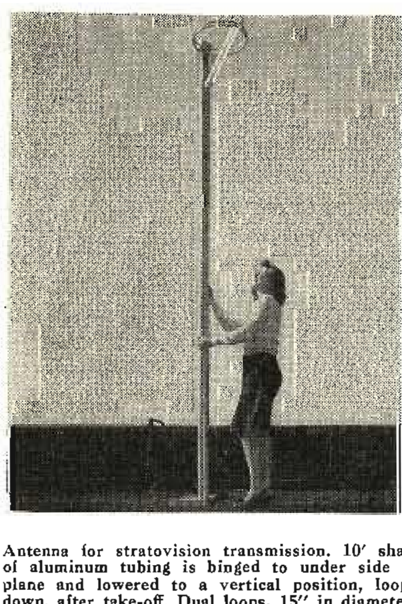
### STRATOVISION ANTENNA



Antenna for stratovision transmission. 10′ shaft of aluminum tubing is hinged to under side of plane and lowered to a vertical position, loops down, after take-off. Dual loops, 15″ in diameter. F-M programs will be transmitted from aircraft during tests scheduled before the end of the year. *(Courtesy Westinghouse)*

•

# THE EFFICIENCY OF A SHORT TRANSMITTING ANTENNA

**By DR. VICTOR J. ANDREW**

**Andrew Company**

IT is often necessary to use a transmitting antenna which is so small that low antenna efficiency results. When an antenna of less than 0.18 wavelength is operated against a ground plane, large losses occur in the antenna loading inductance. This is due to the fact that such an antenna has a low radiation resistance and a high negative reactance. It is necessary to use a large loading inductance with it, and then the loss resistance in the inductance becomes larger than the radiation resistance of the antenna.

### Typical Problems

Typical cases where this difficulty occurs are:

(*1*)—Transmitter on 200 kc. Here the height of the antenna tower is limited to 400′ because of cost. This antenna has a height of 0.08 $\lambda$.

(*2*)—Transmitter operating in an automobile on 1,600 kc. A 6′ whip antenna must be used . This antenna has a height of 0.01 $\lambda$.

(*3*)—A 100-mc transmitter in a fast airplane. For mechanical reasons the antenna must be limited to 8″. This antenna height is 0.07 $\lambda$.

The efficiencies obtainable with short antennas can be illustrated by further consideration of case (*2*). The 6′ whip at 1,600 kc has a radiation resistance of about 0.3 ohm and a negative reactance of about 2,400 ohms. Such an antenna will be loaded with a series inductance which has 2,400 ohms positive reactance. A small transmitting inductance has a $Q$ of about 300. This means that the resistance inherent in the inductance is 8 ohms. And this loss resistance is in series with the antenna resistance of 0.3 ohm. Consequently a 10-watt transmitter will deliver 0.4 watt to the antenna to be radiated. and will have a loss of 9.6 watts in the antenna loading inductance.

A still greater inefficiency results if there is unnecessary capacity between the base of the antenna and ground. In the foregoing case there may be a 6′ leadin from the base of the antenna to the transmitter. This leadin may consist of a coaxial cable with a capacity of 25 mmfd per foot. There may be an additional capacity of 50 mmfd in the base insulator of the antenna and the antenna insulator bushing of the transmitter. Thus we have a total of 200 mmfd of capacity or about 500 ohms negative reactance across the base of the antenna. The antenna loading coil is assumed to be inside the transmitter.

The effect of this added capacity is to make the apparent antenna characteristics 0.009-ohm resistance and 400 ohms negative reactance. The antenna loading coil used with this antenna will have 400 ohms positive reactance. If it has a $Q$ of 300, the coil resistance will be 1.3 ohms. The radiated power will then be 0.07 watt and the power lost will be 9.93 watts. It will be noted that six times as much power would have been radiated if the base capacity had been avoided.

#### *Improving Efficiency*

From this illustration it is seen that the efficiency of any short antenna is very low. However, there are still large variations in the radiated power, depending on the care taken to meet the following conditions:

(*1*)—Use of the greatest possible antenna height.
(*2*)—Highest possible $Q$ in the loading coil.
(*3*)—Lowest possible capacity in the associated leadin.

If the antenna loading inductance is mounted at the base of the antenna rather than inside the transmitter, very substantial gains are possible. These are due to: (*1*)—Inductance has a higher $Q$ when mounted in free space than when mounted inside the metal housing of the transmitter; and (*2*)—leadin is eliminated and capacity across the base of the antenna is a minimum.

•

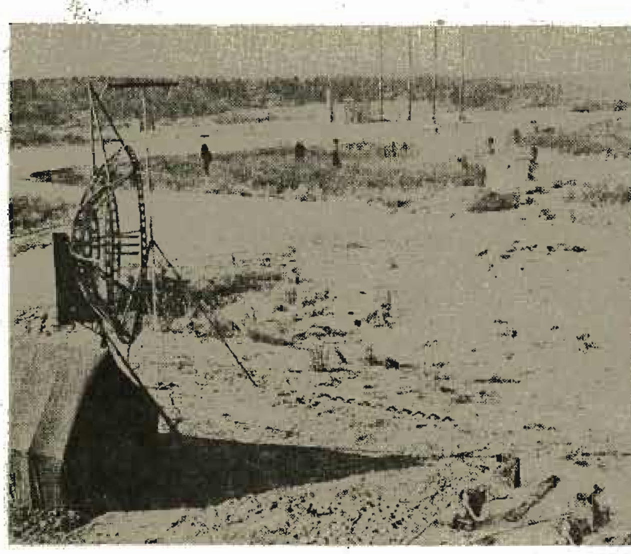
#### *AIRCRAFT RADAR JAMMER*

G. E. electronics engineers, A. J. W. Rhodehamel, and A. P. Heymann, with aircraft radar jammer. AN/APT-4.

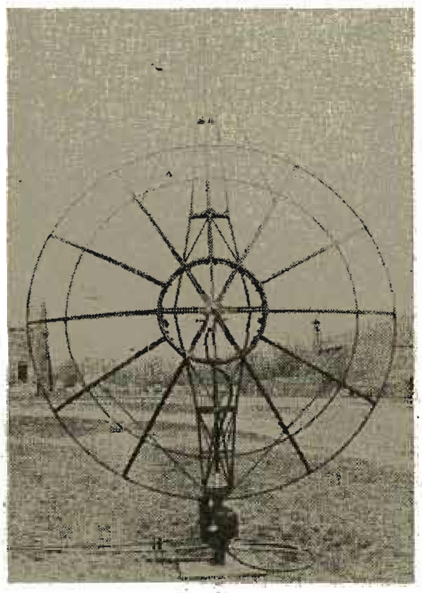
# LIGHTWEIGHT RADAR FOR EARLY WARNING

—by WILLIAM C. HENDRICKS—

Office of the Chief Signal Officer
War Department



Early warning AN/TPS-3 in operation. Tripod-supported antennna served to identify friend or foe aircraft.



Antenna reflector screen of radar unit.

A RADAR set, model AN/TPS-3, which could be transported by plane and set up in forward areas inaccessible to larger detector equipments gave invaluable service in warning of approaching aircraft in the European and Pacific theaters.

This equipment, designed and developed at the Evans Signal Laboratory, Belmar, N. J., weighed only 1,340 pounds when packed and required only two operators.

This radar unit was used for aircraft detection with the fighter-director system and for warning during the low-altitude buzz-bomb attacks against Antwerp and Liege.

On Saipan the set proved to be the most important radar on the island. Reliable ranges of 90 miles were obtained on aircraft of medium size flying at 10,000 feet, and better than 30 miles on aircraft at 200 feet.

The transmitter was built around a 200-kw, 600-mc multi-element oscillator tube developed by Lt. Col. Harold Zahl.[1] The tube, the VT-158, the equivalent of four, was used in a self-contained circuit.

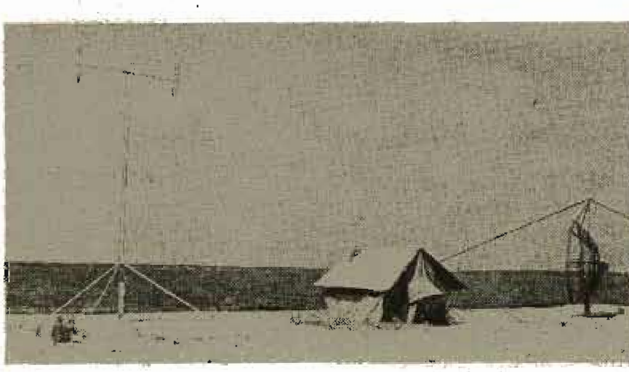
A PPI (plan position indicator) cathode-ray tube, connected through the receiver to a lightweight, rotating, parabolic antenna assembly, gave a presentation of all detected aircraft through the entire 360° of azimuth. An A-type c-r indicator furnished accurate range data and better presentation of weak targets.

The final production model was completed in February 1944 and production started the following month. Because of the urgent tactical need for the equipment on the fighting fronts, eleven shop model units were constructed and shipped to the European and Pacific theaters. The first combat test was with the airborne invasion of Holland.

Installed on the ground, the AN/TPS-3 was housed in a tent directly beneath the antenna assembly. The antenna consisted of three displaced dipoles with lobe switching in a 10′ paraboloid. In searching, the antenna rotated at six revolutions per minute. Target following was by manual tracking. The pulse rate of the transmitter is 200 per second; the pulse length, 1.5 microseconds.

The superheterodyne receiver employs two r-f stages and six i-f stages. The 7″ PPI scope and a 5″ A scope give indications in 20-, 60-, and 120-mile ranges. Accuracy is within 2 miles in range and 2 degrees in azimuth. A gasoline-driven power unit furnishes 1.4-kilowatt, 110-volt, single-phase, 400-cycle a-c, and 0.4-kilowatt, 28-volt d-c.

The equipment was designed to withstand temperatures between −40° F and +140° F, with humidity ranging up to 100%.

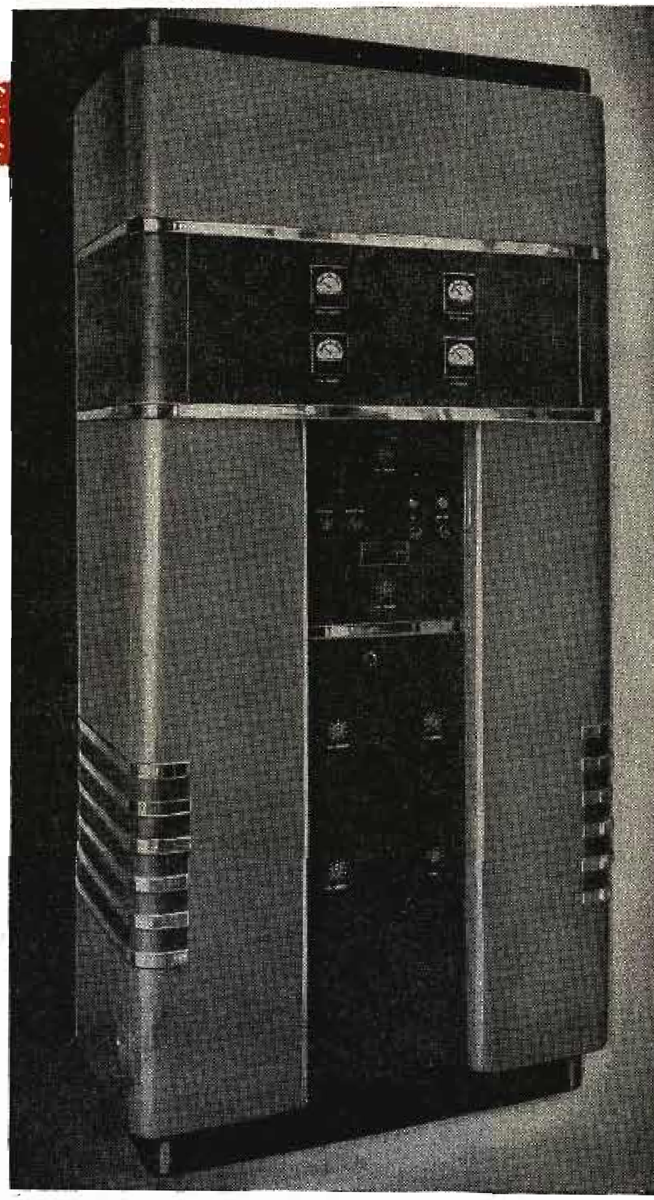


Early warning radar installed for detecting enemy aircraft approaching over water.

