RADIO NEWS

SEPTEMBER
1945
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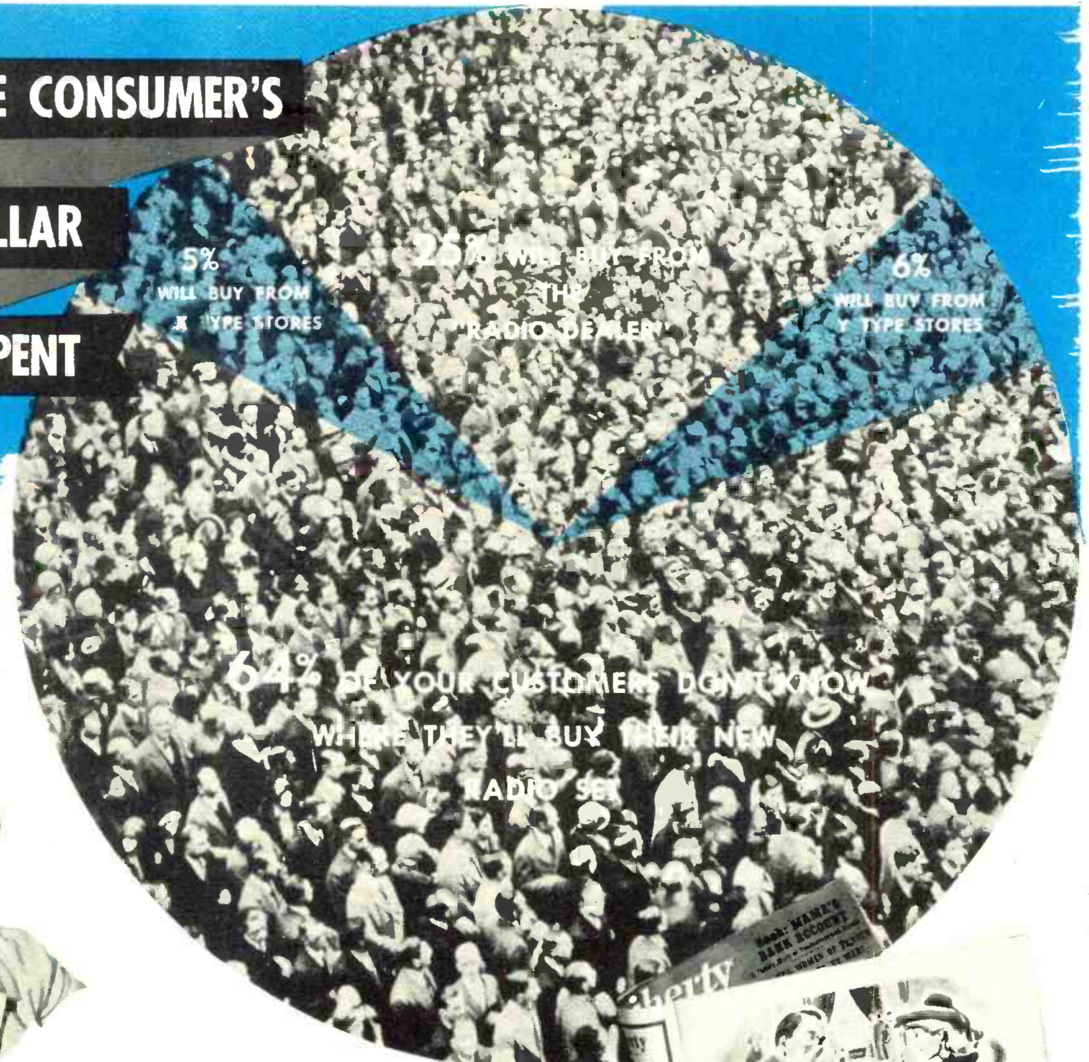

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RADIO NEWS
Reg. U. S. Pat. Off.

SEPTEMBER • 1945

VOLUME 34, NUMBER 3

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COVER PHOTO

By Frank Ross

(Staff Photographer)

Testing GL-826-A 100 kilowatt water-cooled transmitting tube in General Electric tube factory. Doors are opened for purposes of illustration only. Ordinarily they are closed for safety purposes.

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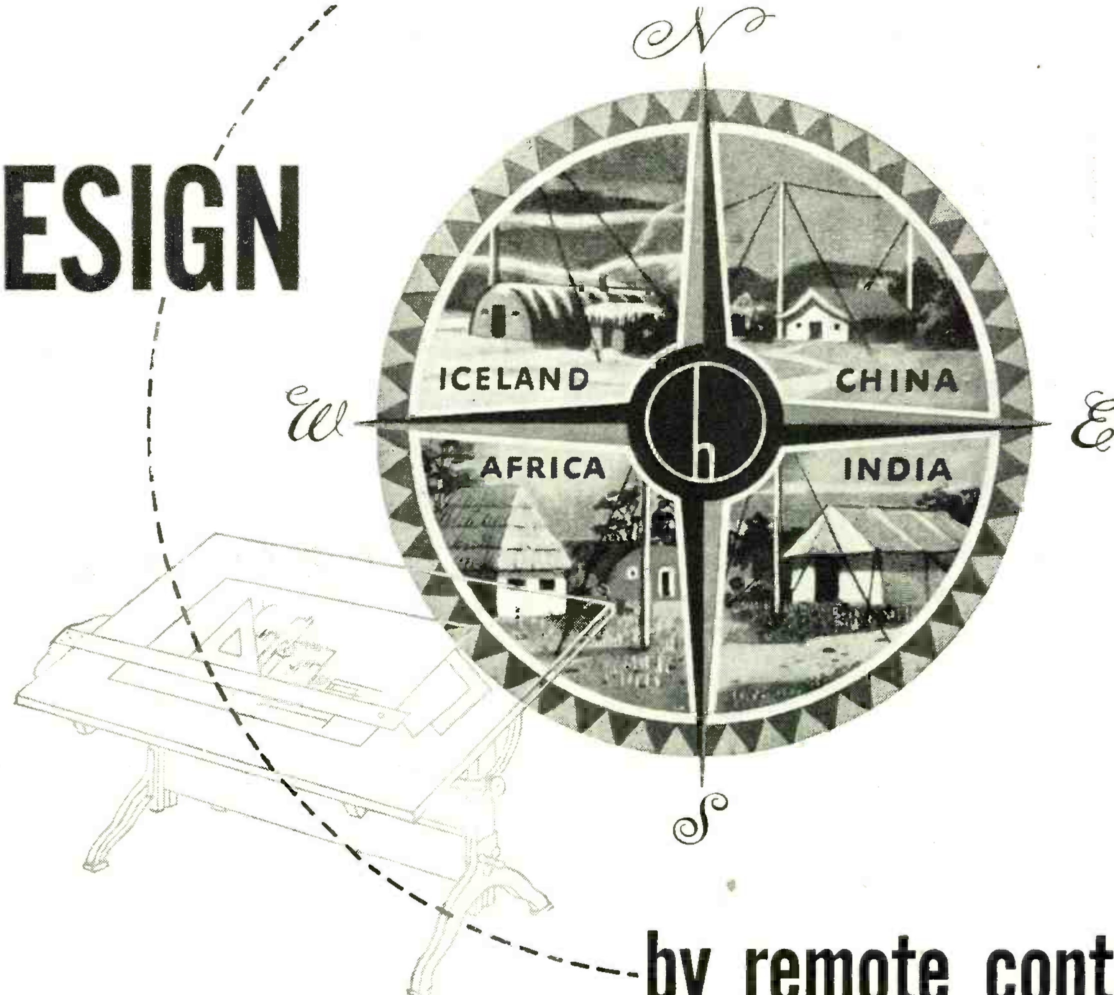

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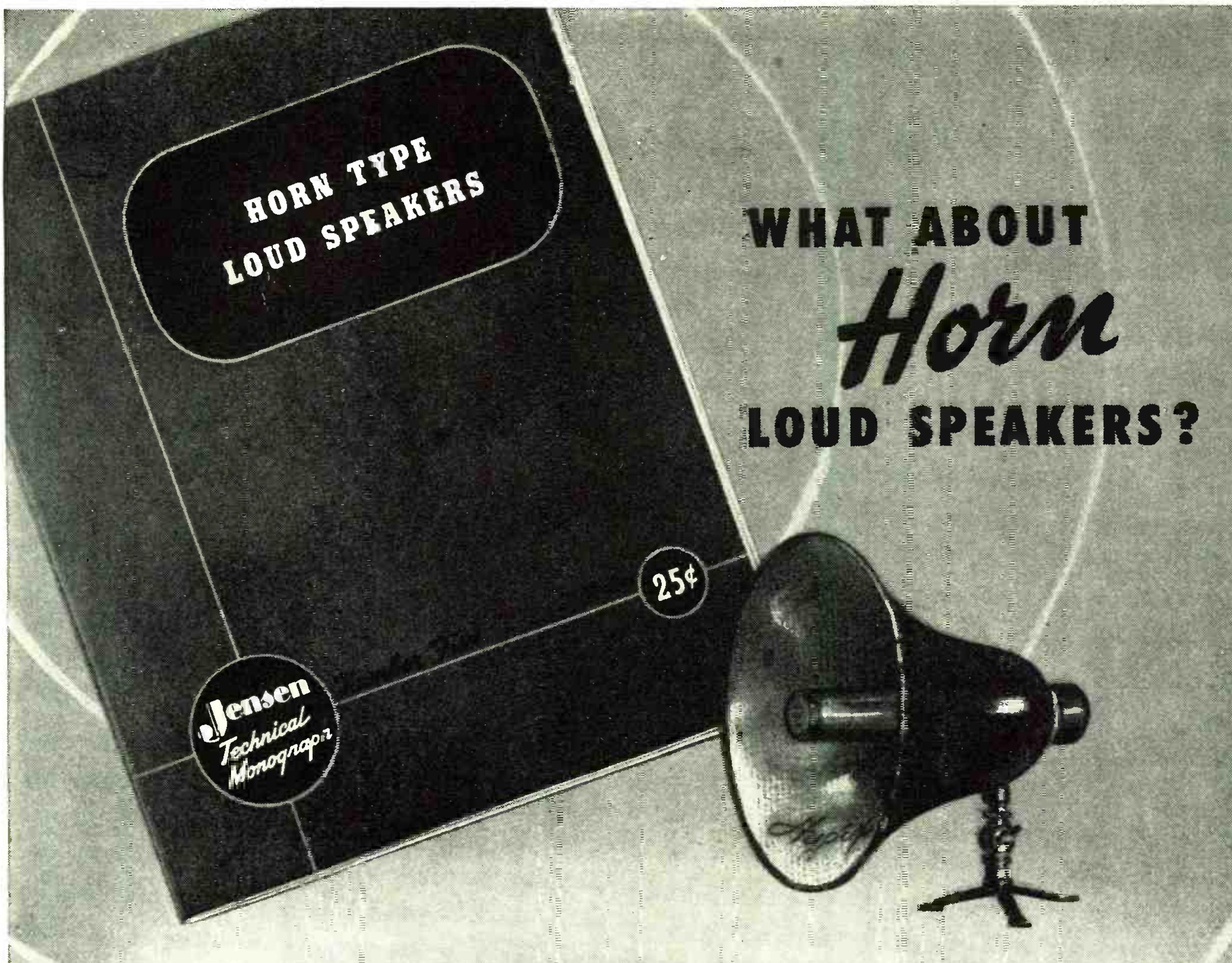

What effect do horn formula, flare and length have on low frequency "cut-off?" In the most commonly used frequencies which horn is most directional — one with large or one with small mouth? What are the advantages of the reflex type horn? How is a 500-watt "bull horn" constructed? What are the advantages of the new Hypex,* originated by **JENSEN**, over the exponential type horn?

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For the RECORD

BY THE EDITOR

DURING the past few weeks officers of the Radio Intelligence Division, Engineering Department, of the Federal Communications Commission have located a number of unlicensed radio transmitters.

The majority of the unauthorized activity has occurred in the cities of Detroit, Michigan; San Antonio, Texas; and Everett, Washington. The equipment in use has varied from that which was classed as carrier current type to actual low-power transmitters operating on frequencies as high as 100 mc. In some instances the calls used were those previously assigned to amateurs, as well as calls presently assigned to ships operating under the jurisdiction of the Commission. Although the power in each instance was 25 watts input or less, in several instances the signals were heard across the international boundary line of our country. Violations of this type are always apt to seriously interfere with other authorized services. This becomes a menace of considerable magnitude when the offended service is one such as aeronautical. marine, and special radio applications now under the control of the War and Navy Departments.