[1]Lewis Winner, IRE Winter Technical Meeting, COMMUNICATIONS; February 1945.

# JOHNSON

## NOW IN PRODUCTION ON PHASING EQUIPMENT



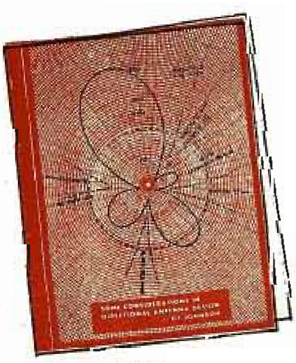
You no longer have to be satisfied with mere planning for better market coverage! Johnson engineers are now ready to tackle your directional antenna problem and to get the Phasing Equipment you need into production.

Phasing equipment by Johnson can be found successfully operating in more than 50 broadcast stations and is backed by over 20 years experience in the manufacture of radio transmitting equipment. All major components used in Johnson Phasing and Antenna coupling equipment are designed and manufactured by Johnson, assuring the best material and workmanship. The quality of the equipment is under control of Johnson engineers at all times.

Shown at right is one of the Johnson installations designed to match existing equipment.

A Johnson Phasing Unit can be made to exactly match your present equipment and thus become an integral part of your station.

Orders for Phasing and Coupling equipment will enter production in the order received. Contact us without delay, directly or through your consulting engineer.



*Write for Brochure-*

**"Some considerations in Directional Antenna Design"**
*—By Johnson*

E. F. JOHNSON COMPANY, Waseca, Minn

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# FUNDAMENTAL RELATIONSHIPS

## A Comparison of F-M and Other Methods of Modulation; Equations for Frequency Modulation are Derived in Their Entirety

by N. MARCHAND*

Chief Engineer
Lowenherz Development Company

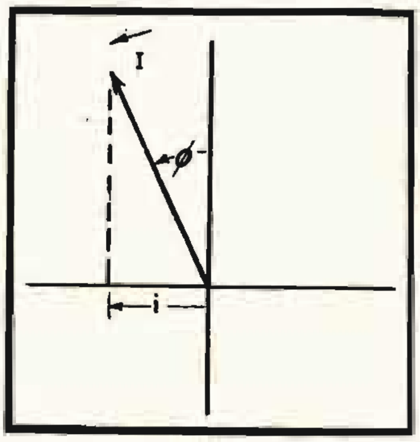



Figure 1
Graphical representation of $i$, the r-f instantaneous current; $i = I \sin \phi$.

MODULATION for radio communications can be considered to be a means of incorporating intelligence into a r-f signal at the transmitter in such manner that it can be reproduced at the receiving station. To analyze it, let us consider the equation for the r-f instantaneous current $i$

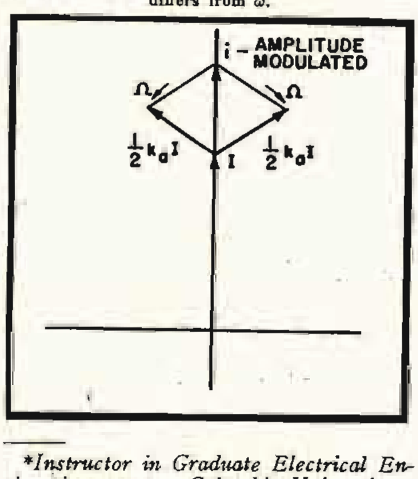
$$i = I \sin \varphi \qquad (1)$$

where $I$ is the magnitude of the peak current and $\varphi$ is the instantaneous phase angle, a function of time. Equation (*1*) may be represented graphically, as shown in Figure 1. $I$ is a phasor which at zero $\varphi$ is vertical. The phase angle $\varphi$ is related to the time $t$ by the following equation

$$\varphi = \Phi + \int \omega_t \, dt \qquad (2)$$

where $\omega_t$ is the instantaneous angular velocity of the phasor $\varphi$ at time $t$ and $\Phi$ is the value of $\varphi$ at $t$ equal to zero.

Figure 2
Phasor diagram for amplitude modulation. The normal assumption for phasor diagrams is made here; all phasors of angular velocity $\omega$ are stationary and al other phasors rotate at a velocity dependent on how much their angular velocity differs from $\omega$.




This is recognizable as the standard representation of a sine wave. If $\omega_t$ is assumed constant and equal to $\omega$, (*2*) becomes

$$\varphi = \Phi + \omega t \qquad (3)$$

This is the equation for instantaneous phase in a constant-frequency wave.

Equation (*1*) indicates that there are only two degrees of freedom and all types of modulation have to be worked into those two degrees of freedom. First, the value of $I$ may vary with the intelligence. From this variation of $I$ all types of amplitude modulation are obtained. Second, the value of $\varphi$ may vary with the intelligence while $I$ remains constant. This may be accomplished, referring now to equation (*2*), by either $\Phi$ varying with the intelligence and with $\omega_t$ remaining constant, which is called phase modulation, or it can be accomplished by $\omega_t$ varying with the intelligence and $\Phi$ remaining constant which is called frequency modulation. These two methods of varying the second degree of freedom are related, but there is a basic difference inasmuch as in phase modulation the phase angle $\varphi$ is varied directly with the modulation voltage, whereas in frequency modulation the first derivative of $\varphi$, the angular velocity, $\omega_t$, is varied with the modulation voltage.

#### Amplitude Modulation

To evaluate the characteristics of modulation, let us now review the derivation of the amplitude-modulation equations.

In amplitude modulation the value of the amplitude $I$ is varied with modulation while $\Phi$ and $\omega$ remain constant. Substituting (*3*) into (*1*) and for convenience since it entails no loss of generality, let $\Phi$ be zero so that

$$i = I \sin \omega t \qquad (4)$$

$\omega$ is defined by

$$\omega = 2\pi f \qquad (5)$$

where $f$ is the carrier frequency. To obtain amplitude modulation $I$ in equation (*4*) has to vary sinusoidally with a modulating frequency $F$. Let the modulating angular velocity $\Omega$ be defined by

$$\Omega = 2\pi F \qquad (6)$$

so that

$$I = I_o (1 + k_a \sin \Omega t) \qquad (7)$$

where $k_a$ is the modulation constant with a maximum value of 1.0. $I_o$ is the value of $I$ when $t$ is zero and is the mean value about which $I$ varies. Substituting equation (*7*) into equation (*4*)

$$i = I_o (1 + k_a \sin \Omega t) \sin \omega t \qquad (8)$$

Expanding equation (*8*)

$$i = I_o [\sin \omega t + \tfrac{1}{2} k_a \cos (\omega - \Omega) t - \tfrac{1}{2} k_a \cos (\omega + \Omega) t] \qquad (9)$$

In equation (*9*) it is shown that in amplitude modulation the frequency spectrum consists of a carrier with a constant amplitude $I_o$ and two sidebands, for each modulating frequency, displaced by the value of that frequency above and below the carrier in the frequency spectrum. Their amplitudes are the same and equal to one-half the product of the modulation constant and the amplitude of the carrier.

Figure 2 shows a phasor diagram of amplitude modulation. The normal assumption for phasor diagrams is made here, namely, that all phasors of angular velocity, $\omega$, are stationary and all other phasors rotate at a velocity dependent on how much their angular velocity differs from $\omega$. Thus, in the diagram, the carrier phasor I is stationary whereas the sideband phasors, $A$, which is equal to $-\tfrac{1}{2} k_a I_o$, and $B$, which is equal to $\tfrac{1}{2} k_a I_o$, ro-

*Instructor in Graduate Electrical Engineering courses, Columbia University.

# OF F-M SYSTEMS

**The First of a Series of Papers Covering the Operation and Design of F-M Transmitters. The Papers Will Include a Mathematical Discussion of Interference, Design of F-M Modulators, Frequency Control Methods, Antenna Designs, and An Analysis of Auxiliary Transmitter Equipment**

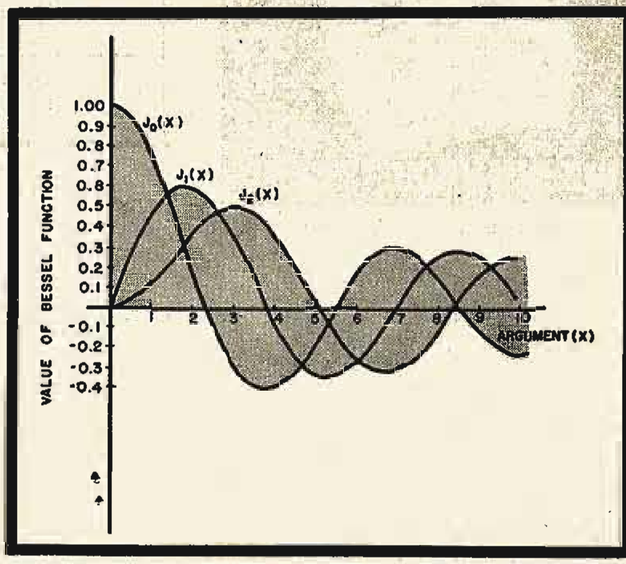



Figure 3
Curves of Bessel functions; tabulated values which may be portrayed as a curve. Each order has its own curve wherein the argument is usually the abscissa and the value of the Bessel function is the ordinate.

tate at angular velocities $\Omega$. The result of adding all three is a phasor $i$ which remains constant as far as variation in frequency and phase is concerned, but it varies in amplitude with the modulating frequency.

#### *Frequency Modulation*

In frequency modulation $I$, the amplitude, and $\Phi$, the phase angle, are kept constant. $\omega_t$ is then varied with the modulation voltage so that

$$\omega_t = \omega(1 + k_f \cos \Omega t) \qquad (9)$$

where $\omega$ is the carrier angular velocity and $k_f$ is the frequency modulation constant. For any $k_f$

$$\frac{\omega k_f}{2\pi} = \text{peak frequency deviation} \qquad (10)$$

Equation (*9*), since it is an expression for instantaneous frequency, must be substituted into equation (*2*) to find the instantaneous phase angle $\varphi$.

$$\varphi = \Phi + \int_0^t \omega(1 + k_f \cos \Omega t)\,dt \qquad (11)$$

In (*11*), since $\Phi$ is a constant, $\Phi$ plus the integration constant can be assumed to total zero without any loss of generality. Thus, integrating (*11*),

$$\varphi = \omega t + \frac{k_f\,\omega}{\Omega} \sin \Omega t \qquad (12)$$

Equation (*12*) can now be substituted into equation (*1*) to obtain the expression for a frequency-modulated wave.

$$i = I \sin\left(\omega t + \frac{k_f\,\omega}{\Omega} \sin \Omega t\right) \qquad (13)$$

Now let

$$m_f = \frac{k_f\,\omega}{\Omega} = \frac{k_f f}{F} = \frac{\text{frequency deviation}}{\text{modulating frequency}} \qquad (14)$$

where $m_f$ is the frequency-modulation factor. Equation (*13*) becomes:

$$i = I \sin(\omega t + m_f \sin \Omega t) \qquad (15)$$

Equation (*15*) is the standard equation for frequency modulation. The f-m factor, $m_f$, is actually the amount of phase shift accomplished by the modulating voltage and is dependent on the amplitude of the modulating voltage and the modulating frequency.

To obtain the amplitudes and frequencies of the sidebands it is necessary to expand (*15*) by using the following identity:

$$\sin(x + y) = \sin x \cos y + \cos x \sin y \qquad (16)$$

Expanding equation (*15*).

$$i = I\,[\sin \omega t \cos(m_f \sin \Omega t) + \cos \omega t \sin(m_f \sin \Omega t)] \qquad (17)$$

Equation (*17*) can be solved by the use of *Bessel functions*, where:

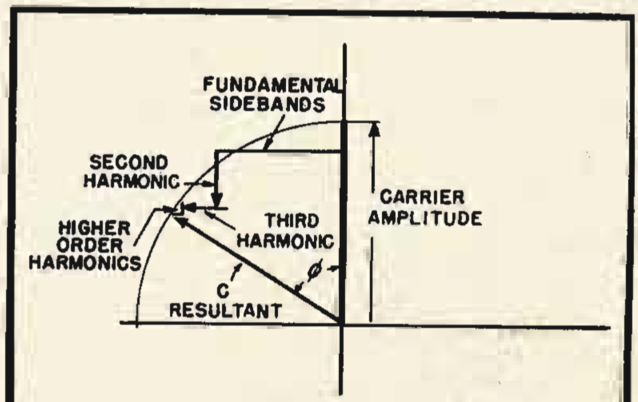
$$\sin(x \sin y) = 2\,J_1(x) \sin y + 2\,J_3(x) \sin 3y + 2\,J_5(x) \sin 5y + \ldots\ldots \qquad (18)$$

and

$$\cos(x \sin y) = J_0(x) + 2\,J_2(x) \sin 2y + 2\,J_4(x) \cos 4y + \ldots\ldots \qquad (19)$$

where $J_n(x)$ means the Bessel function of the first kind and n'th order for the argument $x$. These Bessel functions are tabulated values which may be portrayed as a curve. Each order has its own curve wherein the argument is usually the abcissa and the value of the Bessel function is the ordinate. Curves of a few Bessel functions are shown in Figure 3. It can be seen that for a zero order Bessel function, when the argument is zero, the value of the function is 1.00. As the argument increases the value of the function oscillates, progressively

Figure 4
Frequency - modulation phasor diagram. For simplicity, the resultant of each pair of sidebands is shown. It will be noted that the sidebands in this case are sine terms whereas in a-m they are cosine terms.



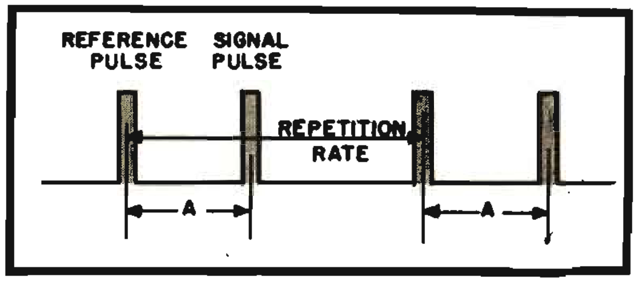



Figure 5
Pulse structure of pulse-time modulation.

decreasing in peak amplitude. For first order functions and higher (the value for zero argument is zero), it rises to a positive peak and then oscillates with a progressive decrease in peak amplitude. It is also interesting to note that the primary peak values of the functions decrease as the order of the function increases.

Now substituting (*16*) and (*17*) into (*15*) and arranging the terms in the order of increasing arguments

$$i = I[J_0(m_f)\sin\omega t + 2J_1(m_f)\sin\Omega t\cos\omega t + 2J_2(m_f)\cos 2\Omega t\sin\omega t + 2J_3(m_f)\sin 3\Omega t\cos\omega t + \ldots\ldots] \quad (20)$$

Comparing (*20*) with (*8*) for the amplitude modulated case, it can be seen that (*20*) is made up of an over-all amplitude factor, I, which is multiplied by a carrier of amplitude, $J_0(m_f)$, plus an amplitude-modulated wave sideband term with a modulating frequency of *F* and resultant amplitude of $2J_1(m_f)$, plus another amplitude-modulated wave sideband term with a modulating frequency of *2F* (second harmonic) and a resultant amplitude of $2J_2(m_f)$, plus another amplitude-modulated wave sideband term with a modulating frequency of *3F* (third harmonic) and a resultant amplitude of $2J_3(m_f)$ and so on. Notice that the carrier actually varies in amplitude as the modulation factor $m_f$ is increased; in fact it will actually go through zero for values of $m_f$ equal to 2.40, 8.65 and others. This is not surprising since the modulated wave contains the same amount of energy as the unmodulated wave. This means that as the wave is modulated the energy is actually removed from the carrier and put into the sidebands.

To complete the visual picture, each term of equation (*20*) except the first, which of course is the carrier, can be split into the sum of the two sidebands, similar to what was done for the amplitude-modulated wave:

$$i = I\{J_0(m_f)\sin\omega t + J_1(m_f)[\sin(\omega+\Omega)t - \sin(\omega-\Omega)t] + J_2(m_f)[-\sin(\omega+2\Omega)t + \sin(\omega-2\Omega)t] + J_3(m_f)[\sin(\omega+3\Omega)t - \sin(\omega-3\Omega)t] + \ldots\ldots\} \quad (21)$$

In Figure 4 is shown the phasor

(*Continued on page 60*)

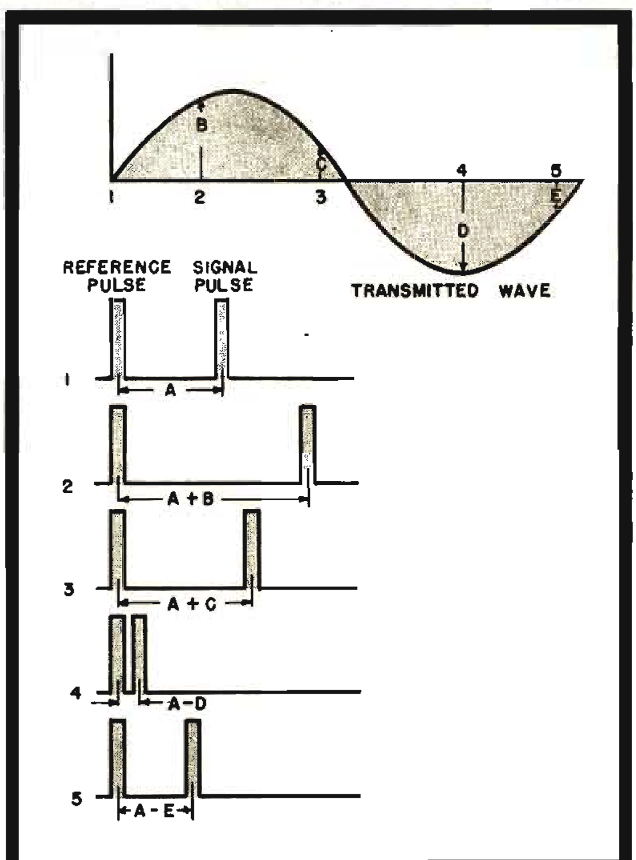



Figure 6
Pulse-time modulation characteristics. As the modulating voltage is impressed the time interval between the pulses are varied in accordance with the modulating voltage. Thus at *1*, when the modulating voltage is *0*, the interval between the pulses is *A*. At *2*, when the modulating voltage is *B*, the interval between pulses is A + B, and so on.

## FREQUENCY MODULATION

(*Continued from page* 58)

diagram for frequency modulation. Instead of showing each pair of sidebands, only the resultant of each pair is shown in order to avoid too much complexity. In other words, in the diagram, the first arrow from the carrier is the resultant of two sidebands rotating at the fundamenal frequency, as in the amplitude-modulated case. Notice, however, the sidebands in this case are sine terms whereas in amplitude modulation they were cosine terms. This means that the resultant of the two sidebands stays constant in phase but is 90° displaced from the carrier. However, for even order harmonics the sidebands are either in phase or 180° out of phase with the carrier. Notice too that the carrier amplitude varies from the original amplitude it had. Adding together all the components yields a resultant that has the same amplitude as the original carrier but shifted in phase in such manner that the first derivative will be the required frequency shift.

### Phase Modulation

In phase modulation both $I$ and $\omega$ are kept constant while $\Phi$ varies with the modulation voltage. Thus

$$\Phi = \Phi_o (k_p \sin \Omega t) + \Phi_1 \qquad (22)$$

where $\Phi_o$ is the peak phase variation, $k_p$ is the modulation constant which normally has values between 0 and 1.0, and $\Phi_1$ is the phase when $t$ is zero. Substituting (*22*) into (*3*) and (*1*) and assuming, since it involves no loss of generality, that $\Phi_1$ is zero

$$i = I \sin (\omega t + k_p \Phi_o \sin \omega t) \qquad (23)$$

Now let

$$m_p = k_p \Phi_o \qquad (24)$$

where $m_p$ is the phase modulation factor. Substituting (*24*) into (*23*)

$$i = I \sin (\omega t + m_p \sin \Omega t) \qquad (25)$$

Comparing (*25*) to (*15*) it can be seen that they are exactly similar except that $m_p$ is used instead of $m_f$. The resolution of (*25*) into sidebands is obviously exactly the same so that the final equations can be written down immediately from (*21*) with $m_p$ substituted for the $m_f$ used in the equations for a frequency-modulated wave.

$$\begin{aligned} i = I \{ & J_o (m_p) \sin \omega t \\ & + J_1(m_p) [\sin(\omega + \Omega)t - \sin(\omega - \Omega)t] \\ & + J_2(m_p) [-\sin(\omega + 2\Omega)t + \sin(\omega - 3\Omega)t] \\ & J_3(m_p) [\sin(\omega + 3\Omega)t - \sin(\omega - 3\Omega)t] \\ & + \ldots\ldots\ldots \} \end{aligned} \qquad (27)$$

Notice now that the value of $m_p$

and therefore the amplitudes of the sidebands are dependent on the modulating voltage only, and independent of the modulating frequency. In frequency modulation this was not true, since in frequency modulation the modulation factor was dependent on the modulating frequency also. However, if the modulation factor in phase modulation were made to vary inversely with the modulation frequency then true frequency modulation would be obtained. This is taken advantage of in the Armstrong method of crystal generated frequency modulation.

The phasor diagram for the phase-modulated wave is exactly similar to the phasor diagram for frequency modulation, except, of course, that in frequency modulation the phase deviation is usually hundreds of radians, whereas in phase modulation it is usually less than a radian.

#### Pulse-Time Modulation

Because of the tremendous amount of wartime research that went into radar, pulse technique has made vast strides. The advantage of using pulses are well known, and in pulse-time modulation this technique is applied to communications. In pulse-time modulation the intelligence is carried by the pulses with the use of a reference pulse and a signal pulse, as shown in Figure 5. The reference pulse is repeated at equal intervals of time at a high frequency, above 15 kc. The higher the repetition rate the better the fidelity. The signal pulse is separated from the reference pulse by a time interval $A$. As shown in Figure 6, as the modulating voltage is impressed the time interval between the pulses are varied in accordance with the modulating voltage. Thus at *1* when the modulating voltage is zero the interval between pulses is $A$. At *2* when the modulating voltage is $B$ the interval between pulses is $A + B$ and so forth. The intelligence is carried in the pulses and more than one signal pulse may be used with the same reference pulse, provided the shift in the signal pulses do not overlap. These pulses are then amplitude modulated on a carrier frequency. The result resembles subcarrier modulation but it is much more advantageous since pulses are employed.

#### References


B. van der Pol, *Frequency Modulation,* Proc. IRE, page 1194; 1930.
S. W. Seeley, *Frequency Modulation,* RCA Review; April, 1941.
H. J. Scott, *Frequency Versus Phase Modulation,* COMMUNICATIONS; August 1940.
H. Roder, *Amplitude, Phase, and Frequency Modulation,* Proc. IRE, page 2145; 1931.

### Victory Celebration

THE 21st Anniversary VWOA Dinner-Cruise, our victory celebration, will be held on Saturday, February 16, 1946, on the Belvedere Roof of the Hotel Astor, Times Square, New York City. A Marconi Memorial Service Award Plaque will be presented to the American Radio Relay League . . . "In significance of the magnificent contributions of the radio amateur to the winning of World War II."

Marconi Memorial Medals will be awarded to outstanding communications heroes of the armed services. High ranking members of the military will be guests of honor.

Reservations for this dinner-cruise, which promises to be one of the best, should be mailed in at once. Tables of ten can be reserved.