Our readers are, in most cases, familiar with the Commission's rules and regulations pertaining to the operation of low-power radio frequency devices. When one voluntarily operates equipment of the carrier current type, that person is obligated to insure that these regulations are not violated. The field strength of such radiations is restricted to a value not greater than 15 microvolts per meter at or beyond approximately 1/6 wavelength (157,000 ft. ÷ freq. in kc.) from the transmitter. Section 2.103 states that the provisions of rules 2.101 and 2.102 shall not be construed to apply to any apparatus which causes interference to radio reception. These facts may not have been pointed out with sufficient clarity or emphasis in most magazine articles dealing with carrier current operation. As a result, many of those apprehended violating these regulations seem greatly surprised upon being advised of the circumstances.

The above information comes from George Sterling, Assistant Chief Engineer and Chief, Radio Intelligence Division of the Federal Communications Commission. In the October 1944 issue of RADIO NEWS we gave a complete report on the activities of the RID. We can appreciate the vast amount of work confronting them. The war is not over as yet, at least at this writing. This is certainly no time to burden RID personnel with additional "policing." They still have a vital job to perform.

Let's not jump the gun. Let's handle our carrier current apparatus with extreme care. Let us not be guilty of violations that can easily be avoided.

All amateurs are naturally eager to return to the air, and we are no exception. The fact that certain South American amateurs are again permitted to carry out communications is no reason why we should expect the same privilege at the moment.

We might suggest, on the other hand, that the FCC take initial steps to reinstate amateur license holders immediately, as a means for expediting the deluge of applications which will be shortly forthcoming.

Applications in Great Britain can now be made for the re-issue of full transmitting licenses to those who held them before the war. This has been made possible as a result of discussions between the General Post Office and the Radio Society of Great Britain. We think this is a step in the right direction and the objective is to assist the General Post Office in making necessary arrangements in order to save as much time as possible. We are told that British prewar holders of licenses are making formal application to the Radio Branch giving full particulars of the former license. These include the name of the licensee, the address of the station, call letters, and the correct address to which all future correspondence is to be sent. No other information is required. In Great Britain there are many so-called "artificial aerial licenses." These are possessed by those who have not previously held licenses. Amateurs who have changed their address since their apparatus was impounded at the outbreak of the war have been requested to notify the Radio Branch of the Engineer in Chief's Office of the GPO. In case of British amateurs, it is not necessary for them to submit a detailed list of their impounded equipment. Up to this writing there has not been any date set for the release of this equipment.

Reports from Britain tell of several amateur transmissions using G7 call letters being heard. We are told that these have been serving a special purpose and that the operators in all cases have received official sanction. This special service has now been suspended.

WE KNOW that our more than 80,000 readers will welcome the news that our old friend John Rider will again be back in the fold writing for RADIO NEWS exclusively. John

(*Continued on page* 86)

RESERVE YOUR POST-WAR

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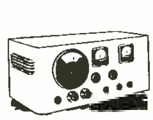
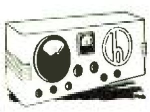
MODEL SX-28A—This is the latest model of Hallicrafters famous *Super Sky-Rider* . . . the finest communications receiver built today! Has a frequency range of 550 kc. to 42 Mc. continuous in 6 bands. With crystal, less speaker, net..................**$223.00**



MODEL SX-25—The *Super-Defiant* . . . long-time favorite of amateurs who want fine performance at a moderate price. Has a frequency range of 545 kc. to 42 Mc. continuous in 4 bands. With crystal, less speaker, net..........**$94.50**



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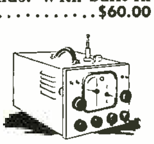
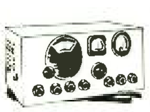


MODEL S-39—*Sky Ranger* portable . . . operates from its own self-contained batteries or 115 volts a.c. or d.c. Has frequency range of 540 kc. to 30.5 Mc. continuous in 4 bands. Net..........**$110.00**



MODEL S-36—Covers both old and new FM bands. Operates on FM, AM, or CW. Outstanding for sensitivity, stability, high fidelity and versatility in the *very high frequencies.* Range from 27.8 Mc. to 143 Mc. continuous in 3 bands. Less speaker, net.........**$307.50**

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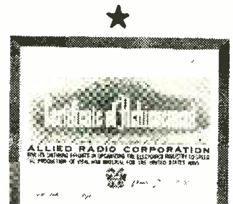

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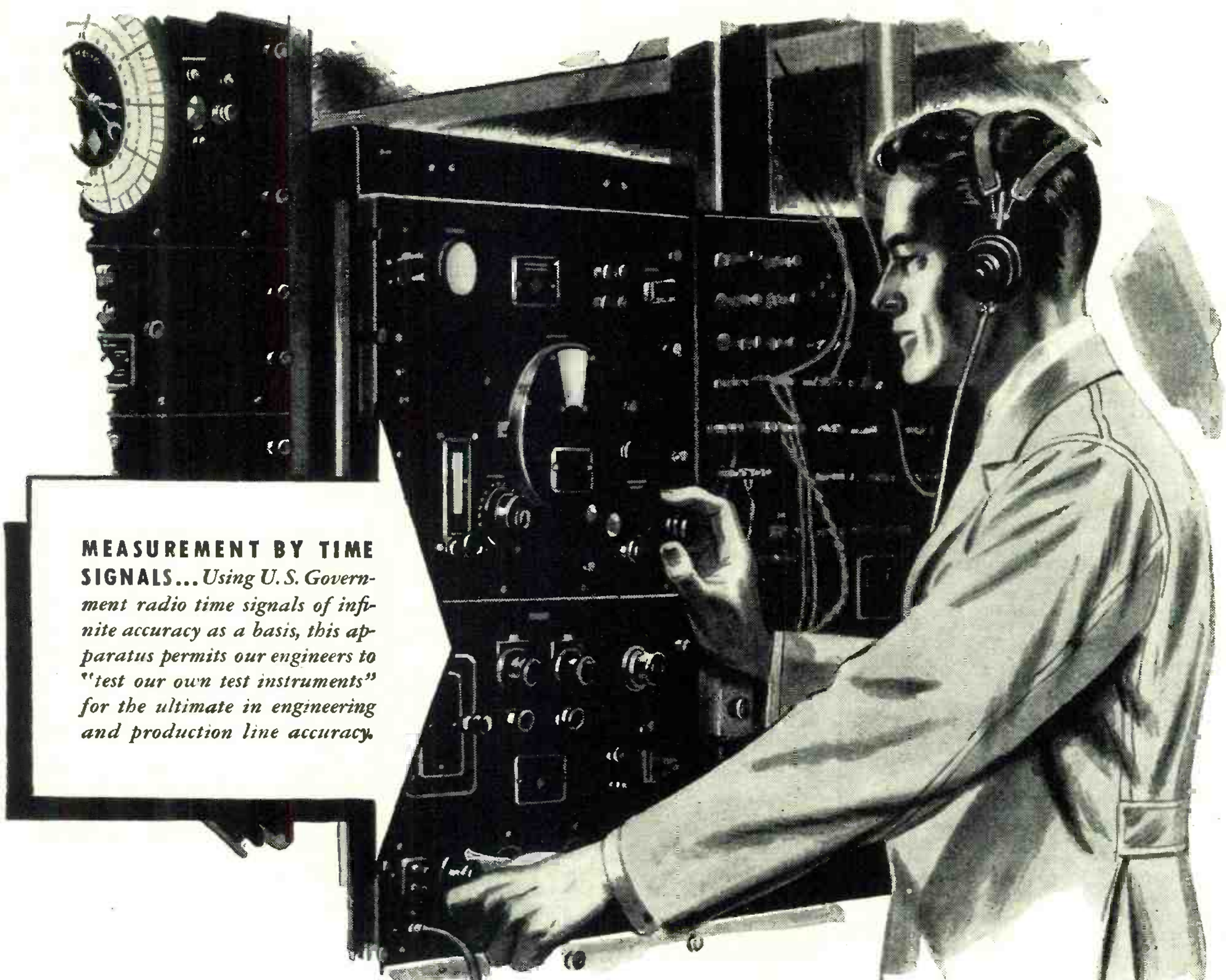

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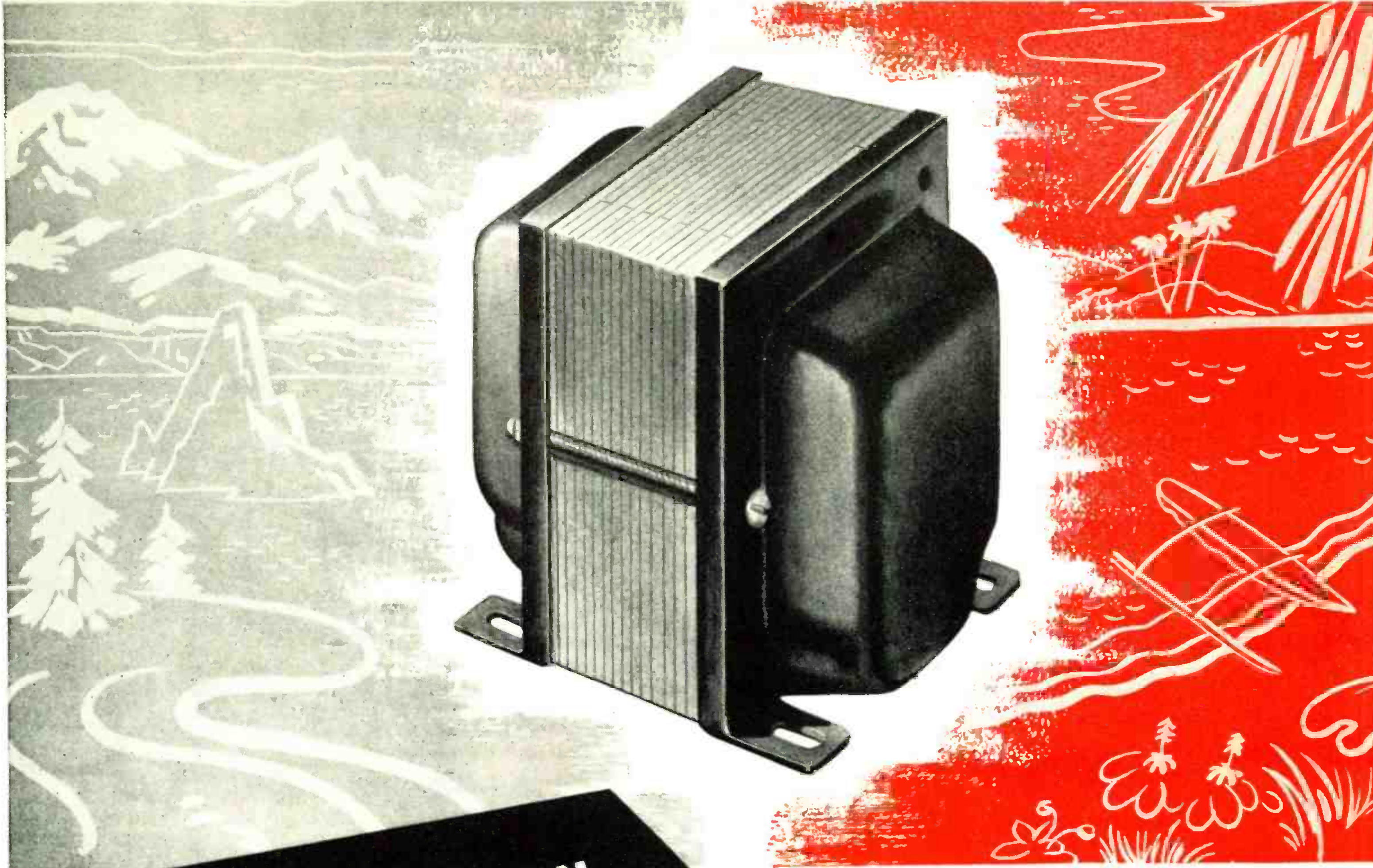

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Spot Radio News

★ ***Presenting latest information on the Radio Industry.***

By FRED HAMLIN
Washington Editor, RADIO NEWS

THE RADIO INDUSTRY, now struggling through the first phase of its difficult reconversion program, predicts that new home receivers will reach the market in time for the Christmas buying rush but that a substantial volume can not be expected until the first quarter of 1946.

Many major problems must be solved, however, before production reaches the high level necessary to meet the tremendous pent-up demand for new sets, and those problems are the chief concern right now of manufacturers and government agencies as OPA and WPB. Overshadowing the whole picture, of course, are military contracts for radio and other electronic equipment, which remain at a high dollar-volume level despite cutbacks. But the military demand is not static. Its movement up or down is the controlling factor in the rate at which the manufacturing industry can make the changeover to civilian production. A sudden stiffening of Jap resistance or a severe setback for Allied forces in the Pacific might result in almost complete concentration of the industry on electronics for war purposes. Such a contingency is not anticipated but it is always uppermost in the minds of both government and industry experts at work on reconversion planning.

Because of the spotty cutback situation, a number of manufacturers have idle plants and are dropping employes while others are still geared to full production schedules. To relieve those whose plants have dropped out of military manufacturing, WPB recently amended Order L-265, barring civilian radio production, to permit resumption of non-military activities on a "spot" basis. This spot authorization order, or "hunting license" as it is called, establishes a simplified procedure to cover applications for permission to produce electronic equipment, including home radio sets.