### Personals

LIFE member Captain Pierre Boucheron, U.S.N.R., has returned to Farnsworth Television and Radio Corporation as director of public relations. . . . Life member E. A. Nicholas is president of Farnsworth. . . . It was good to see Harry Sadenwater of NC-1 fame at several recent radio functions. Harry is one of the genuine oldtimers . . . Life member Raymond F. Guy, radio facilities engineer of NBC has been spending many days in Washington recently. Ray is currently a director of the IRE. . . . Grand to say hello to E. J. Girard of Federal Telephone and Radio, a prominent VWOA member of years ago, at the recent Radio Pioneer's Party. . . . Had interesting talk recently with life member E. H. Rietzke, president of Capitol Radio Engineering Institute, where we now have two scholarship students. EHR is president of the Council of Technical Correspondence Schools. . . . "Bill" Simon, treasurer and executive secretary extends his sincere appreciation for the splendid response to his recent statements for dues. . . . Our own life member "Bill" Halligan is chairman of the set division or the RFC surplus property disposal organization. . . . Best wishes to "Bill" on his plans for a $600,000 Hallicrafters

Commander V. H. Eberlin, Air Communications Officer, receiving the Bronze Star from the late Rear Admiral W. D. Sample, aboard the aircraft carrier *Hornet*, while she was in the waters of Japan.

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plant. . . . Received a delightful Christmas greeting from Lt. Commander Leroy Bremer, Chief Radio Officer of the S. S. Uruguay, from Tokyo, mailed on the significant date of December 7, 1945. LB's raise in rank to Lt. Commander was one of only five made in the entire U. S. Maritime Service. The Uruguay carries several thousand troops back from the Orient, on each trip. After a few more round trips LB plans to fulfill his annual committment, taking charge of five Alaska costal radio stations for the summer. LB proudly included the credo of the U. S. Merchant Marine on his Christmas card: "We took them over, and we'll bring them back." . . . Glad to see A. F. "Steve" Wallis on his recent visit to New York. He has been in Florida for some time now and may make it his permanent residence and business address. . . . Congratulations to Col. Thompson H. Mitchell, vice president and general manager of RCA Communications upon his recent election as executive vice president. . . . At the annual VWOA meeting, held at the Hotel Astor on January 10, 1946, ballots in the recent election of officers and directors were tabulated. Results will be announced next month. . . . Ye prexy attended the annual dinner of the Radio Club of America with life member Arthur H. Lynch. . . . Life member Commander Fred Muller, U.S.N.R., was toastmaster and life member Captain Pierre Boucheron, U.S.N.R., was the guest of honor. . . . Veteran VWOA member Fred Klingenschmitt is president of the club. . . . VWOA members at the dinner included George McEwen, Dick Egolf and Commander E. J. Quinby, U.S.N.R. . . . The December 13th VWOA party was highly successful. Prizes donated by radio dealers throughout the metropolitan area were a highlight of the evening. . . . Harry Cornell of Standard Oil won an electric clock presented by Harvey Radio. . . . Jack Bossen of Mackay won the VWOA prize of a container of good spirits. . . . E. H. Price, recently elected a vice president of Mackay was at the party. Quite a group of Mackay boys came along, too. . . . Ed Tyler, sales manager of Micamold was there with a guest. . . . V. P. Villandre of Radiomarine assisted with the arrangements. . . . Arthur H. Lynch was chairman of the meeting. . . . Bill Marshall of the N. Y. Telephone Company radio unit, and H. H. Parker, former secretary did their share of the work.

### Eberlin Cited

Commander V. H. C. Eberlin, who served as Air Communications Officer on the staff of Rear Admiral W. D. Sample (later unfortunately killed in a routine flight), during the Battle of the Phillipine Sea, aboard the aircraft carrier Hornet, was highly praised for his daring and skill in the citation that accompanied his second Bronze Star award. (See photo on this page, taken at Wakayama, Japan.)

*Said the citation: "For meritorious achievement in connection with operations against the enemy while serving as Communications Officer on the staff of the Commander of an Escort Carrier Division during the period 17 February to 31 August 1945. Through superior administrative ability and outstanding technical skill, he welded the Task Unit's communication organization into a highly efficient unit and brought about decided improvement in the maintenance and operation of communication equipment in the unit, thereby contributing materially to the success of the Task Unit's operations and the ultimate defeat of the enemy. In the course of one amphibious operation of unprecedented length, operational necessity forced the Flag and its entire communication organization to move a total of 14 times to and from temporary flagships. Due largely to his high professional ability and devotion to duty, the Task Unit's communications were maintained at peak efficiency throughout despite these hardships. His unparalleled cooperation and leadership were at all times outstanding and in keeping with the highest traditions of the United States Naval Service. J. B. Oldendorf, Vice Admiral U.S.N."*

Commander "Ebbie" is now back with Tropical Radio, enjoying home life. Welcome home.

# *New!* Series 200

# A RELAY BY GUARDIAN with *Interchangeable Coils*

## BUILT IN TWO PARTS

★ Two basic parts—a coil assembly and a contact assembly—comprise this simple, yet versatile relay. The coil assembly consists of the coil and field piece. The contact assembly consists of switch blades, armature, return spring, and mounting bracket. The coil and contact assembly are easily aligned by two locator pins on the back end of the contact assembly which fit into two holes on the coil assembly. They are then rigidly held together with the two screws and lock washers. Assembly takes only a few seconds and requires no adjustment on factory built units.

A.C. Coil Assemblies available for 6 v., 12 v., 24 v., 115 v.
D.C. Coil Assemblies available for 6 v., 12 v., 24 v., 32 v., 110 v.

Contact Assemblies
Single pole double throw
Double pole double throw

SERIES 200 RELAY

## *On Sale at Your Nearest Jobber* NOW!

See it today! . . . this amazing new relay with interchangeable coils. See how you can operate it on any of nine different a-c or d-c voltages—simply by changing the coil. Ideal for experimenters, inventors, engineers.


### TWO CONTACT ASSEMBLIES

The Series 200 is available with a single pole double throw, or a double pole double throw contact assembly. In addition, a set of Series 200 Contact Switch Parts, which you can buy separately, enables you to build dozens of other combinations.
Instructions in each box.

### NINE COIL ASSEMBLIES

Four a-c coils and five d-c coils are available. Interchangeability of coils enables you to operate the Series 200 relay on one voltage or current and change it over to operate on another type simply by changing coils.

*Your jobber has this sensational new relay on sale now. Ask him about it. Or write for descriptive bulletin.*

**GUARDIAN ELECTRIC**
1610-A W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

# NEWS BRIEFS

### *FCC ASSIGNS SIX TELEVISION CHANNELS TO OPERATING STATIONS*

The FCC has assigned channels to present commercial television licensees and licensees of ten existing experimental television stations. All of the commercial assignments are for metropolitan stations with their existing powers and antenna heights.

Assignments were: **WBKB**, Chicago, channel 4 (66-72 mc); **WCBW**, New York, channel 2 (54-60 mc); **WABD**, New York, channel 5 (76-82) mc); **WNBT**, New York, channel 4 (66-72 mc); **WPTZ**, Phila., channel 3 (60-66 mc); and **WRGB**, Schenectady, channel 4 (66-72 mc).

Existing television stations that must change frenquency will go off the air on or before March 1, 1946 and return to the air with regular programs on or before July 1, 1946.

Amateur service will change from the frequency space between 56 and 60 mc to the space between 50 and 54 mc on March 1, 1946.

Stations assigned channel 2 (54-60) may not begin operation before the 56-60 mc frequency space is vacated by the amateur service.

* * *

### *INTER-CITY HIGHWAY MOBILE RADIO-TELEPHONE SERVICE TRIALS TO BEGIN*

Trials of intercity highway mobile radiotelephone service between Chicago and St. Louis, via Ottawa, Peoria and Springfield, Illinois; New York, Albany and Buffalo; and New York and Boston, will be inaugurated soon by the Bell System.

When these services are established it will be possible for any suitably-equipped vehicle on the highways along these routes or any boat on adjacent waterways to make and receive calls to or from any telephone connected to lines of the Bell System. Transmitting and receiving stations required to provide the two-way voice communication service will be located along the routes.

Applications for authorization to establish the first stations to serve the Chicago-St. Louis route have already been filed with the FCC. It is expected that applications for the other routes will be made soon.

* * *

### *HARRY B. SEGAR DIES*

Harry B. Segar, Buffalo, New York, died recently. He was a sales representative of the American Phenolic Corporation and Jensen Radio Company of Chicago, International Resistance Company of Philadelphia, and other radio and aircraft companies.

* * *

### *MILWAUKEE-CHICAGO MICROWAVE NET PLANNED*

Plans for a $500,000 chain of 4000-mc relay stations between Milwaukee and Chicago which will be employed for television transmission in cooperation with WMJT, the Milwaukee Journal television station, have been announced by the A. T. & T. Applications for permission to build the system and to operate it on an experimental basis were filed with the FCC.

The service also will be available to any other broadcaster who might be able to use

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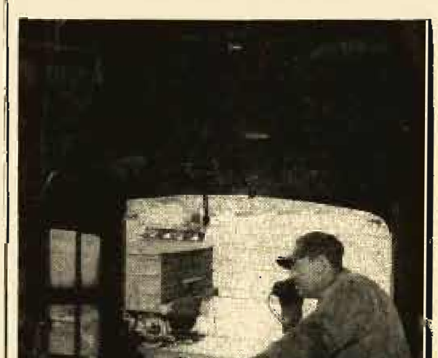
### *RR RADIO ON NEW HAVEN*



F-M 156-mc radio communications system in operation on the New York, New Haven and Hartford. System was recently installed. (*Courtesy Westinghouse*)

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it. If the FCC approves, the network will be ready for tests in the spring of 1947.

Three relay stations consisting of 120' towers and buildings to house power and other equipment, will be built about 25 miles apart, near Barrington, Illinois; Wilmot, Wisconsin; and at Prospect, Wisconsin.

* * *

### WIDLAR NOW MEC-RAD G-M

Walter Widlar has been appointed general manager of the Mec-Rad division of Black Industries, Cleveland, Ohio.

Mr. Widlar has been a project engineer for Mec-Rad since November, 1944. He was with WGAR as relay facilities engineer for many years.

* * *

### L. R. O'BRIEN JOINS RAYTHEON

L. R. O'Brien has been named general sales manager of the radio receiving tube division of Raytheon Manufacturing Co.

He was formerly director of sales for the Ken-Rad Tube and Lamp Corp. at Owensboro, Kentucky.

* * *

### PHILCO PROMOTES DAVID B. SMITH

David B. Smith has been appointed vice president in charge of engineering of Philco Corporation.

* * *

### CHAMBERLAIN RETURNS TO CBS AS CHIEF ENGINEER

After more than three years of wartime service with the United States Navy, Captain Adolph B. Chamberlain has returned to his post in CBS' general engineering department as chief engineer.

* * *

### DR. E. U. CONDON SUCCEEDS DR. L. J. BRIGGS AS DIRECTOR OF NATIONAL BUREAU OF STANDARDS

Dr. Edward Uhler Condon has been appointed

(*Continued on page 66*)

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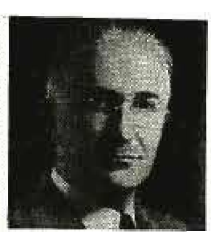
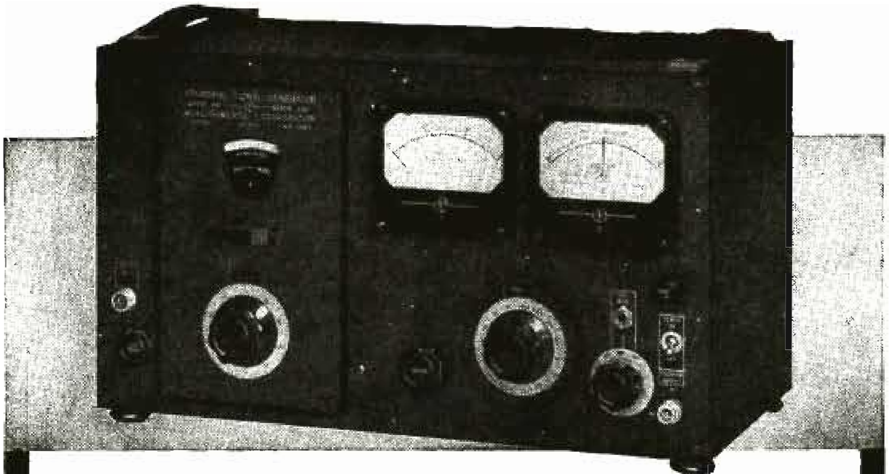
### GOLDMARK AND HARTLEY WIN IRE AWARDS



Dr. Peter C. Goldmark (left), of CBS, who won the IRE Morris Liebmann memorial medal, and Ralph V. L. Hartley (right), of Bell Telephone Labs, who was awarded the IRE medal of honor at the winter IRE meeting in N. Y. City.









## NEWS BRIEFS

(Continued from page 65)

director of the National Bureau of Standards, succeeding Dr. Lyman J. Briggs. Dr. Condon was also recently named technical advisor to the Special Senate Committee on Atomic Energy.

He was formerly associate director of research of Westinghouse.

* * *

### G. D. RICE WINS LEAR PROMOTION

George D. Rice, who had been in charge of the home radio service group of Lear, Incorporated, has been advanced to the post of acting assistant chief engineer of the radio division.

* * *

### G. E. APPOINTMENTS

H. M. Wales has been appointed sales manager of aviation electronic equipment for the transmitter division of G. E.

E. H. Fritschel is now manager of sales of the tube division of the G. E. electronics department.

Philip G. Caldwell has been named sales manager of television equipment in the G. E. transmitter division.

Ewing Lawrence, Jr. has been appointed sales manager of marine electronic equipment for the G. E. transmitter division.

P. G. Caldwell

* * *

### GATES OPENS N. Y. C. OFFICE

The Gates Radio Company, Quincy, Illinois, has opened a New York City office at 40 Exchange Place.

* * *

### J. RIDDLE JOINS HALLICRAFTERS

Jim Riddle has been named special aviation consultant for the Hallicrafters Company, Chicago.

Riddle war formerly with the RCA engineering and aircraft sales division.

J. Riddle

* * *

### TACO ANTENNA CATALOG

A catalog describing noise-reducing and multiple antenna systems, store-demonstrating an-

•

### WALKIE TALKIES FLOWN TO MEXICO

Braniff Airways hostess Eleanor Crosland, and Joe Poynton, assistant manager of Belmont Radio, RFC division, with the walkie talkies recently shipped to Mexico for ranch service.

tenna systems, transmission lines, couplers, and a variety of dipoles, has been published by Technical Appliance Corp., 46-06 De Long Street, Flushing, N. Y.

* * *

### G. R. LARSEN JOINS MARION INSTRUMENT

George R. Larsen has been named development engineer for the Marion Electrical Instrument Company, Manchester, N. H.

During the war Mr. Larsen was associated with the Signal Corps Engineering Laboratories at Fort Monmouth, N. J.

* * *

### NEW YORK TRANSFORMER CO. MOVES

The New York Transformer Company offices have been moved to 62 William St., New York 5, N. Y.

J. B. Scheafer has been named plant manager of the New York Transformer Company. Mr. Schaefer will direct engineering and manufacturing activities at the Alpha, New Jersey plant.

* * *

### RICHARD W. WEADON BECOMES YARDENY S-M

Richard W. Weadon has been appointed sales manager of Yardeny Laboratories, Inc., N. Y. City.

Mr. Weadon was formerly supervisor of sales engineering of Lear, Inc.

* * *

### ALTMAYER NOW ASCO CORP. PRES.

John Altmayer has heen elected president of the Asco Corporation, 874 East 140th Street, Cleveland 10, Ohio.. E. E. Slabe, president of the Slabe Machinery Products Company of Cleveland, is secretary and treasurer.

J. L. Wurm has been named purchasing agent and A. R. Keskinen, formerly with the engineering department of Bendix Radio, is project engineer.

* * *

### STUPAKOFF CERAMICS BULLETIN

A bulletin describing ceramic padder and trimmer bases, resistor ceramics, strain and spreader insulators, and ceramic rod and tubing, has been published by the Stupakoff Ceramic and Manufacturing Co., Latrobe, Pa.

Examples of Kovar glass-metal hermetie seals are illustrated in the bulletin.

* * *

### NATIONAL UNION TUBE SELECTOR BULLETIN

A 4-page selector chart of preferred tubes, including data on miniatures, has been released by the National Union Radio Corp., 15 Washington Street, Newark, N. J.

* * *

### HUTCHESON LEAVES CBS

Guy C. Hutcheson has resigned from the CBS general engineering department. He will open a consulting engineer office in Texas.

* * *

### JOHN CREUTZ OPENS CONSULTING SERVICE

John Creutz, former WPB Radio and Radar Division executive, has opened a consultant office at 1404 New York Ave., N. W., Washington, D. C.

* * *

### WALT NEFF DEAD

Walter J. Neff, former sales manager of WOR, died recently. Mr. Neff was broadcast director of WAHG (now WABC) in 1924.

* * *

### EASTON NOW MANAGER OF GENERAL RADIO N. Y. OFFICE

Ivan G. Easton has been named manager of

(*Continued on page* 68)

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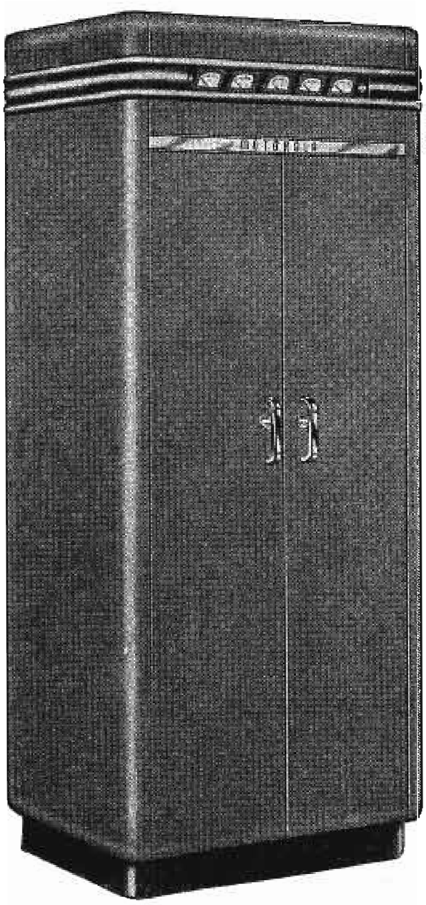
### GHIRARDI DISPLAY

Display for Ghirardi books recently prepared for dealers.



# NEWS BRIEFS

(Continued from page 67)

the New York district office of General Radio Company, at 90 West Street, New York 6, New York.

* * *

### WALTER LEMMON JOINS GLOBE WIRELESS

Walter S. Lemmon has been elected vice president of Globe Wireless, Ltd., San Francisco, Calif.

Globe Wireless has acquired from International Business Machines Corp. its interest in the radiotype developments of Mr. Lemmon.

The transaction is said to include United States and foreign patents of the IBM high-speed automatic radiotypewriters.

* * *

### RCA PROMOTIONS

E. W. Engstrom has been elected vice president in charge of research of the RCA Laboratories division.

E. C. Anderson is now vice president in charge of the commercial department of RCA Laboratories.

Dr. C. B. Jolliffe, vice president in charge of RCA Laboratories, has been elevated to executive vice president in charge of RCA Labs.

Joseph B. Elliott is now vice president in charge of RCA Victor home instruments; Meade Brunet, vice president in charge of the RCA Victor engineering products; L. W. Teegarden, vice president in charge of the tube division; J. W. Murray, vice president in charge of RCA Victor records, and J. H. McConnell, vice president and general attorney of RCA Victor.

* * *

### SYLVANIA ACQUIRES WABASH

The Wabash Photolamp Corporation and Birdseye Electric Corporation, Brooklyn, N. Y., have been purchased by Sylvania Electric Products, Inc. A. M. Parker remains as president and general manager of Wabash.

* * *

### EVERSON AND FARLEY JOIN COLLINS

Claude T. Everson, formerly with the U. S. Army Air Corps communication and microwave equipment unit, has become a member of the research division of the Collins Radio Company, Cedar Rapids, Iowa.

William W. Farley is now an assistant director of the research division. For the past four years he has been engaged in radar development at the Harvard Radio Research Laboratory and the M.I.T. Radiation Lab.

C. T. Everson

W. W. Farley

* * *

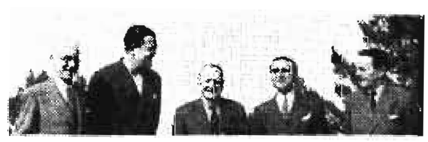
### ALLIED CONTROL BUYS MILLER TRANSFORMER CO.

Allied Control Company, Inc., New York City, has bought the B. F. Miller Company, manufacturers of transformers, Trenton, New Jersey. B. F. Miller remains as executive vice president and general manager of the Miller Co.

E. A. Taylor has been appointed general sales

●

### BERMUDA TELECOMMUNICATIONS CONFERENCE



United States and United Kingdom delegates to the Bermuda Telecommunications Conference, at Belmont Manor in Warwick. Left to right: Sir Claude Hollis, acting chairman of the Commonwealth Telecommunications Conference; Paul A. Porter, chairman of the FCC and vice chairman of the U. S. delegation; Sir Raymond Birchall, director general of the General Post Office in London and head of the British delegation; James Clement Dunn, U. S. Assistant Secretary of State and chairman of the conference, and Sir Stanley Angwin of the General Post Office in London.

manager of the Allied Control Company, Inc. Mr. Taylor was formerly with G. E.

J. S. Speer has been named eastern sales manager, and Hugh M. Noble will be western sales manager with headquarters at Chicago.

* * *

### H. V. NIELSEN JOINS U. S. TELEVISION

Harold V. Nielson has been appointed chief engineer of the United States Television Manufacturing Corporation, 106 Seventh Avenue, New York 11, N. Y.

He was formerly with Sparks-Withington Co., Jackson, Michigan.

* * *

### D. P. WILSON JOINS FTR

Lieutenant Commander Don P. Wilson has been appointed aviation sales manager of the Federal Telephone and Radio Corporation.

* * *

### BLACKLIDGE NOW STANCOR G-S-M

James M. Blacklidge has been named general sales manager of the Standard Transformer Corporation, Chicago, Ill.

Mr. Blacklidge was formerly sales manager of the industrial division.

Earl T. Champion is now with Stancor's distributor sales division.

* * *

### MBS OPENS NEW STUDIOS IN NEW YORK

Three new studios, approximately 25′ x 40′, are now being used jointly by WOR and the

(*Continued on page* 71)

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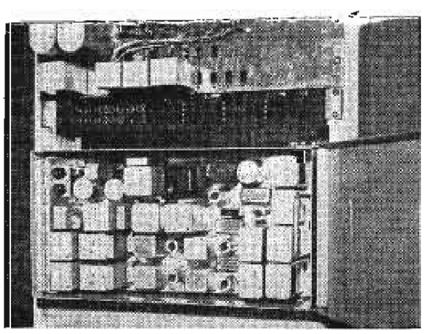
### R-F POWER LINE TELEPHONE SYSTEM

Carrier telephone system recently installed by the Bell System and the Rural Electrification Administration on the power lines of the Craighead Cooperation Corp., Jonesboro, Arkansas. Above, Oscar Robinson, secretary-treasurer of Craighead, testing system at a farm home. Below, terminal equipment.



Mutual network at network headquarters, 1440 Broadway, N. Y. City.

The studios, built adjacent to one another, are isolated by a 12" wall with an additional internal wall that is mounted on rubber and springs and separated from the main wall by rock-wool blankets. The studio ceilings are hung from the building ceiling by means of springs. The floor is floated on springs. Bumpers mounted on springs have been constructed along the baseboards.

Studios feature non-parallel surfaces to reduce the tendency of the room to resonate at one particular tone.