In the past, appeals under L-265 have been considered only in cases of unusual hardship, and complete lists of materials to be used in the production of end equipment and components had to be filed. The new instructions require only the filing of a form and a listing of the quantities of seven of the most critical electronic components—sockets, capacitors, resistors, tubes, transformers, loud speakers, and reactors.

The amendment also sets forth simple rules to be followed in asking for permission to use idle and excess inventories on hand for civilian production. In the past, a special authorization was required, but now no additional application is needed.

This relaxation of L-265, to be followed by complete revocation of that restricting order when military requirements drop to 75 per cent of the needs in the first quarter of 1945, paved the way for partial reconversion of the industry but it solved only one of many problems. While it permits a start on work for civilian products, the "spot" plan does not ease the component parts situation. Those operating on the "spot" plan still must find components without benefit of government priorities. And components still remain as the principal bottleneck in the reconversion struggle.

Although the materials supply is getting better, the parts industry and the OPA are unable after months of conferences to reach agreement on a pricing plan for parts. Until ceilings on parts are fixed, prices on completed sets cannot be determined.

The OPA, following the provisions of its broad pricing policy, insists that new home receivers be sold at prices near those prevailing in immediate prewar days. Consensus of parts manufacturers is that sharply increased production and administrative costs prohibit a return to prewar prices. OPA obtained cost data from three tube companies and they indicated no rise in costs of materials and only a moderate rise in labor costs. Applying the OPA reconversion formula to civilian radio tubes on the basis of that information would allow only a small increase over prewar prices. Parts makers, pressing for a liberal pricing formula on components for civilian radio sets, and OPA officials have agreed to supplement the meager cost data compiled and a questionnaire on that subject has been distributed to 75 companies in the parts industry. The facts and figures assembled will form the basis of a new pricing formula.

Both radio set and parts industry spokesmen have asked that radio equipment be removed from price control because of the highly competitive

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If you want to have a look at the Capacitors and Resistors of tomorrow, step in and see what has been going on in the Sprague Engineering Laboratories (if wartime restrictions would permit!). Then it will be easy to understand why Sprague has been a FIVE TIME WINNER of the coveted Army-Navy "E" Award!

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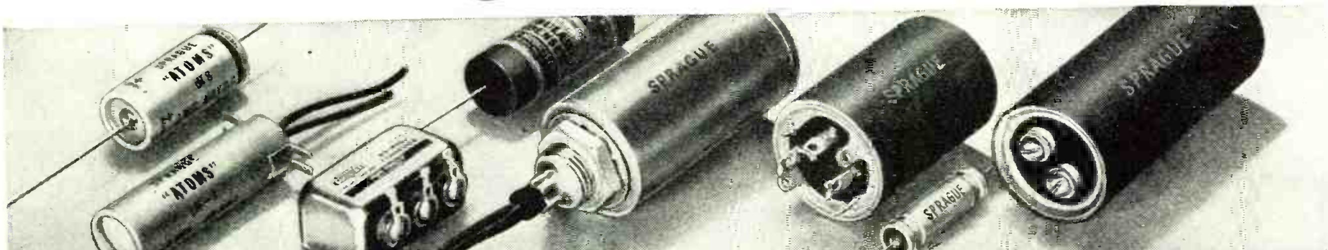
SPRAGUE PRODUCTS COMPANY, North Adams, Mass.

(Jobber Sales Organization for Products of the Sprague Electric Co.)

SPRAGUE

ARMY E NAVY



CAPACITORS FOR EVERY SERVICE, AMATEUR AND EXPERIMENTAL NEED

character of the industry. OPA officials balk at that on the ground that price control of radio products must remain in effect now because of the short supply. A few tube manufacturers have threatened to sell their civilian tubes directly to jobbers unless OPA agrees to liberalize prices.

Meanwhile, OPA has proposed to the OPA Radio Set Manufacturers' Industry Advisory Committee a reconversion pricing formula for radio receivers. It would set up a plus or minus factor as the basis for an application for price change. It applies, however, only to radio receiver models substantially similar to 1941 models. If and when the new regulation becomes effective, it will supplant the program under which radio set prices have been set. The decision as to parts prices will, of course, have a direct bearing on any receiver prices arrived at.

WITH FCC ALLOCATIONS FOR FM, television, facsimile, non-government fixed and mobile services, and amateur service determined (44 to 108 megacycle band), industry and FCC engineers turned to the important task of drafting new standards of good engineering practice for the operation of FM, television and facsimile broadcasting in the new region of the spectrum. The revised rules provide information to be used in proceeding with planning and design of new receiving sets and transmitters.

The FCC was concerned primarily with the FM frequencies, since all the other services in the 44-108 band also have allocations in other portions of the spectrum and were not wholly dependent on their additional assignments. FM on the other hand is receiving an assignment only in that portion of the spectrum. It now has a permanent position and one that is as free as possible from interference and other shortcomings.

After a series of hearings and oral arguments dating back to September, 1944, the FCC selected the third (with some modifications) of three proposals for FM. The three considered were: 50-68 megacycles, 68-86 megacycles and 84-102 megacycles. Number two (68-86) was ruled out immediately and choice lay between the other two. Chief objection to Number 1 (50-68) was the amount of sky-wave interference which would result among FM stations.

The FCC report pointed out, for example, that interference among 50 kilowatt FM stations at 58 megacycles from sporadic E transmissions alone might be expected for 140 to 480 hours a year at the 50 microvolt contour from stations 900 to 1000 miles distant, respectively. In contrast, at 84 megacycles, interference would be anticipated for only 6.5 to 25.5 hours a year. In addition to measurements of interference by FCC, the American Radio Relay League reported that there have been thousands of communications via sporadic E in the 56-60 mc. amateur radio band but that there have been no recorded instances of such transmission in the 112-116 megacycle band. The amount of sporadic E interference will vary, says FCC, with the particular frequency involved, the power of the transmitters, the distance between transmitters, the number of transmitters on a channel, and other factors. But regardless of these factors, the region of the spectrum above 84 megacycles is superior to the region below 68 megacycles with respect to interference.

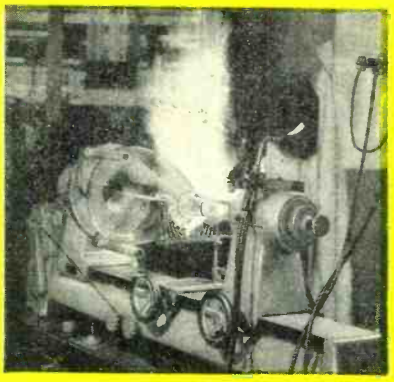
The FCC report also contained this paragraph, "For listeners buying FM receivers in reliance on a belief that FM is an interference-free service, these figures are extremely serious. They mean, for example, that a listener tuned to a station which is carrying the program of his choice may suddenly find, either that the program to which he is listening is being interfered with by a station hundreds or even thousands of miles away, or else that control of his receiver has been seized altogether by a distant station completely obliterating the desired program of the local station. These distant transmissions, moreover, are sporadic in nature, with the result that his enjoyment may be further destroyed by an alternative of first one program and then another as transmission vagaries decree. The effect may well be to render FM receivers useless to many listeners for substantial periods of time."

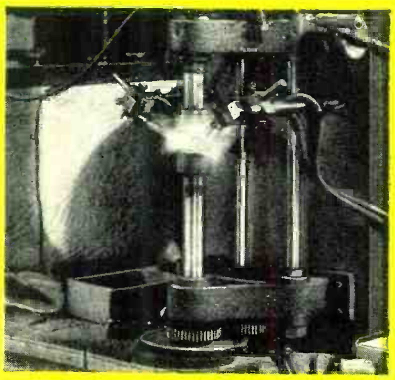
On the question of a possible delay if FM were assigned to higher frequencies, the FCC had this to say, "At the time of the oral arguments, the estimates of delay were reduced (from two years) to four months. It may well be that competition will markedly reduce even this four-month estimate. Moreover, this report makes it possible for manufacturers to begin at once their planning and design for the higher frequencies. The War Production Board has not yet authorized construction of AM, FM, or television equipment for civilian use. Some months may still elapse before manpower or materials become available in sufficient quantities for such production to begin. If so, the planning and design of equipment for the higher frequencies can be completed before civilian production of any AM, FM, and television equipment is authorized."

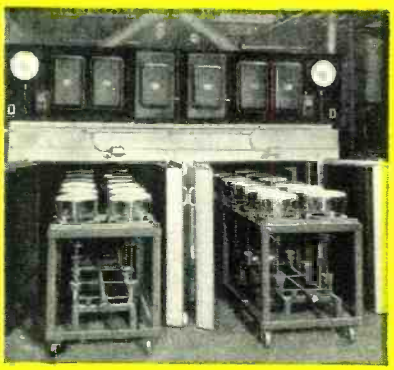
The FCC adopted alternative Number 3, with certain modifications, the specific allocations between 42 and 108 megacycles being as follows: 42-44 mc., non-governmental fixed and mobile; 44-50 mc., No. 1 television channel; 50-54 mc., amateur; 54-60 mc., No. 2 television channel; 60-66 mc., No. 3 television channel; 66-72 mc., No. 4 television channel; 72-76 mc., non-government fixed and mobile; 76-

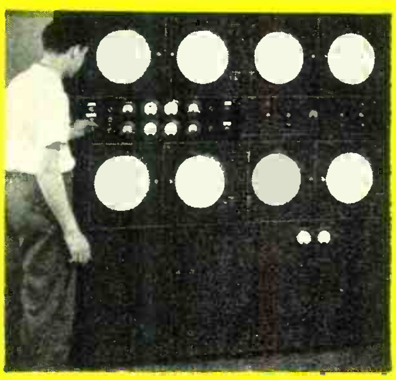
(*Continued on page* 136)

CATHODE RAY TUBE PRODUCTION AT RAULAND


Sealing on tube neck


Manufacturing header


Baking screens and wall coating.


Life-testing tubes.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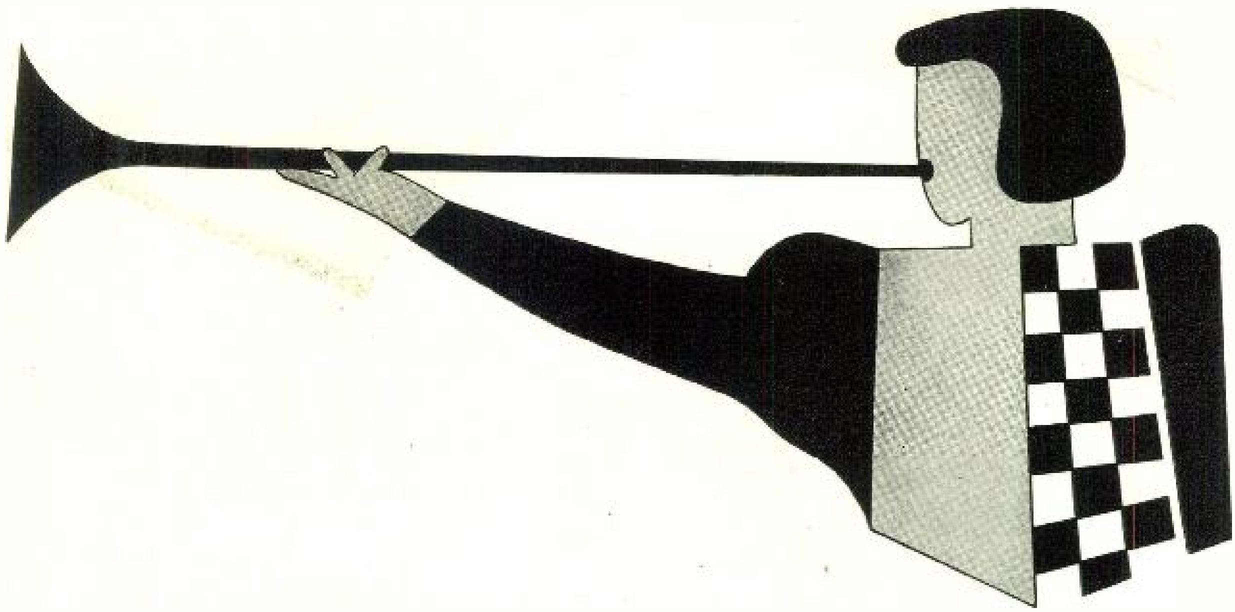