* * *

### A.S.T.M. ISSUES 1945-1946 STANDARDS ON ELECTRICAL INSULATING MATERIALS

A 560-page issue of standards on electrical insulating materials has been released by the American Society for Testing Materials, 260 S. Broad Street, Philadelphia 2, Pa.

Prepared by committee D-9, the report offers more than seventy-five widely used specifications and test methods covering electrical insulating materials, plastics, rubber, textiles and paper products.

The reports discussing the tests cover dielectric strength, impact, tensile strength, power factor, resistivity, and for insulating liquids several others such as pour point, viscosity, etc.

Plates, sheets, tubes and rods are covered in twenty-one standards. There are also specifications and methods on insulating paper, mica products, rubber products, textile materials, etc.

## NEWS BRIEFS

*(Continued from page 69)*

* * *

### J. M. CAGE NOW WITH RAYTHEON

John M. Cage has been appointed manager of the industrial electronics division of Raytheon Manufacturing Co., Waltham, Mass.

Mr. Cage was formerly with Allis-Chalmers Manufacturing Co. in charge of an industrial electronics group.

* * *

### J. K. SPRAGUE AND DR. P. ROBINSON ELECTED SPRAGUE VICE PRESIDENTS

Julian K. Sprague and Dr. Preston Robinson have been elected vice presidents of the Sprague Electric Company, North Adams, Mass.

Mr. Sprague has been with the company since 1926, when the became one of the original group of four employes at the old Quincy, Mass., plant where he served as production manager. Dr. Robinson, has been associated with the company since 1929, serving as chief engineer and director of research.

* * *

### T. R. WARNER JOINS GREYHOUND

Thomas Ryan Warner has been appointed assistant communications engineer of the Greyhound Corporation.

Mr. Warner was formerly chief of the Department of Communications, Cavalry School, Fort Riley, Kans., where his rank was lieutenant-colonel. Previously he had been chief radio engineer of the Michigan State Police.

* * *

### LEWYT TO MAKE BRUNSWICK RECEIVERS

Lewyt Corporation, Brooklyn, New York, will produce for the Brunswick radio division of Radio and Television, Inc., New York, table model radio receivers, electric phonographs and combinations.

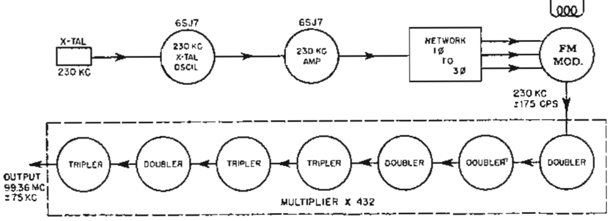
* * *

### W. F. SOULES JOINS ELECTRO-VOICE

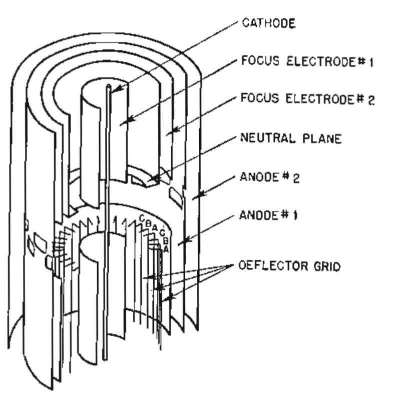
Lt. Col. Webster F. Soules, now on terminal

*(Continued on page 72)*

### G.E. F-M PHASITRON MODULATOR TUBE




Left, block diagram of exciter unit of f-m circuit using the Phasitron tube. Right, cross-section of tube. The output of the crystal-controlled oscillator (crystal frequency = carrier frequency/432) is amplified and fed into a phase-splitting network which converts the single-phase r-f voltage to three phase. Tube was originally proposed by Dr. P. Adler of Zenith. Development of tube, circuit and basic ideas were contributed by Dr. F. M. Bailey and H. P. Thomas of G. E.



# NEWS BRIEFS

*(Continued from page 71)*

leave from the Army Signal Corps, has been named sales manager of Electro-Voice, Inc., South Bend, Ind.

* * *

### DU MONT APPOINTS CRAMER TELEVISION BROADCASTING HEAD

Leonard F. Cramer has been named director of the television broadcasting division of the Allen B. Du Mont Laboratories, Inc., Passaic, N. J. Mr. Cramer has been vice president and a director since 1942.

* * *

### J. M. HUNT JOINS TUNG-SOL

Major Joseph M. Hunt has been appointed sales manager for renewal sales of the Tung-Sol Lamp Works, Inc., 95 Eighth Avenue, Newark, 4, N. J.

Major Hunt was with the U. S. Army Signal Corps, on the staff of the Chief Signal Officer.

* * *

### MARION CATALOG

A 28-page book describing standard and hermetically sealed electrical indicating instruments, has been released by Marion Electrical Instrument Company, Manchester, N. H.

* * *

### D. L. WARNER RETURNS TO ALLIED RADIO

D. L. Warner has resumed his prewar activities as director of the amateur equipment and sales division of Allied Radio Corporation, 833 W. Jackson Boulevard, Chicago, Ill.

* * *

### GARLICK AND EMLEN PROMOTED BY AMERTRAN

Walter Garlick, Jr., has been named vice president, in charge of sales, of American Transformer Company, Newark, N. J.

A. A. Emlen is now vice president, in charge of engineering.

* * *

### WESTINGHOUSE PROMOTES NARY

E. R. Nary has been named assistant to Walter Evans, vice president of Westinghouse.

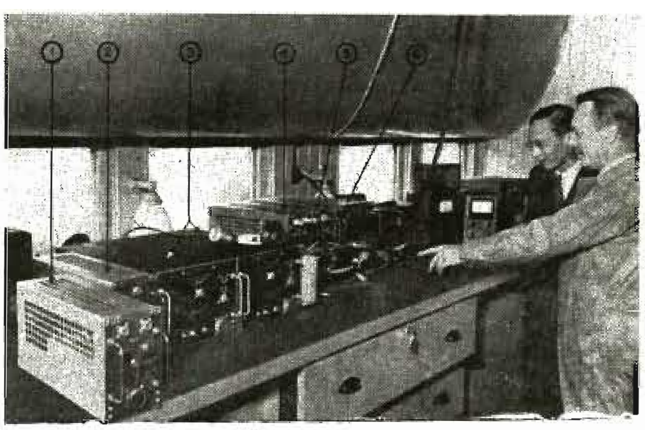
* * *

### BRENGLE NOW AERO NEEDLE REP.

Commander Ralph T. Brengle, has been appointed Aero Needle district sales manager for Indiana, Illinois and Wisconsin.



### AIREON RAILROAD RADIO LAB CAR



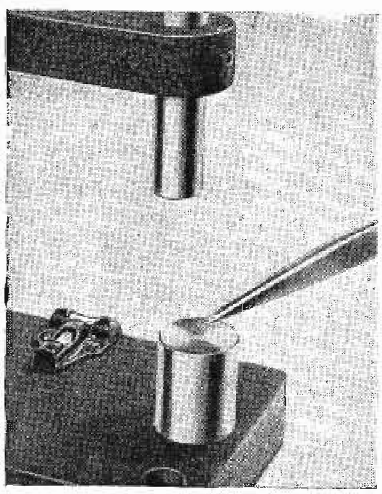

Aireon railroad radio laboratory car used to conduct road tests of equipment, with William Bishop (right) in charge of railroad radio for Aireon and Sze Ping, communications engineer for the Chinese National Railways, studying a typical setup: (*1*) 152-162 mc, 15-watt transmiter; (*2*) v-h-f receiver; (*3*) inductive transmitter-receivers; (*4, 5, 6*) v-h-f transmitter-receiver and power supply

# THE INDUSTRY OFFERS . . . —

### *G.E. MAGNETIC HARDNESS TESTER*

A magnetic hardness tester for gaging of hardness of small, ferrous, metal parts has been announced by the G. E. meter and instrument division, West Lynn, Mass.

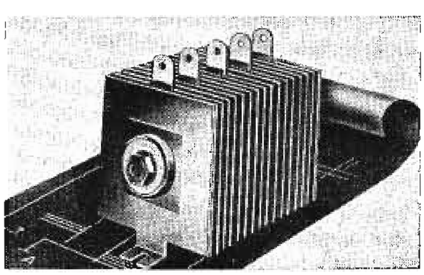
The tester, 6" long, 3½" wide, and 7" high, consists of an alnico bar magnet set in an adjustable, soft-iron frame, which permits the air gap, and thereby the field strength, to be set at the correct value for testing pieces of different size, whose dimensions are between 1/16" and 1/2". A knurled thumbscrew locks the air gap adjustment. A brass block for positioning the specimens is mounted on the base of the tester, a little out of the direct line of the magnetic field. A two-way level is attached to the base to show when the tester is properly positioned.



* * *

### *BENWOOD-LINZE COPPER SULPHIDE RECTIFIER*

A dry-disc metallic rectifier which does not require forced cooling, has been developed by the Benwood-Linze Company, St. Louis, Mo. It is rated 50 amperes for 6-volt automotive battery taper charging. Two rectifiers may be operated in parallel from separate transformer secondaries to provide 100 amperes maximum charging rate without a fan.



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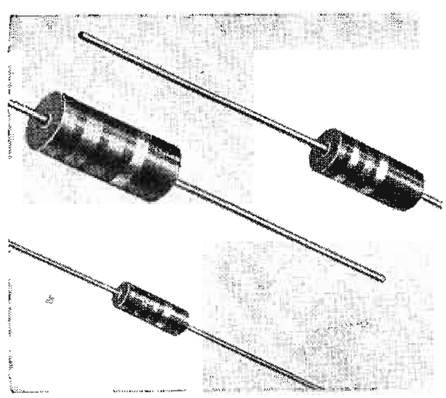
### *OHMITE INSULATED COMPOSITION RESISTORS*

A series of small size, insulated, ½, 1- and 2-watt fixed composition resistors has been announced by the Ohmite Manufacturing Company, 4835 Flournoy Street, Chicago 44, Illinois.

The ½ watt unit is ⅜" long x 9/64" diameter; 1 watt, 9/16" long x 7/32" diameter; 2 watt, 11/16" long x 5/16" diameter.

Ratings for maximum continuous voltage drop

*(Continued on page 74)*



# THE INDUSTRY OFFERS . . . —

(*Continued from page 73*)

are: 500 volts for the ½-watt unit, 1000 volts for the 1-watt unit, 3500 volts for the 2 watt unit.

All resistors are color coded. Available from stock in RMA standard values (10% tolerance) from 10 ohms to 22 megohms.

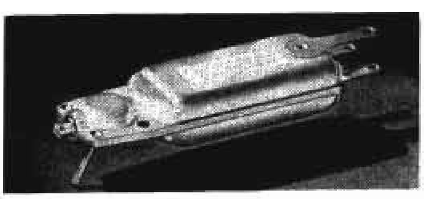
* * *

### SHURE LEVER-TYPE PICKUP CARTRIDGES

A crystal pickup cartridge with the crystal driven by a lever has been announced by Shure Brothers, Chicago.

Lower needle point impedance is said to be obtained. The lever arrangement is said to absorb the full impact of sudden jars to the cartridge or needle. Needle force of ¾ to 1⅛ ounce is attainable with the output voltage from 1.6 to over 3.

Cartridge is available in an aluminum case. Weight, .43 ounce. It is also furnished in steel weighing .85 ounce.



* * *

### EIMAC TRIODES

A medium mu, forced-air cooled, external anode transmitting triode, 3X2500A3, has been developed by Eitel-McCullough, Inc., San Bruno, California. The grid terminates in a ring interposed between the plate and filament, to permit use as a grounded grid amplifier at high frequencies with coaxial plate and filament tank circuits.

The tube is also provided with a low-inductance cylindrical filament-stem structure that is said to allow a smooth transition between a linear filament tank circuit and the tube.

A single tube will deliver a r-f output of 5000 watts at 3500 plate volts at low frequencies, and 3500 watts at 3000 plate volts at 110 mc Diameter is less than 4½".

* * *

### RCP POCKET MULTITESTER

A pocket multitester, model 448, has been announced by Radio City Products Co., 127 West 26th St., New York.