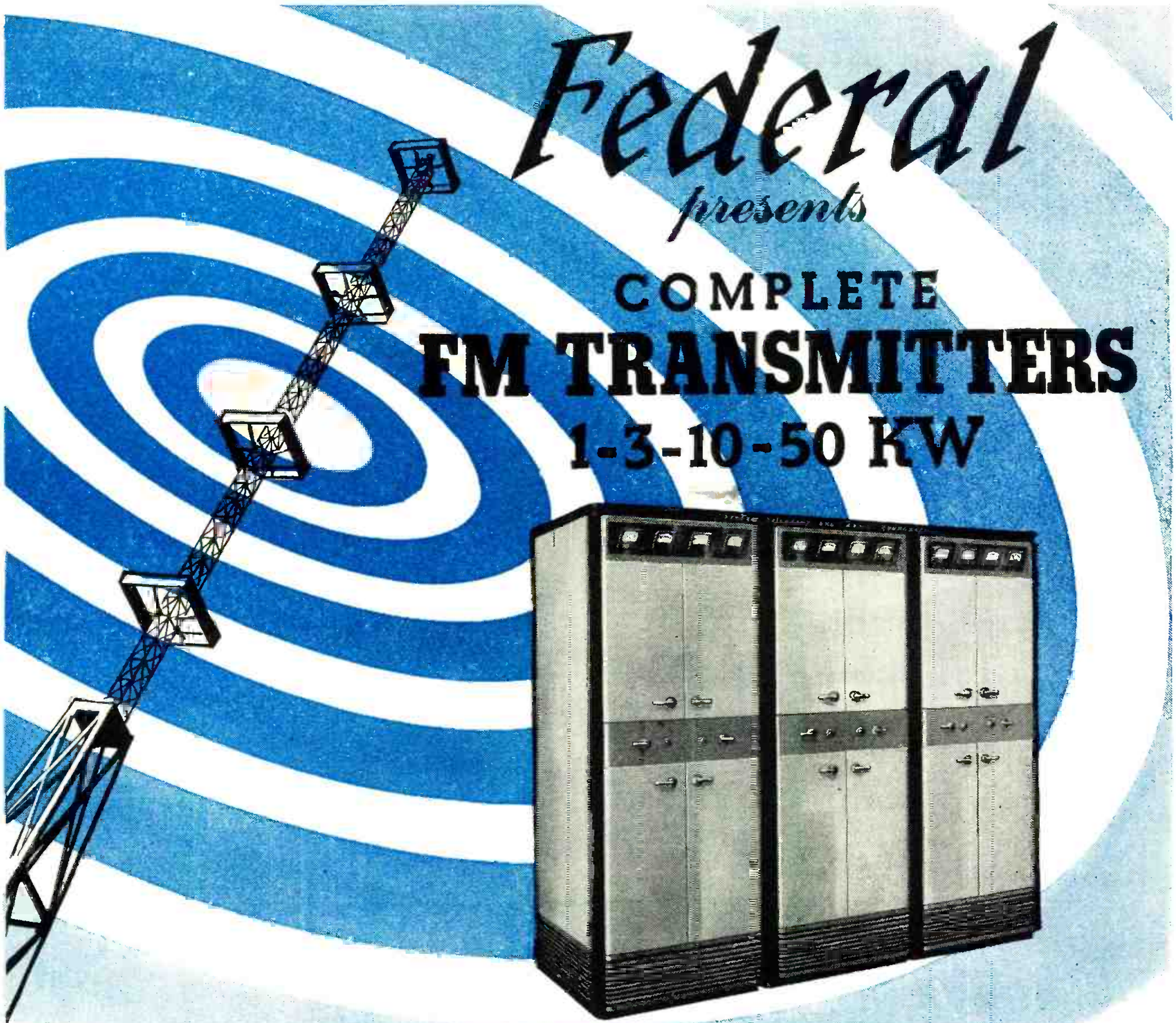

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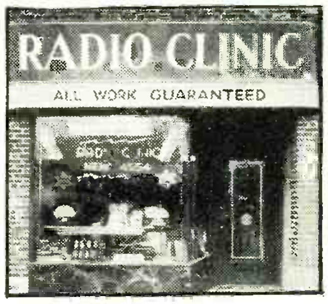

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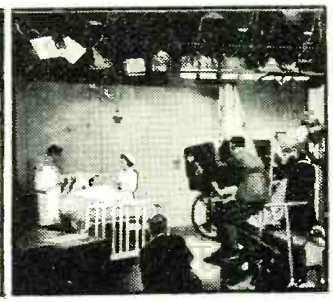

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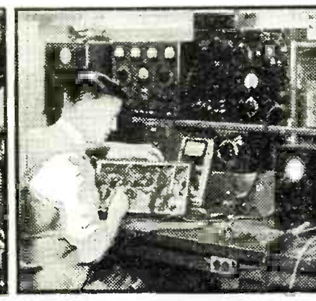

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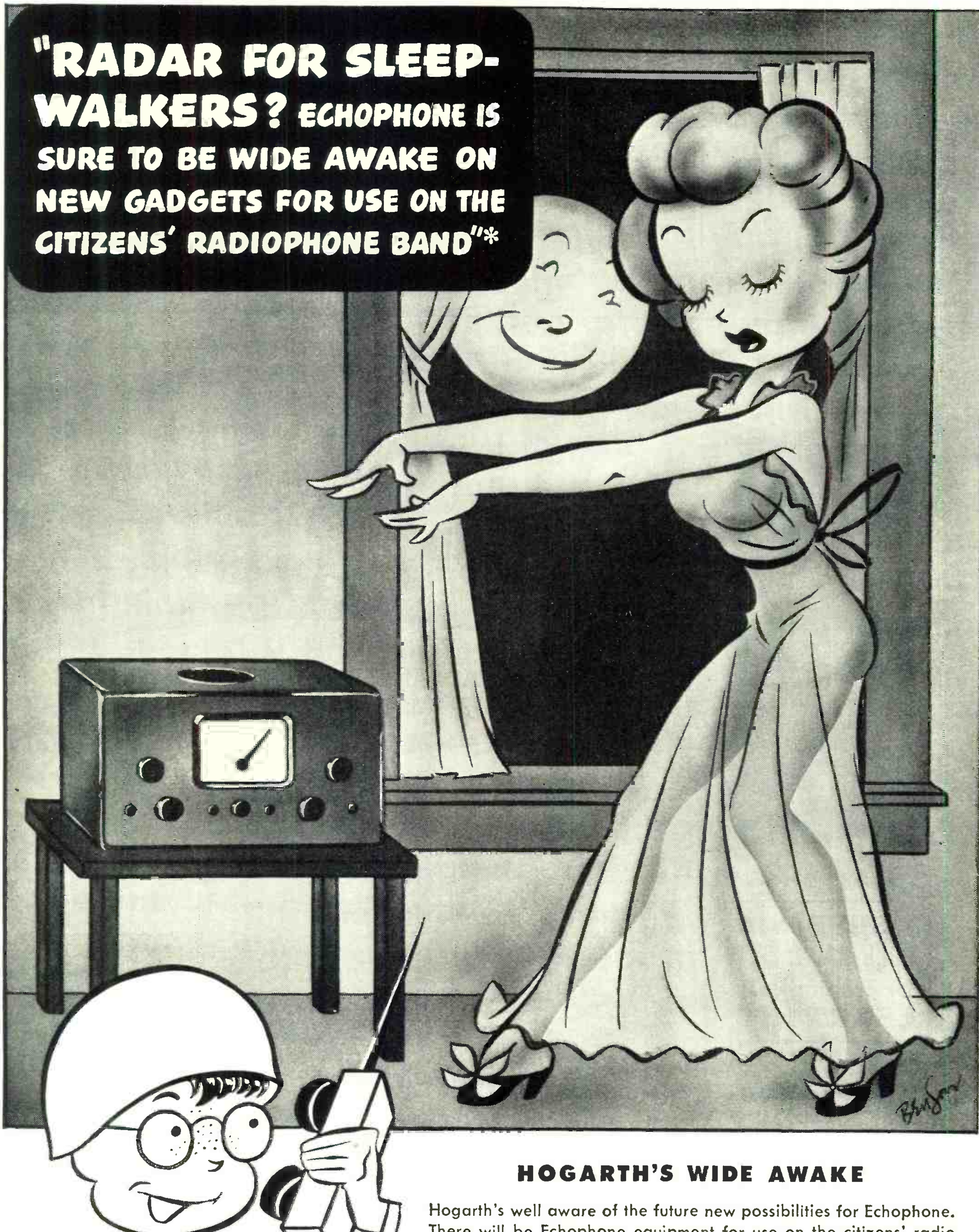

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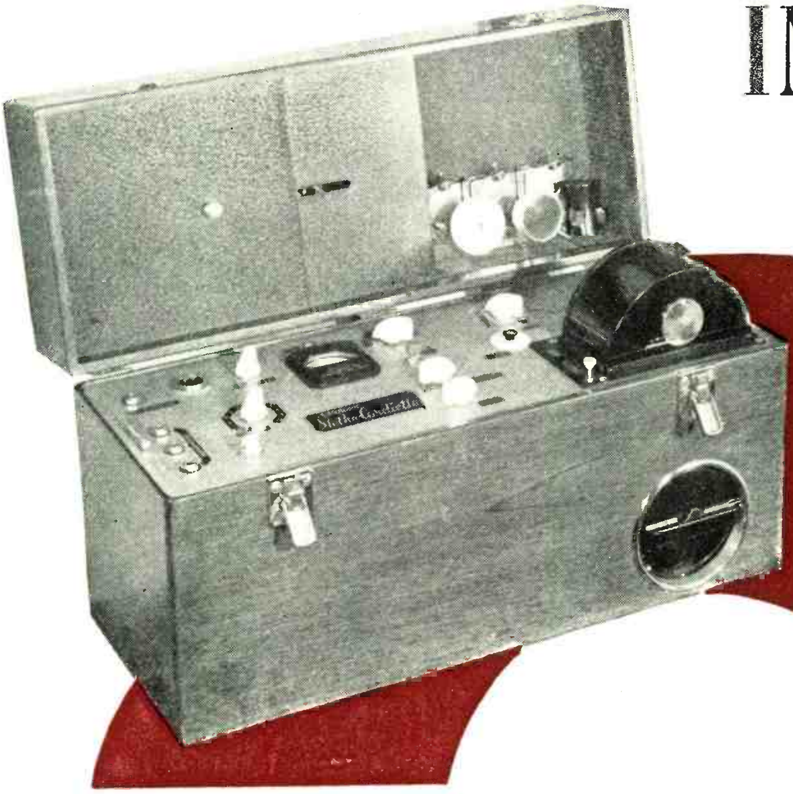
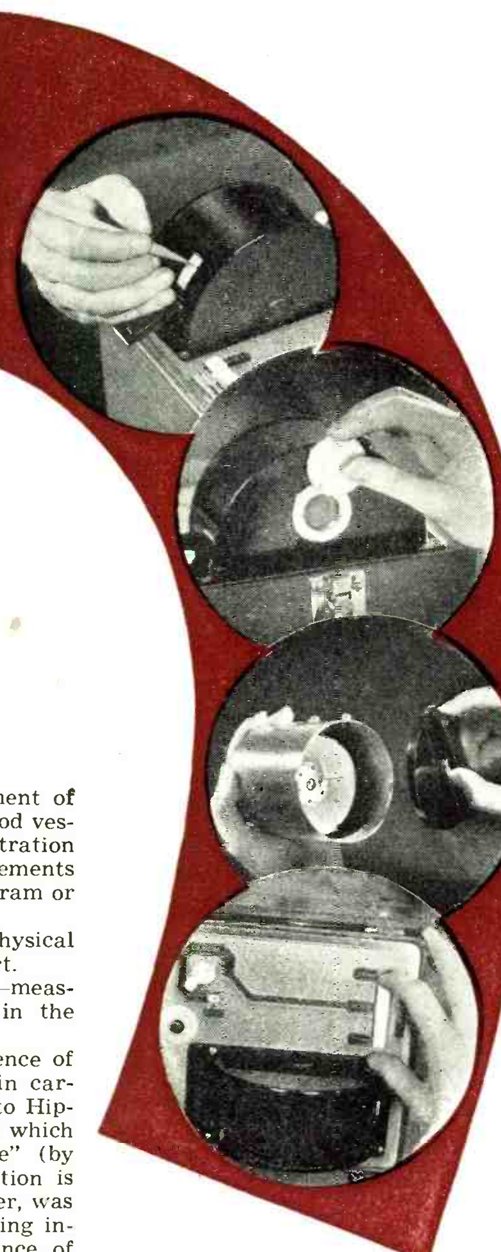
MANUFACTURERS OF PRECISION COMMUNICATIONS EQUIPMENT

Development of
CARDIAC DIAGNOSTIC INSTRUMENTS

By **MAURICE B. RAPPAPORT**
Research Eng., Sanborn Co.





The electronic industry has again furthered the advancements in the medical field by supplying more modernly designed equipment used extensively by cardiologists for diagnosing heart ailments.

SOME of the more important measurements that must be made by a cardiologist in making a diagnosis of the heart are:

1. The electrocardiogram—a graphic registration of the action potentials of the heart. The action potentials are electrical impulses which are generated by nerves and conducted by nerve fibers to the various components of the heart. The action potentials and the nerve conduction system act like an automobile ignition-distributor system for triggering the chambers of the heart to create a proper pumping sequence.
2. The phonocardiogram and the stethoscope—sounds are generated by the heart, valves, and vascular system which may be heard via the stethoscope or registered graphically by means of the phonocardiograph or stethograph as it is alternately called.
3. The mechanical pulsations—the pumping action of the heart creates a mechanical movement of the chest and over the blood vessels. The graphic registration of these mechanical movements is known as the sphygmogram or polygram.
4. X-ray—measures the physical size and shape of the heart.
5. The sphygmomanometer—measures the blood pressure in the arteries.

Some knowledge of the presence of heart sounds and their value in cardiac diagnoses may date back to Hippocrates' work, *"De Morbis,"* in which vague reference to "immediate" (by placing ear to chest) auscultation is made. William Harvey, however, was one of the first to give convincing information regarding the presence of heart sounds (*"De Motu Cordis"*). It was not until 1819 that the character of heart sounds under normal and pathological conditions was described by Laënnec (*"Traité de l'auscultation médiate,"* tome 1) who employed "mediate" (via stethoscope) auscultation in obtaining his data. Laënnec's ob-

Fig. 1. The Stetho-Cardiette instrument produced by the Sanborn Company. It provides simultaneous or separate stethogram and electrocardiogram, plus amplified auscultation. The circular inserts show various views of the photographic film chamber.

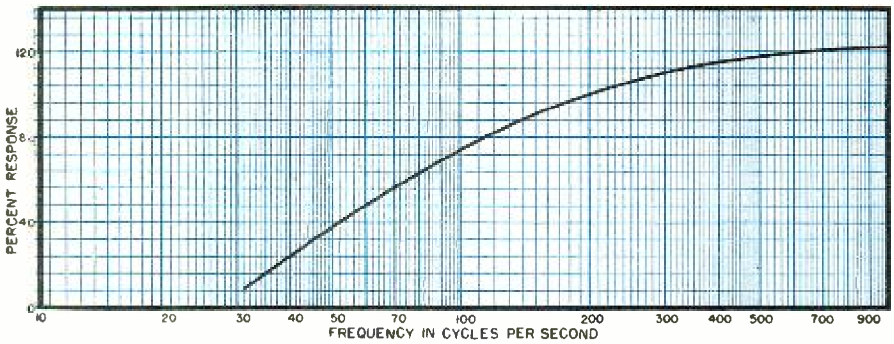


Fig. 2. Frequency response characteristic of the average of a large number of acoustic stethoscopes, minus the effects of the chest piece.

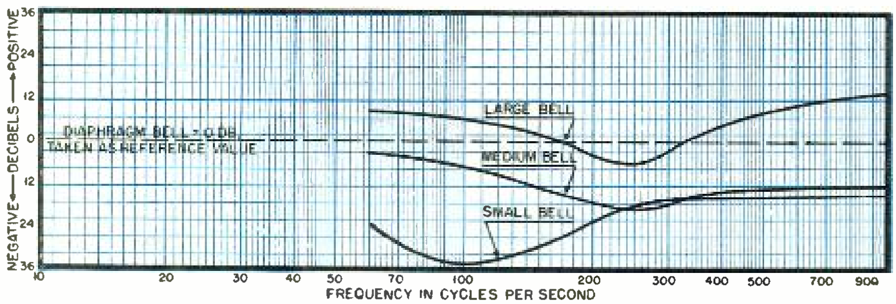
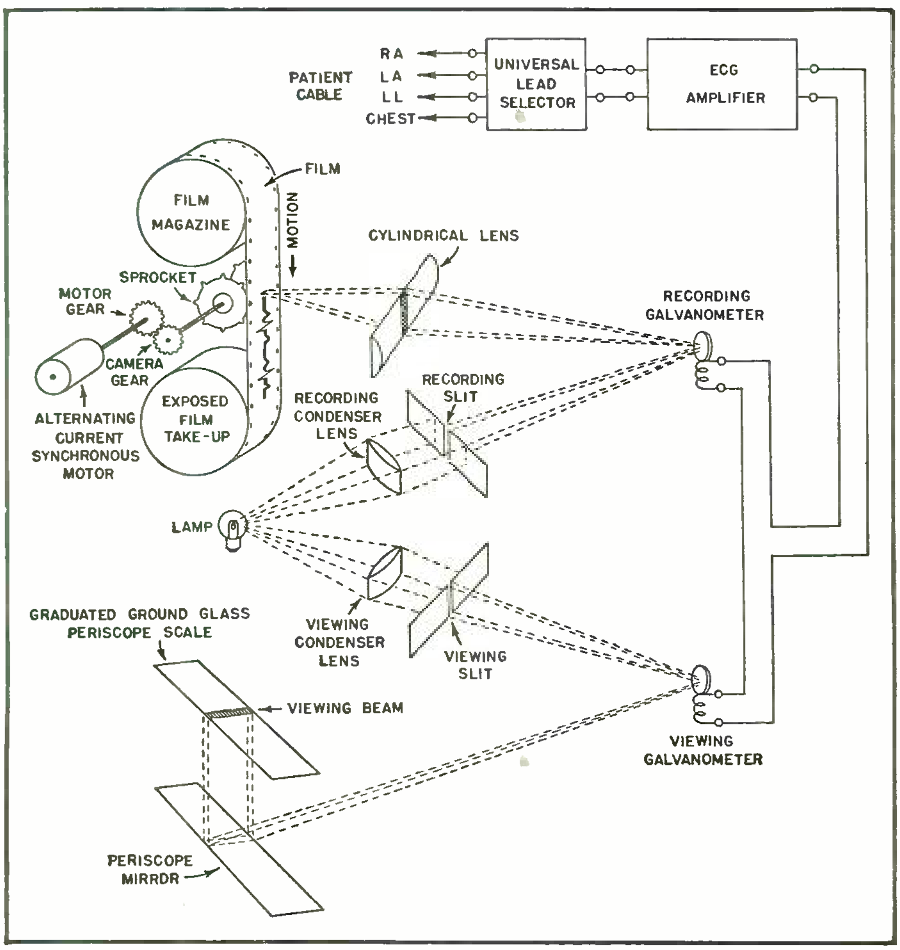


Fig. 3. Resultant curves of the three open chest pieces of Fig. 5, as compared with diaphragm type chest piece. The higher the decibel reading, the higher is the relative efficiency of the chest piece.

★ ★

Fig. 4. Diagram showing the elaborate optical system employed in a continuous recording electrocardiograph. This instrument will operate unattended for 26.7 hours.



servations were purely qualitative, as it was obviously impossible for him to make any positive measurements with his monaural stethoscope.

Hürthle,[1] in 1893, described a method of measuring graphically the apex beat (chest wall movement caused by cardiac action) and the instant of occurrence of the first heart sound (to every normal heart cycle four possible sounds may be heard, namely the auricular, first, second and the third). The apparatus consisted of a microphone which excited an induction coil; this in turn excited a frog nerve-muscle preparation which scratched a tracing on a smoked screen. In 1894, Einthoven and Geluk[2] substituted a capillary electrometer for Hürthle's frog nerve-muscle preparation and obtained the first graphic representation of the vibrations covering the first heart sound. Some years later, Einthoven[3] replaced the capillary electrometer with the string galvanometer, which increased the accuracy considerably.

Electrical phenomena of cells, tissues, and organisms have been studied with increasing intensity during the past 150 years. However, in 1856, Källiker and Müller first showed that electrical phenomena occur during heart action by observing rhythmic contractions in a nerve-muscle preparation placed in contact with the beating heart. Waller, in 1887, was the first to record the human electrocardiogram and shortly after this Bayliss and Starling obtained the first satisfactory tracings on mammalian hearts. The capillary electrometer was used in this early work and was the first instrument capable of recording voltages produced by the heart. Einthoven,[4] in 1903, introduced the first clinically practical and accurate instrument for registering the electrocardiogram, known as the string galvanometer. Einthoven who was a physicist as well as a physiologist may be further credited with the preliminary development of electrocardiography as an important clinical science. For nearly 20 years, clinical electrocardiograms were taken exclusively with string galvanometers and they are extensively used today. With the perfection of the thermionic vacuum tube, which took rapid strides soon after World War I, it became possible to record electrocardiograms with oscillographic units operating in conjunction with electronic amplifiers. Electronic electrocardiographs are more popular now because of their greater flexibility.

About the turn of the century, Mackenzie[5] developed a clinically practical polygraph. The term "polygram" means many writings and as applied to the circulatory system refers to the many writings which can be secured as a result of activity of three anatomical units of the circulatory system. Thus a tracing secured from the venous circulation is called a phlebogram; a tracing from the arterial circulation is called an arteriogram and a tracing from the precordial area is called a cardiogram. The apparatus is also quite commonly called a sphygmograph.

A sphygmogram, or polygram, as differentiated from an electrocardiogram, depicts entirely different phases of heart activity. Electrocardiograms principally depict three of the five properties of heart tissue, namely, stimulus production, excitability, and conductivity. Polygraphy is principally concerned with the function of contractibility. There is as yet no graphic method that yields information concerning the fifth property of heart muscle, which is tonicity.

X-rays and fluoroscopy, which will not be discussed in this article, serve to give the cardiologist information as to heart size, location, shape, etc.

The sphygmomanometer, which all physicians carry at all times in their medical bags, is a development of the initial experiment of Stephen Hales in 1733. Hales was the first to actually record the blood pressure of a horse by inserting a tube into the femoral artery and allowing the blood to rise in a vertical tube; from the height of the blood column, Hales calculated the pressure. The procedure of inserting a cannula into an artery is a rather impractical clinical procedure. Thus, indirect methods were devised which permit the estimation of blood pressure without entering the interior of an artery and are the type used at present by all physicians. The first indirect sphygmomanometer was devised by Riva-Rocci,[6] in 1896, and has been considerably perfected since by many investigators. An electronic blood pressure recorder has been devised and described by Rappaport and Luisada.[7]

Although the acoustic stethoscope has been in constant use by the medical profession since 1819, the acoustic characteristics had not been investigated to any great extent until 1941 by Rappaport and Sprague[8, 9] who considered the acoustic stethoscope as a closed acoustic system for conducting sound by air transmission from the surface of the chest to the observer's ear. It was observed that the sound vibrations are altered by the acoustic stethoscope. The degree of modification depends to a considerable extent upon the type of chest piece employed. Rappaport and Sprague's conclusions on the characteristics of acoustic stethoscopes are:

1. The open stethoscopic chest piece, or bell, when applied to the patient's chest, may be considered as a diaphragm type of chest piece. The skin which is bounded by the lip of the bell forms the diaphragm, and the fleshy portion under the skin acts as a damping medium.
2. The larger the diameter of the open stethoscopic chest piece, the better its response to low-pitched sounds. This is accomplished at the expense of the higher frequency components.
3. The greater the pressure with which the open stethoscopic chest piece is applied to the patient's chest, the better is the response of the stethoscope to higher frequency components. Thus, by varying the application pressure, the physician exerts a variable selective action upon the sounds because the natural period of the skin diaphragm which is bounded by the chest piece depends on the pressure with which it is applied.
4. The principle of operation of the Bowles (diaphragm) chest piece is similar to that of the open bell, except that additional attenuation of the lower pitched heart and chest sound components is accomplished by the action of the rigid diaphragm of the Bowles chest piece.

Fig. 2 shows the manner in which the average of a large number of stethoscopes modifies the heart sound vibrations with respect to frequency. This curve does not include the modifying effects of the stethoscopic chest pieces. The frequency response characteristic of any single acoustic stethoscope is not as regular as in Fig. 2 because all acoustic stethoscopes possess resonance peaks which superimpose themselves upon the smooth average curve.

Fig. 3 shows the approximate relative efficiency of the four chest pieces of Fig. 5 with respect to frequency, as ascertained by Rappaport and Sprague. Some of the more important

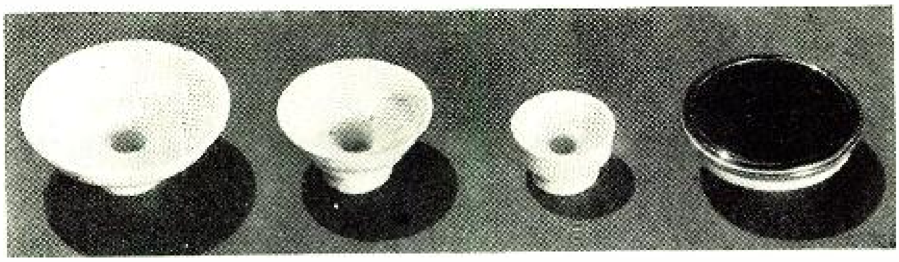


Fig. 5. Photograph of three open and one "Bowles" diaphragm chest pieces represented in Fig. 3. The dimensions of the bells are as follows: The lip diameter of the large open bell is 2.0 inches; of the medium open bell, 1.5 inches; and of the small bell, 1.0 inch. The "Bowles" chest piece employs a diaphragm 0.015 inch thick and a freely working diameter of 1⅜ inches. The internal volume of the large bell is 12.7 c.c.; of the medium bell, 6.2 c.c.; of the small bell, 2.3 c.c.; and of the diaphragm bell, 2.5 c.c.