Ranges are: D-c voltmeter 0-5-50-250-1000 (first scale division, 0.1 volt); a-c voltmeter 0-5-50-250-1000 (first-scale division, 0.1 volt); output voltmeter 0-5-50-250-1000 (first scale division, 0.1 volt); d-c milliammeter, .5-10-100-1000 ma (first scale division, .01 ma); ohmmeter, 0/1000 . . . 0/10,000 . . . 0/.1 meg . . . 0/1 meg; decibel meter, —6 to +10 . . . —14 to +26 . . . —28 to +40 . . . —40 to +52 db.

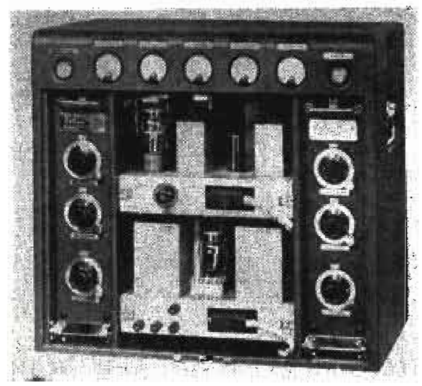
Db range is calibrated for a line of 500-ohm impedance. For lines of other impedance, correction charts are supplied. Size, 5⅞" x 3-1/16" x 2⅛". It weighs 1¼ pounds with self-contained batteries.

### AIREON 50-WATT AIRCRAFT STATION

A 50-watt 2 to 8-mc/118 to 132-mc/200-410 kc a-m transmitter, type RS-1, for aircraft applications, has been developed by Aireon Manufacturing Corporation, Kansas City, Kansas.

Channels are pre-tuned.

Other features include two-channel telephone emission with frequency ranges for both day and night operation and 100% modulation in all frequency ranges.



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### CHERRY RIVET UMBRELLA PLUG

An umbrella plug that fits into the center of the hollow type Cherry rivets and furnishes a cap to cover the head of the rivet has been announced by the Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California. The plugs are available in aluminum, copper or plastic.

The shank is knurled and tapered. The pointed end of the shank is inserted into the installed rivet, and the plug is pushed in by hand.

Plugs may be used in hollow type Cherry rivets of 1/8", 5/32", 3/16" and 1/4" diameters.

* * *

### MULTI-PRODUCTS TOOL SOLDERING IRON

An automatic-feed, electric soldering iron, the Eject-O-Matic, has been developed by the Multi-Products Tool Company, Newark, N. J. It is trigger operated and ejects a measured amount of solder from a reel concealed in the handle. A retracting feature is said to prevent the melting of excess solder. The actual amount of solder released is regulated by a micrometer adjusting wheel mounted in the handle of the iron.

* * *

### WILCOX 400-WATT TRANSMITTERS

A 400-watt, 125 to 525 kc/2 to 18 mc/100 to 160 mc transmitter, type 99 A, intended particularly for aeronautical, point-to-point, or police service, has been announced by Wilcox Electric Company, Inc., 1400 Chestnut Street, Kansas City, Missouri.

Ranges are covered by radio-frequency subchassis, which are removable.

Audio input level (100% modulation) 0 db; audio input impedance, 500 ohms; audio-frequency response, 200 to 3000, audio frequency distortion, less than 10%; maximum keying speed, 150 wpm.

Tubes in l-f, i-f chassis: 2—6AC7/1852, 1—807, 1—4-250 A, 1—6SN7GT, 1—OC3-VR105, 1—OD3-VR150, 1—6V6GT.

Tubes in h-f, r-f chassis: 2—6AC7/1852, 1—807, 1—813, 1—250TL, 1—6SN7GT, 1—6B4G.

Tubes in v-h-f, r-f chassis: 1—6C4, 2 (miniature)—6V6, 1—829, 2—4-125A, 1—6SN7, 1—6V6.

Rectifier and modulator tubes include: 2—

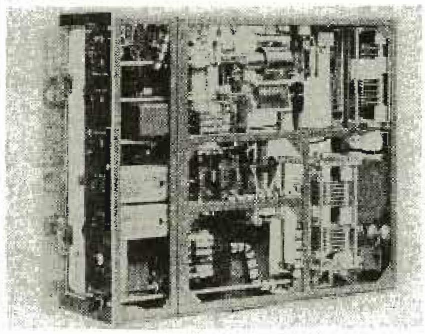
(*Continued on page 76*)

## THE INDUSTRY OFFERS . . . —

(*Continued from page 74*)

6SN7GT, 2—807, 2—813, 1—5Z3, 2—872A, 4—866A.

Overall cabinet size is 32" wide, 26" deep, and 72" high.



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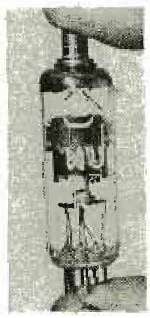
### NATIONAL UNION MINIATURE RECTIFIERS

A miniature type (2⅛" bulb) half-wave high vacuum rectifier, the N. U. 1Z2, has been developed by the National Union Radio Corporation, 15 Washington Street, Newark 2, N. J.

The tube can handle 20,000 volts. In addition to its usual application as a half-wave rectifier at line frequencies, the tube is said to be suited for fly-back pulse rectifiers, and r-f supplies for television circuits.



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### UNIVERSAL TUBE TESTER

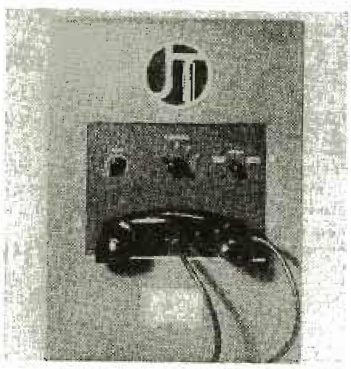
A tube tester for testing of receiving tubes, ballast tubes, cold cathode rectifiers, acorn tubes, tuning eye tubes for glow, screw base and bayonet base dial light bulbs, flashlight bulbs, and several types of low power transmitting tubes, has been announced by Universal Instrument Co., 306 E. McMillan St., Cincinnati 19, Ohio. Features include 10-step line voltage adjustment with line reading on the meter; 4½" rectangular meter with poor-good scale and a 0-100 division scale for comparison or matching of tubes; filament voltages from .75 to 117.

Size: 14¾" x 11¾" x 6".

• • •

### JEFFERSON-TRAVIS 25-WATT MARINE UNIT

A 25-watt radiotelephone for marine installations has been announced by Jefferson-Travis Corporation, 245 East 23rd Street, N. Y. 10, N. Y.



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### COLLINS REMOTE AMPLIFIER

A 3-stage remote amplifier, type 12Y, is now




in production at the Collins Radio Company, Cedar Rapids, Iowa. It is a single-channel, high-fidelity type.

It weighs 7 pounds in its carrying case. Maximum gain, 84 db. Universal input; 600-ohms output.

Operates from 115 volts a-c, 60 cycles.

• • •

### L. A. B. VIBRATION TESTER

A vibration test table to test packages and products has been announced by the L. A. B. Corporation, Union Place, Summit, New Jersey.

Table size, 5'x5'; capacity, 1,000 pounds.

• • •

### FAIRCHILD TEST OSCILLATOR

A 40-115 mc/115-500 mc test oscillator, primarily designed to provide a source of calibrated high-frequency signals for testing in the field, has been announced by the Fairchild Camera and Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.

Adjustable pickup loop provides control of the output power. Either an unmodulated or a modulated signal available. Modulation may be either 1000 cycle sine wave at about 50% modulation, or a special short regulated pulse used in certain classes of equipment.

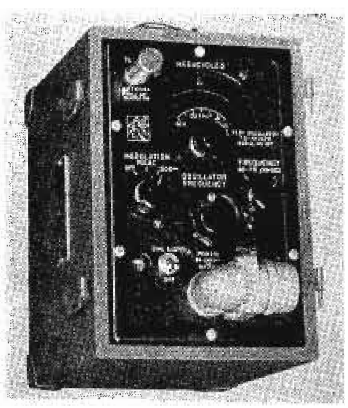
The complete test oscillator is composed of four main subassemblies: (1) Aluminum casting, forming the main chassis of the instrument; (2) butterfly circuit assembly, mounted on an individual casting; (3) power supply and modulator shelf; and (4) the panel with controls, power cable receptacle, and output connector.

The oscillator frequency is controlled by the butterfly circuit, one part of which may be opened by a switch. For the high-frequency band, the switch remains closed and the butterfly operates normally. For the low-frequency range, the switch is opened. An external, permanently connected coil completes the butterfly circuit and resonates with the butterfly capacitance.

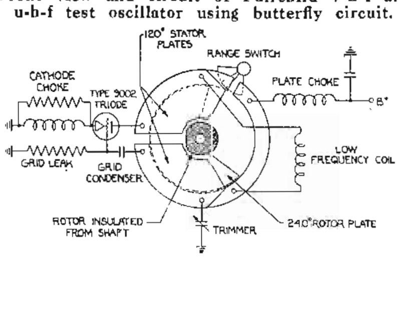
Output power is obtained through a pickup loop, rotated in the magnetic field of the oscillator-tuned circuit. This power is fed through a 50-ohm coaxial line to an output connector mounted on the panel.

Oscillator operates either from a-c or d-c. A switch permits adaptation of the instrument for use with a-c from 50 to 2600 cycles, at voltages of 80, 115, or 230. It is also made adaptable for use with d-c voltages of 6.3 and 220. For operation with battery supplies, 220 volts are obtained from five 45-volt dry batteries, and the 6.3 volts from four 1.5 dry batteries.

In the oscillator-tuned circuit, a modified insulated rotor butterfly with two sets of 120° split stator plates and 240° rotor plates (a floating rotor) is used. A three-turn coil is permanently connected across a gap in the stator or inductive element of the butterfly, and a range switch is used to open or close this inductive element. The range switch itself is composed of a number of spring vanes that slide in slots in the butterfly stack. This provides multiple contact with consequent low inductance and resistance.



Front view and circuit of Fairchild v-h-f and u-h-f test oscillator using butterfly circuit.

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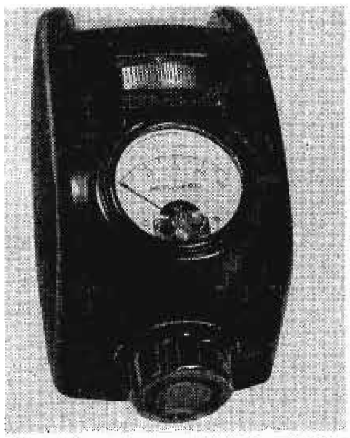
### G. R. U-H-F WAVEMETER

A u-h-f wavemeter, type 1140-A, for the 240 to 1200 mc band has been announced by the General Radio Company, Cambridge 39, Mass.

The range is covered in a single direct-reading range with an accuracy of ±2%. Tuning element is a butterfly-type tuned circuit which is coupled to a standard cartridge-type crystal detector. Crystal current, as indicated in a microammeter, gives an indication of resonance. Where the available power is not sufficient to actuate the microammeter, the reaction of the wavemeter upon the current in the circuit under measurement can be used.

Housed in a molded plastic case.

Size, 3⅞" x 7¼" 4½", overall; net weight, 3¼ pounds.



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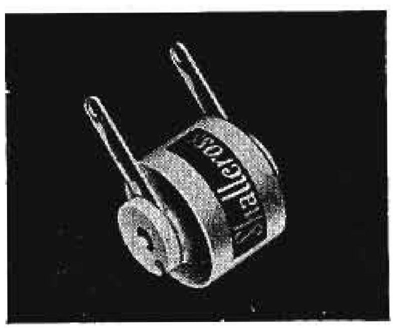
### SHALLCROSS 0.5-WATT HERMETICALLY-SEALED RESISTORS

Hermetically-sealed resistors, type 1101, rated at 0.5 watt and ⅛" long x ⅞" in diameter have been announced, by the Shallcross Mfg. Co., Jackson and Pusey Avenues, Collingdale, Pa.

Maximum resistance value when wound with nickel chromium wire is 350,000 ohms; maximum voltage, 420.