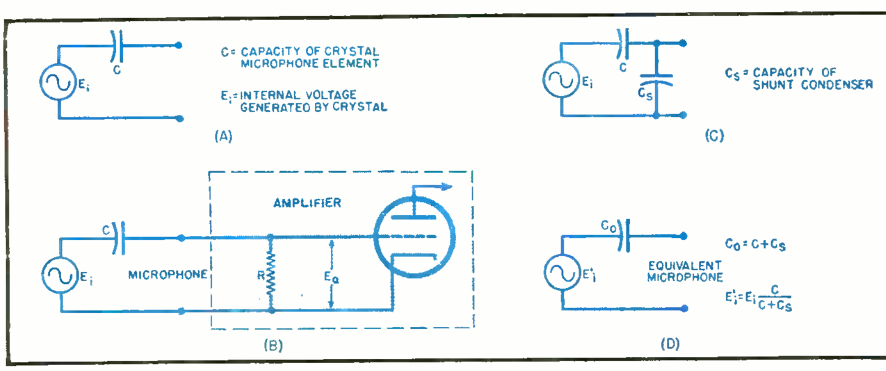
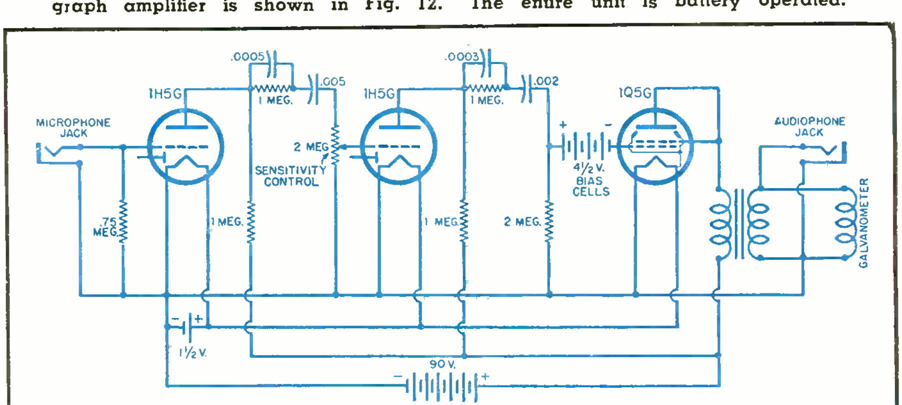


Fig. 6. Step by step analysis of applying a crystal type microphone to pulse wave recording. The standard crystal, as we know it, is not suitable as the time constant RC is too small when used with an amplifier. By adding shunt capacity across this crystal, it can be well adapted to pulse recording equipment.

Fig. 7. Schematic diagram of the sound amplifier employed in the Stetho-Cardiette. The complete unit is shown in Fig. 8, while the schematic for the electrocardiograph amplifier is shown in Fig. 12. The entire unit is battery operated.



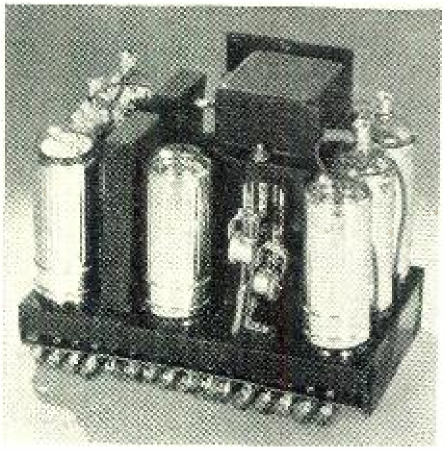


Fig. 8. The Stetho-Cardiette amplifier employing a total of 7 radio tubes; a set of 3 tubes is used for the stethograph section while the other 4 are used for the electrocardiograph. Schematic diagrams for this unit are shown in Figs. 7 and 12.

conclusions that may be drawn from these curves are as follows:

1. The efficiency of the three open bells improves, with respect to that of the diaphragm bell, as the frequency is decreased.
2. The larger the diameter of the open bell, the more efficient is the bell at the lower frequencies.
3. The large bell exhibits a resonance effect in the upper auscultatory region that is characteristic of a Helmholz resonator of such dimensions. The resonance points of the smaller bells are above the auscultatory range and so are not shown in the graph.

If a summation of the frequency response curves of the average acoustic stethoscope and any of the chest pieces is taken, the over-all frequency response curve may be manifested. Obviously, as the resultant curve is not linear, the sounds must be altered before reaching the observer's ears. A characteristic of average normal hearing is the inability of the human ear to perceive as of equal loudness, sounds of differing frequency which possess the same intensity. A graphic representation of this nonlinear characteristic of human hearing is known as an audiogram, and is obtainable by plotting, as ordinates, the minimum perceptible sounds applied to the tympanum of the ear (expressed in dynes per-square-centimeter or bars), and as abscissae their frequency in cycles-per-second. Fig. 10 is an average audiogram (heart sound range) which was obtained on a large number of persons with normal hearing. The individual audiogram is not so smooth; peaks and valleys are superimposed. In addition, only rarely are two pair of ears found to react alike, or even the two ears of any one person.

The curvature of the average normal audiogram approximates what is mathematically known as a logarithmic curve. Thus, it can be concluded that the human hearing mechanism alters or distorts logarithmically, with respect to frequency, the relative intensities of the components of the sounds that are transmitted to the tympanum of the ear by the stethoscope.

Since the development of the Mackenzie polygraph, various mechanical methods have been devised to record the sphygmogram or pulse. Some make use of lever systems in direct contact with the skin, so that the skin motion is magnified, and the tip of the final lever traces out the record on a moving surface. Other devices couple the lever system to the skin by an air column contained within a piece of rubber tubing. A pickup mechanism (glycerine pelotte or a funnel) is applied to the skin and connected to one end of the tubing. The opposite end of the tubing is connected to a receiving tambour whose diaphragm actuates a recording lever system.

The vibration characteristics of these lever systems unfortunately are not suited to accurate recording of the pulse wave for two reasons. Their deflection speed is usually so slow as to obscure rapid fluctuations in the graph, and they are often not properly damped, so that they have a tendency to produce spurious vibrations in the record as a result of their own oscillation.

In an attempt to remove the distortion caused by slow deflection speed, an optical rather than a mechanical recording system was used and brought to a high state of perfection by Frank. The air column coupling is retained, but the diaphragm at the far end of the tube carries a mirror which is arranged to twist as the diaphragm moves under the influence of the air pressure variations within the rubber tubing. A beam of light reflected from this mirror acts as optical lever which is capable of providing a greatly magnified record of the mirror movement on the photographic film, without in any way adding to the inertia of the moving parts. This optical method can be made to have a deflection speed which is satisfactory for pulse recording.

It would seem, therefore, that an electrical method of recording the pulse is desirable. The electrical method requires, first, changing the skin motion into an electrical energy by some form of microphone. This involves a short air column coupling from the skin to the diaphragm of the microphone. The output of the microphone, which consists of a series of electrical impulses occurring at cardiac rate, may then be recorded by a standard electrocardiographic amplifier and galvanometer system.

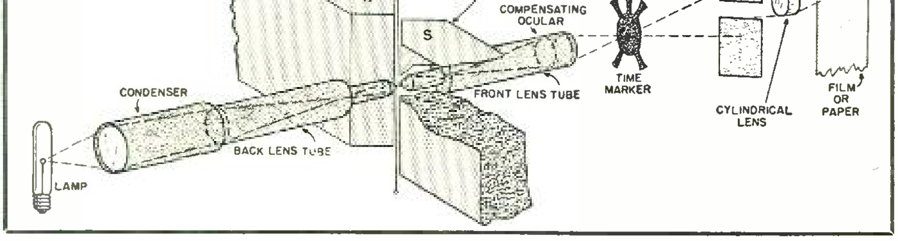
Miller and White[10] devised a generator method, whereby the mechanical energy actuates some form of electrical generator which converts the mechanical energy directly into electrical energy for the transition process. As such, the crystal microphone appears to be peculiarly adapted to this problem of pulse recording. This device is based upon the property which some crystals have of generating an electrical voltage when the crystal itself is twisted or squeezed; the magnitude of the voltage is proportional to the applied force.

The electrical energy is led off from the crystal by thin, metal-foil electrodes, cemented to opposite faces of the crystal. The combination of the electrodes and crystal, when no pressure is applied to the crystal, forms a condenser of definite capacity. When pressure is applied to the crystal, the condenser appears to have a generator added to it.

Electrically, therefore, the crystal microphone may be represented by a generator in series with a condenser, as shown in Fig. 6A. The electrical energy developed within the crystal is too small to be used directly with recording instruments. It is necessary, therefore, to insert an amplifier between the microphone and recording instrument. The load which the amplifier, Fig. 6B, presents to the microphone will be essentially a resistance (the grid leak of the first tube). The voltage delivered to the amplifier (E_a) will differ from that developed by the microphone (E_i) because of the presence of the condenser (C). The distortion introduced by the capacity C is a function of the rate at which the voltage E_i is varying and the relative sizes of C and R, which can be gauged by a single factor,

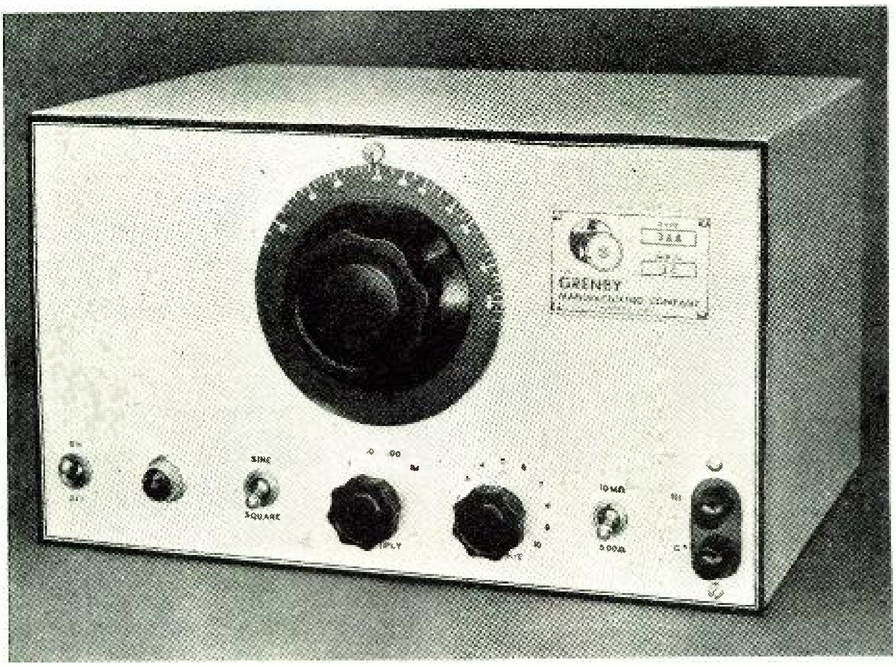
(*Continued on page* 106)

Fig. 9. Schematic arrangement of string galvanometer electrocardiograph. The physical principle upon which the Einthoven string galvanometer is based is the same as that used in the electric motor. The moving part of the instrument is a very fine filament called the string which carries the current to be registered. When a current flows through the string it moves in proportion to the magnitude of the current. The movement is magnified by the optical system and recorded by the camera.



AUDIO OSCILLATORS and their Applications

By
J. C. HOADLEY



Audio oscillator described in the December, 1943, issue of RADIO NEWS. This instrument had the added feature of providing both sine and square waves.

The audio oscillator is an indispensable test instrument for either the home or the laboratory.

AN AUDIO oscillator is one of the most versatile pieces of equipment which is within the reach of the majority of radio repairmen, amateurs, and laboratory workers. Its uses are manifold.

An audio oscillator is essentially a generator of sinusoidal audio frequency voltage, i.e., those frequencies which the human ear can perceive. This range is generally 20 c.p.s. to 20,000 c.p.s., although some so-called audio oscillators go as high as 200,000 c.p.s. More generally the range immediately above audibility, i.e.., 20,000 c.p.s., is referred to as supersonic.

There are many types of audio oscillators, including "beat-frequency" or "heterodyne" type, Wien bridge, parallel T network, resistance stabilized, and even our old friend the Hartley oscillator which may be used to generate audio frequencies. There are a host of others, but the most frequently used are the beat-frequency and Wien bridge RC types.

The beat-frequency oscillator consists of two radio frequency oscillators, usually operating in the neighborhood of 100 kc., being beat together in a detector. The frequency of one is varied, which results in a beat frequency from zero cycles-per-second to forty kilocycles or more. This type, if properly designed, may be accurately calibrated, possesses low distortion, and has the big advantage that a large frequency range may be covered on one rotation of the frequency dial, and the output is very constant.

The Wien bridge, or RC oscillator, consists of a degenerative amplifier in which the frequency of oscillation is determined by a resistance-capacity network that provides regenerative coupling between the input and output. Means is usually provided to maintain the output voltage constant, and may take the shape of a small lamp which is placed in the cathode circuit of one of the tubes. Its "variable resistance with current" characteristic provides an "automatic volume control" effect and is very effective in maintaining the output of the oscillator constant. The Wien bridge has the advantages that it is inexpensive to build, is very stable, and has unusually low distortion by virtue of its large amount of degeneration.

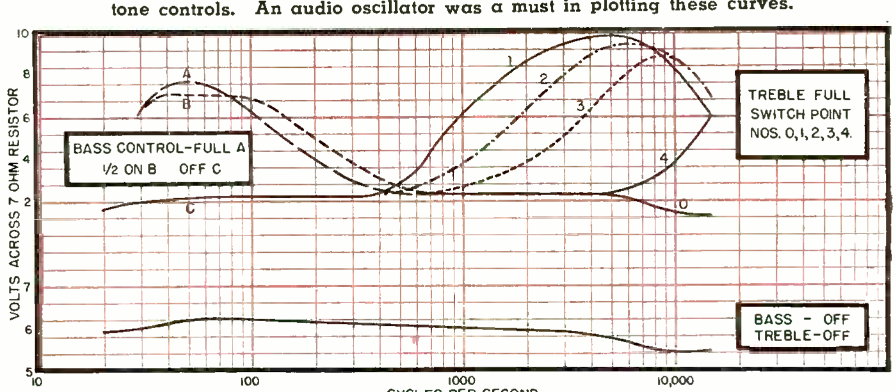
There are many excellent models of both types on the market, or those who would like to build their own can refer to the simple models described in the May and December 1943 issues of RADIO NEWS.

One of the most typical uses of the audio oscillator is in the determination of the frequency response characteristics of an audio amplifier. The oscillator output is introduced into one of the amplifier's inputs and the oscillator's output voltage is held constant. The amplifier is now terminated in a suitable resistive load across which is connected an a.c. voltmeter.

Incidentally, a.c. voltmeters of the copper-oxide rectifier type do not have a flat response characteristic. They are prone to fall off at the high frequencies. Fig. 2 shows the actual response characteristic of a typical unit. The response is uniform up to 1000 cycles-per-second, and then it falls off, being down almost 50 per-cent at 30,000 c.p.s. This curve was obtained by connecting the voltmeter to an audio oscillator to which was also connected

(*Continued on page* 138)

Fig. 1. Response curves of an audio amplifier with both bass and treble tone controls. An audio oscillator was a must in plotting these curves.



An Improved WHEATSTONE BRIDGE

By
McMURDO SILVER
McMurdo Silver Company

Simple in design and construction, this precision resistance bridge is in reach of all servicemen.

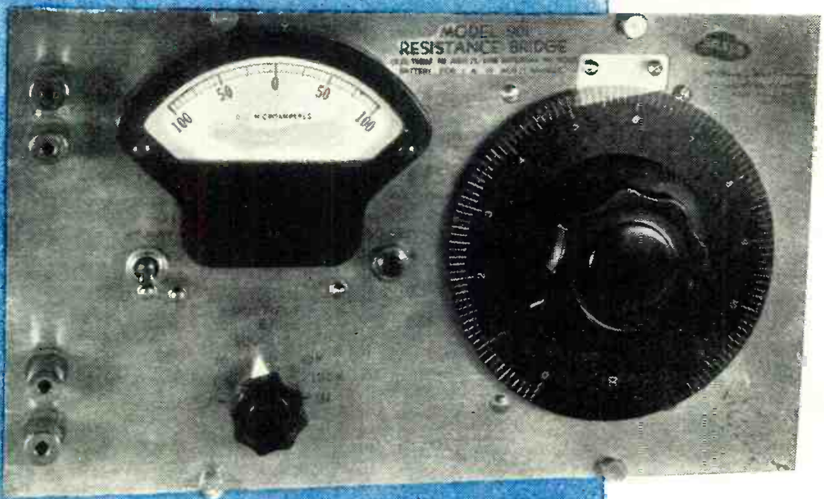


Fig. 1. By employing a novel method of calibrating an ordinary standard dial, an accuracy of .2% is obtained.

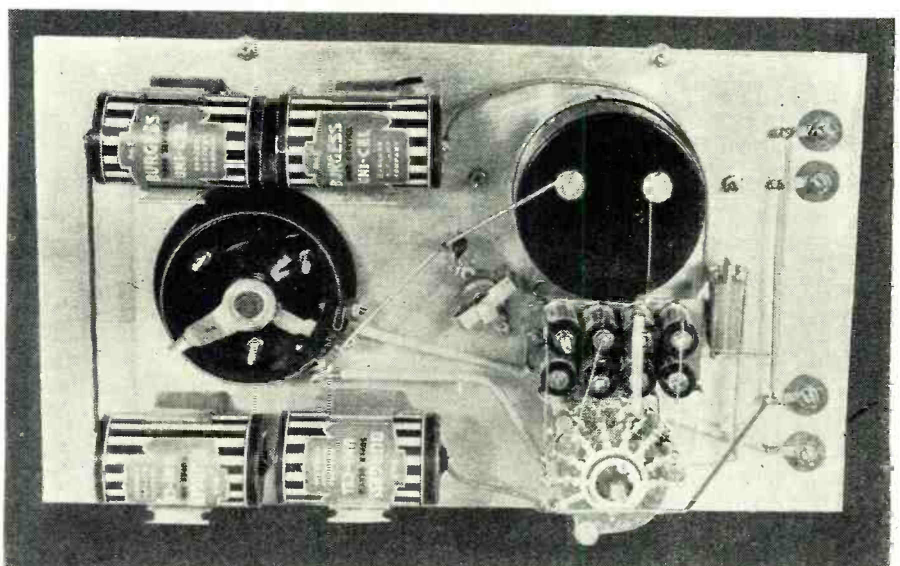


Fig. 2. Simplicity is the keynote for construction. All components are mounted directly to the front panel.

IN THE design, development, and servicing of radio and electronic equipment three types of measurements are primary and fundamental essentials. Voltage, current, and resistance must be capable of being measured to an order of accuracy depending upon the particular design problem involved. As the complexity of a particular design or maintenance problem increases, measurements will of necessity involve other quantities and characteristics, but they will practically all stem from the basic root of voltage, current, and resistance. The degree of accuracy with which final and complex relationships may be determined may, in many instances, depend upon the accuracy of the measurement of the fundamental quantities.

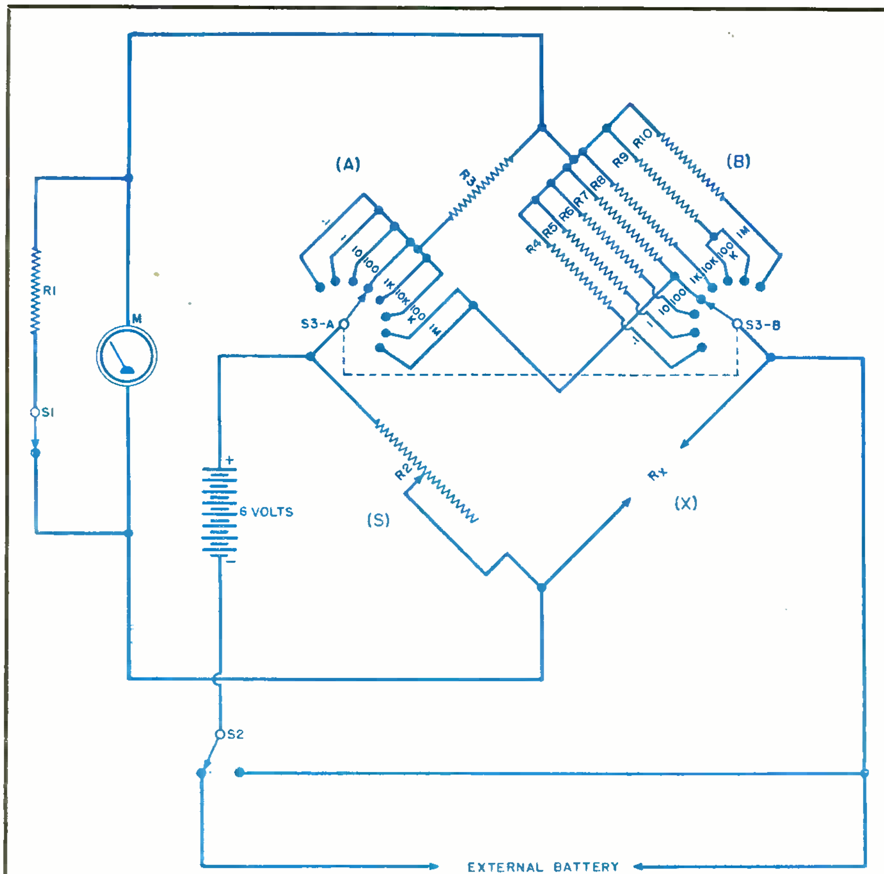
Voltmeters, ammeters, and resistance-measuring instruments are available in normal times, of accuracy rising with cost, adequate for almost any order of precision. Because, outside of the serious laboratory, instruments permitting of precise measurement of resistance are not too frequently encountered, and because of recent developments operating to materially reduce the cost of such instruments, it is felt that a description of a wide-range precision d.c. resistance-bridge reflecting these advances may be welcome.

Reference to any good engineering textbook will reveal what most readers already know—that there are in general use two basic methods of resistance measurement. The first, or volt-ammeter method, involves determination of resistance of an unknown sample in terms of measurement of the voltage across and the current through the sample resistor. Accuracy is a function of the voltmeter and ammeter used. For general all-around use, this method is not particularly convenient.

The conventional ohmmeter may be regarded as a simplification of the volt-ammeter method in that a known voltage is presumed and resistance of an unknown specimen, therefore, becomes a function of the current flowing through the circuit of battery, milliammeter, and unknown resistance. Direct reading of resistance values is made possible by suitable calibration of the milliammeter scale in resistance values. Probably the most commonly used method of resistance measurement today, the ohmmeter method in commercial form, is seldom capable of a high order of accuracy. Consideration of the substantially logarithmic slope of the resistance scale of the usual ohmmeter indicates that it becomes increasingly difficult to read due to extreme crowding on high values of resistance. For low values the ohmmeter scale is not unduly crowded, but the meter error here usually contributes to a significant order of inaccuracy. This can be easily understood when it is remembered that the average milliammeter is rated in accuracy at plus or minus 2% of *full scale reading*. Thus an error of 2% at full-scale may translate into an error of ten times this magnitude, or 20% when readings are made at 10% of full-scale value. A careful examination of several commercial and generally available ohmmeters reveals errors of this magnitude as not unusual—errors so great as to destroy the validity of measurements made with such instruments for all except the roughest sort of field servicing of very simple radio receivers and the like.

The second basic method of resistance measurement is through the use of a Wheatstone Bridge circuit. Here the accuracy of the microammeter, usually employed as an indicator, is of little or no consequence, since its function is purely to indicate a condition of no current or no voltage brought about through the adjustment of known standard resistors which may be produced to provide almost any desired order of accuracy, and in terms of which the resistance of an unknown resistor may be precisely determined. The instrument to be described is of this type and so is suitable for use in the serious laboratory where accuracies of four significant figures are required.

Because of war-occasioned developments in the processes of producing the various required components to a high degree of accuracy, in large quantities, and at relatively low cost, it becomes possible to produce a highly accurate, wide-range resistance bridge at a final price markedly below heretofore available designs. This is also made possible by substitution, as has infrequently been done heretofore, of a continuously variable potentiometer for a mass of individual resistors and their associated switches. This is no new or novel concept, but merely the application of the obvious to a field which has seemed, in the main, to adhere to construction and design methods necessary some decades ago when continuously variable resistors of adequate permanence and accuracy could not be produced. Very definite advantages accrue from this technique, including a direct reading instrument with which a multiplicity of individual figures need not be mentally added to yield a result, markedly increased speed of operation, and the ability to employ the resultant bridge as a "limits bridge," as in production testing.



R_1—10 ohm, ½-w, w.w. res. ± 1%
R_2—11,400 ohm, pot. ± 2%
R_3, R_8—10,000 ohm res.
R_4—1 ohm res.
R_5—10 ohm res.
R_6—100 ohm res.
R_7—1,000 ohm res.
R_9—100,000 ohm res.
R_{10}—1 megohm res.

R_3—R_{10} inclusive are to be one watt, non-inductive, zero temperature coefficient, wire wound, plus or minus .1% units.
S_1—Closed circuit s.p.s.t. push-button switch
S_2—S.p.d.t. toggle switch
S_3—Double pole 8 position wafer type rotary sw.
M—100-0-100 microammeter. Internal res. not over 70 ohms.