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### U. S. TELEVISION YOKES

Iconoscope yokes with 3" maximum length have been developed by United States Television Mfg. Corp., 106 Seventh Avenue, N. Y. City.

Vertical inductance, 2 millihenrys, at 1000 cycles; horizontal inductance, 100 microhenrys at 1000 cycles.

Outside diameter approximately 2¾" exclusive of connecting terminals, which are toward the rear (away from the mosaic).

* * *

### GRAYHILL DEMAGNETIZER

A demagnetizer for small tools has been an-

*(Continued on page 78)*

## THE INDUSTRY OFFERS . . . —

(*Continued from page 77*)

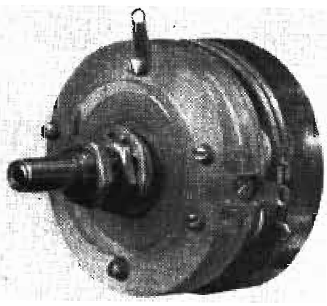
nounced by Grayhill, 1 North Pulaski Road, Chicago 24, Illinois The unit is 3" x 1¾" x 1¾" and operates from 115 volt a-c

The demagnetizer is energized by depressing a switch button and de-energized by releasing a button.

To demagnetize a tool, such as a small drill, the coil is energized and the tool is passed completely through the hole of the demagnetizer. The coil is not de-energized until the tool is approximately 6" away from the demagnetizer

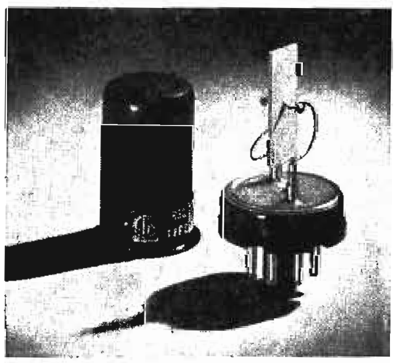
### CALTRON 145-MC RING TUNER

A variable tuning unit covering 140 to 160 mc, with 3.5-mmfd tube capacity has been developed by the Caltron Company, 11916 West Pico Blvd., Los Angeles, Cal Rotation 180°. Diameter of body 2", shaft diameter ¼". mounting hole ⅜".



### KNIGHTS CRYSTALS

Metal tube shell mounted quartz crystals, JK T-9AD, for 200 to 65 kc are now being pro



duced by The James Knights Company, Sandwich, Illinois.

Frequency tolerance is said to be less than .01% over a temperature range from —50° to +70° C. It can be supplied with a nominal frequency tolerance of .005% at 25° C.

Contact with the plated quartz is through shock absorbing wire leads soldered directly to the crystal surface plating.

* * *

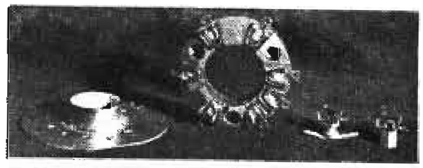
### NATIONAL CERAMIC COMPONENTS

Ceramic sockets and capacitors developed during the war, are now available from the National Radio Company, Malden, Mass.

The socket, XLA, is for acorn tubes. Seven contacts are provided so that the new 6F4 can be accommodated in addition to the popular 950 series, requiring 5 contacts.

A silver-plated shield, XLA-S, for pentode acorns, is also available.

The ceramic capacitor, type XLA-C, may be mounted inside the socket in place of the contact screw. Values are 100 mmfd, 50 mmfd. 25 mmfd, and 7 mmfd.



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### HORNI METAL-PLATE RECTIFIERS

Selenium, metal-plate rectifiers, Se-RON, with square rectifying elements have been developed by Horni Signal Manufacturing Corp., 421 W. 54th St., New York 19, N. Y.

Square elements are said to provide approximately 20% more rectifying area.

Eight sizes of plates range from 1" x 1" to 5½" x 7¾". with current capacities from a few milliamperes to 22 amperes per element.

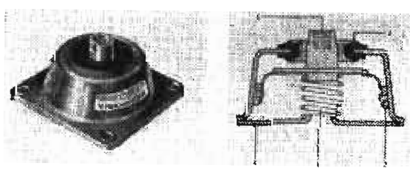
Illustration shows one arm of a three-phase, bridge rectifier that will deliver 1000 amperes at 18 volts, d-c. Size 5½" x 7" x 10", overall.

* * *

### ROBINSON VIBRATION MOUNT

An anti-vibration mounting unit, Vibrashock, has been annoonced by Robinson Aviation Inc., Teterboro, N. J.

The load is carried by a stainless steel spring with three-way freedom of movement and built-in, three-way limiting snubbers furnishing a resilient stop to limit heavy shock loads. By elimination of rubber or synthetic for load carrying the new mount is said to avoid permanent set and vulnerability to cold, heat and humidity



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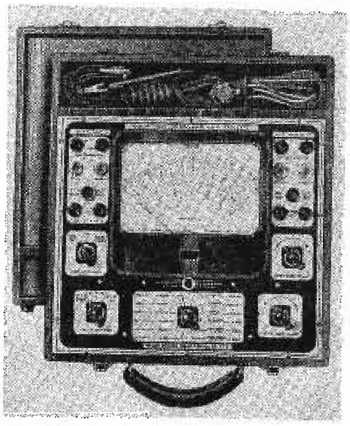
### PRECISION MULTI-RANGE V-T VOLTMETER

Portable, vacuum tube multi range testers type EV-10 P. with zero-center vacuum-tube voltmeter ranges, have been developed by the Precision Apparatus Company, 92-27 Horace Harding Blvd. Elmhurst, N. Y. Direct-reading megohmmeter, milliammeter, ammeter Also includes output and decibel meter plus standard sensitivity 1000 ohms-per-volt a-c/d-c voltmeter ranges

Employs a stabilized bridge circuit using three tubes, 6Q5, 6X5 and VR-150. Meter is said to be zero-center on all ranges when used in the vtvm circuit, indicating polarity and magnitude without reversing prods or use of a polarity switch.

Eighth zero-center vtvm ranges from ±3 volts d-c to ±6000 volts d-c full scale; six resistance ranges from 0-2000 ohms to 0-2000 megohms; eight a-c and eight d-c ranges from 600 microamps to 12 amperes; eight output ranges from 3 to 6000 volts and eight db ranges from −26 to +70 db.

Overall dimensions are 12"x13"x6", approximately.



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### CINCINNATI ELECTRIC HERMETIC SEALS

Multiple hermetic terminals (doublehead electrode, hollow tube electrode and flattened pierced electrode) for cans, are now being produced by Cincinnati Electric Products Company, Cincinnati 12, Ohio.

Sealers and temporary punching and forming tools are also available.

* * *

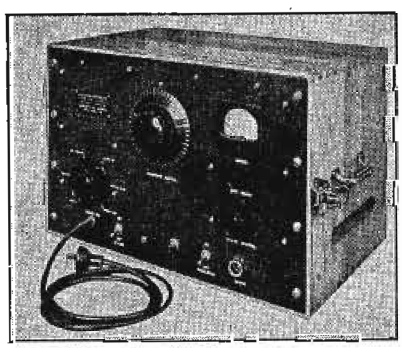
### BARKER AND WILLIAMSON R-F SIGNAL GENERATOR

A high-level r-f signal generator covering a 400 kc to 60 mc range in six steps has been announced by Barker and Williamson, 235 Fairfield Avenue, Upper Darby, Pa.

Modulation of 30% at 1000 cps is optional by means of a panel switch. Output is 3 volts (rms) at all frequencies and is read directly from a panel voltmeter. Output is through an output jack and coaxial cable terminated in a 75-ohm resistive load.

Calibration is said to be better than ½ of 1% and is read from a calibrated chart.

The six ranges are: 400 kc to 1000 kc; 1000 kc to 2500 kc; 2500 kc to 6 mc; 6 mc to 13 mc; 13 mc to 28 mc; 28 mc to 60 mc.



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### G.E. MIDGET THYRATRONS

All-metal midget thyratrons, type GL-502 A, have been announced by the tube division of G.E.

The GL-502 A is an inert-gas-filled, double-grid thyratron with negative control characteristics. Control characteristic is said to be independent of ambient temperature over a wide range.

Net weight, two ounces. Height, 2½"; diameter, 1⅝".

# ADVERTISERS IN THIS ISSUE

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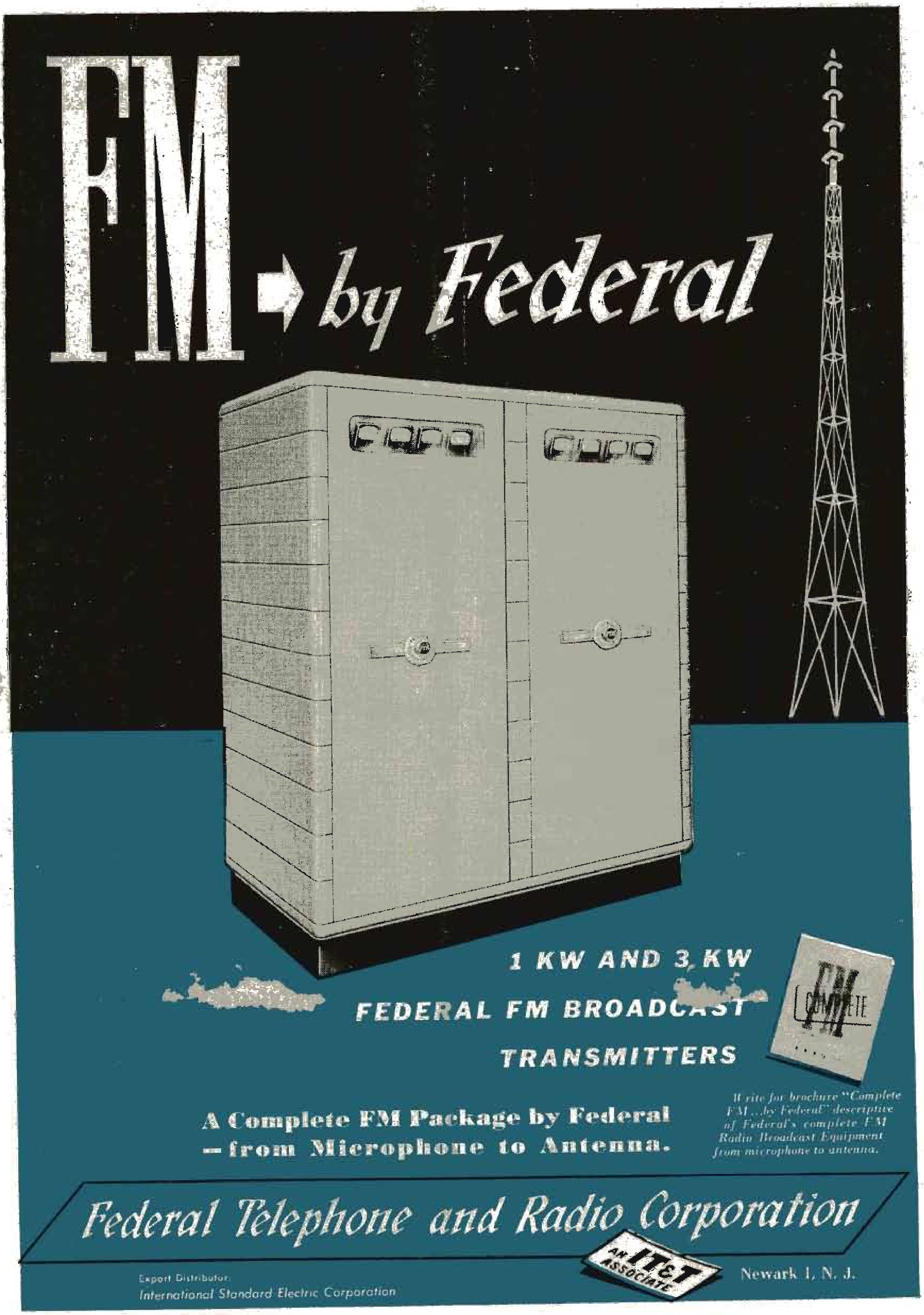

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