Fig. 3. Diagram of resistance bridge. Meter employed is a 100-0-100 microampere type.

Figs. 1, 2, and 3 illustrate and diagram the *McMurdo Silver Company* Model 901 resistance bridge, completely self-contained, and having a total range of from .01 ohms through over 10 megohms, the latter obtained by addition of an external dry battery of approximately 90 volts potential. Housed in a grey-enameled metal cabinet but 12¼" long, 7¼" high and 3½" deep, all components are mounted directly upon a reverse-etched 7" by 12" aluminum panel 3/32" thick finished in a very light grey color obtained by chemical treatment of the aluminum. The non-glare satin finish so obtained is protected by application of a permanent clear lacquer and provides an ideal background against which to read the black figures permanently etched thereon. For visual contrast, the actual resistance dial is reversed in color-scheme—white figures upon a gloss black background obtained from anodizing the 5" diameter aluminum dial.

As can be seen from Figs. 1 and 2, all component parts are mounted upon the two faces, front and rear, of the panel. This results in an order of simplicity and accessibility which is a far cry indeed from usual more complex and no more accurate resistance bridges of heretofore conventional and costly construction. In operation, an unknown resistor specimen to be measured is connected to the pair of substantial binding posts marked "Rx" at the lower left of the panel, the "MULTIPLY BY" range switch set to give a range upon the large dial in which the unknown resistor is presumed to lie, the left center toggle-switch thrown upward to apply the internal 6-volt battery to the bridge circuit, and the main dial rotated to produce a zero, or center, reading upon the "null indicator" microammeter. Rough bridge balance so obtained, the push-button switch to the lower right of the meter is pressed to increase meter sensitivity to maximum, and the main dial readjusted to give zero reading on the microammeter. Resistance value of the unknown specimen is then read directly from the main dial by multiplying its reading by the appropriate decade factor as indicated by the position of the "MULTIPLY BY" knob.

For resistance values in the range of 1 to 11 megohms the 6-volt internal battery does not give sufficient meter

(*Continued on page* 132)

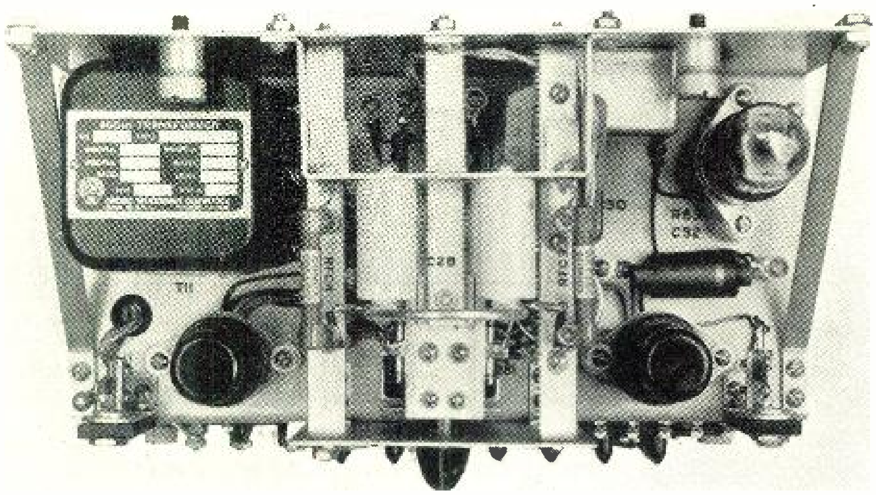
V.H.F. for FEDERAL AIRWAYS

By
SWANEE TAYLOR

The conversion of all airway radio equipment to the static-free, very-high-frequency ranges, will mean safer flying days.

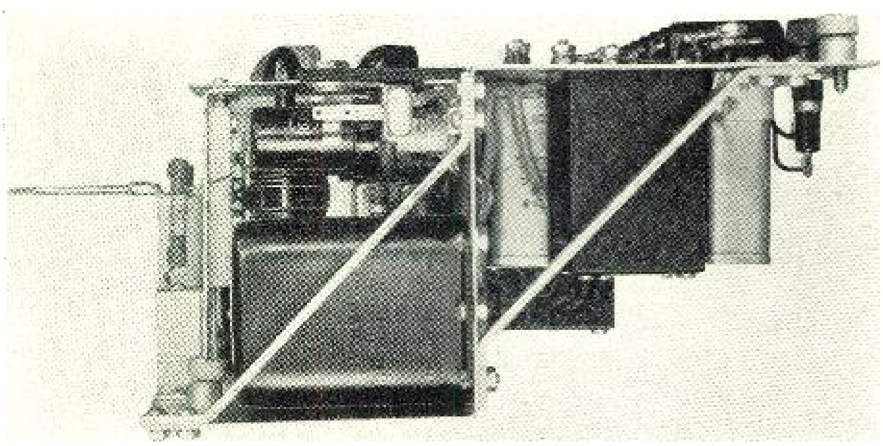
OF THE great multitude of technical marvels predicted for postwar living, airmen look forward most hopefully to the switch to very-high-frequency (v.h.f.) ranges along the Federal Airways. For, adoption of this staticless system will remove one remaining "insoluble" bugaboo in aerial navigation, thereby giving hearty assurance of many happy landings to come. Furthermore v.h.f. ranges are not war babies all swaddled in the mysterious uncertainties of military secrecy such as, for example, radar. Rather, v.h.f. is a prewar development by the Civil Aeronautics Administration and its application is simple and readily understandable to every pilot.

In order to duly appreciate the magnitude of v.h.f.'s value in aviation it is well to recall the many problems radio engineers were faced with when they undertook to supply air transportation with safe, dependable and, most important, acceptable navigational aids. Quite naturally the starting point lay in the realm of the then existing low frequency system. Low frequency had been highly successful in maritime service and in the field of program broadcasting. But when radio took to the air, literally, engineers became acquainted with a new and inordinately loud yowl of dissonance—soon to become known as pilot-static.



Top view of field detector unit. This instrument has particular application in measuring the radio field strength of airport glide paths.

Side view of field detector unit shows sturdiness of construction, important when designing very-high-frequency radio equipment.



From the start aviators set up bitter and sustained complaint against a new instrument which had offered so much promise. Of course the early equipment, designed especially for aircraft use, had to be more or less along experimental lines. Lightness and compactness were the watchwords, with a result of some sacrifice in performance. But even so, radio engineers were at a loss to understand the vehemence of pilot reaction. Few, if any, radio men were flyers and, safe to say, none of them had an inkling of the completeness with which airmen had hailed radio as the panacea to all their navigation ailments. Pilots pointed out that they couldn't hear the signal in their headsets because of some strange noise and flatly declared that radio was a failure.

Whereupon, research minds set about first to seek out the noise, and secondly to silence it. Which procedure, in passing, has, with time, proved to be a success.

Radio engineers soon discovered that spark plug ignition was a very pronounced source of disturbance. The cure here was an easy one, achieved simply by shielding the individual plugs and thereby preventing "signals" from the plugs being picked up in the receiving sets. Oddly enough, in later years it would be noted that spark plugs "broadcast" at very-high frequencies and therefore must be shielded better still.

However, eliminating spark plug interference merely marked the first losing leg of a long chase by radio engineers to overtake airmen's objections. It would seem that each time radio science rose to overcome a problem, it automatically reared a new complexity with which to wrestle. The case of spark plug noise was the first and a highly apt example; once the engineers damped out the clatter set up by spark plugs, this gave the pilots an opportunity to hear and really appreciate the full effect of atmospheric static. Words fail utterly to carry the true content of the pilots' anguish at this turn of affairs. This time the tenor of their complaint was, "What good is radio when you can't hear it in bad weather, at a time when you need it most!" Which, in all fairness, raises a reasonable objection.

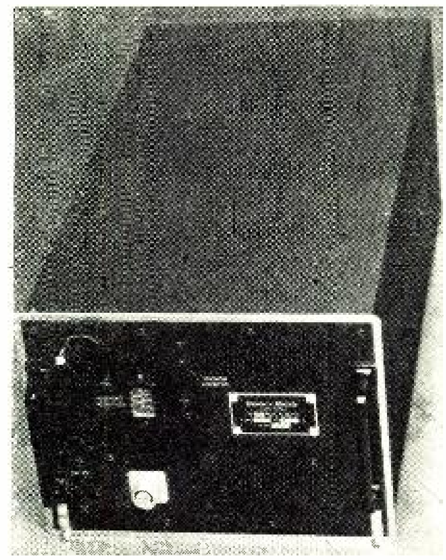
The best brains in radio promptly set out to overtake and pass this, the leading problem in radio air navigation. All manner of static eliminators were tried. Experiments were made with new types of transmitters to very little avail. As a matter of fact, the loop antenna proved to be a dismal failure in that it introduced the so-called night effect and station interference. The horizontal legs of the loop were responsible for signals bouncing off the ionic layer and returning to earth hundreds of miles away. Again it must be left to the imagination to conjure up the blistering thoughts of a pilot trying to pick the call letters of Grand Forks out of the Nebraska night only to get some station in Southern Virginia.

Added difficulties came in the form of snow and rain static with increased speeds of aircraft. Each raindrop and each snowflake contains a small electrical charge which is released upon striking a surface. In the early days of slow moving, fabric-covered airplanes, this went unnoticed. But with the coming of metal aircraft, moving at speeds from 2 to 3 miles-per-minute, an enormous quantity of raindrops strike the wings and fuselage in the short space of seconds. Naturally, the metal surfaces conduct the electrical discharges straight into the radio system. Happily, though, this particular howl against radio was subdued with the grounding out of the phenomenon.

The story of the other principal difficulty which haunts the low frequency band, multiple or split beam trouble, and how it was overcome, is too well known to be repeated here. Needless to say, static remained the villain of the tale; true, a somewhat subdued villain, but a bad actor still. So much so that neither visual-directional aids nor instrument landing (under zero-zero conditions) could become a part of every-day flying. As far as visual on-course indicators were concerned, static affected the needles to such an extent that it was utterly undependable within 50 miles of an electrical storm. Rain and snow static, even heavy fog, ruled out all possibility of instrument landings even being considered.

And if airmen were concerned over a lack of perfection, their radio counterparts were far more so. The flyers regarded the situation with uninhibited cynicism, while radio engineers accepted it as a never-ending challenge to their talent and ingenuity. Thereupon, all the personnel within the Radio Development Section of CAA bent to the challenge with redoubled efforts. And, happy to say, these efforts produced a steady flow of innovations, improvements, and refinements in aviation radio. So much so that in a phenomenally short time, almost a matter of months, the aviation industry wholeheartedly accepted the radio art as a vital adjunct to safe flight. Even the pilots modulated their yowl to a soft mutter.

With the technical development, familiar to all friends of radio, the radio range system on Federal Airways outgrew itself. It came as a startling

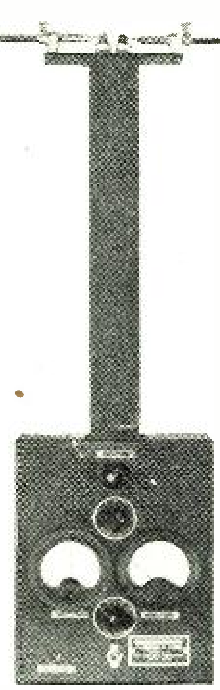


Aircraft v.h.f. receiving set.

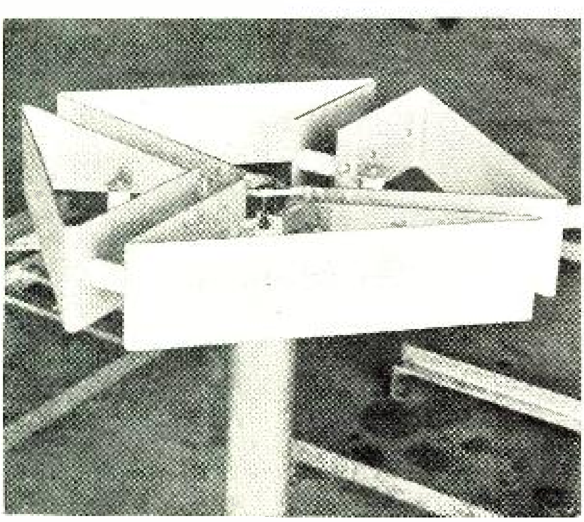
truth that radio air navigation had actually come to need more "air space." By 1938 there were some 291 range stations operating in the allotted 200-400 kc. band, raising the problem of station overlapping and with no relief in sight. Obviously, if air travel were to continue to grow in this country, sufficient "air space" had to be sought at some other frequency. The only practical band open was in the v.h.f. domain, somewhere between 30 and 300 megacycles.

Of course, considerable research had gone on in the field of very-high-frequency by the Radio Development Section. In fact visual markers, checkpoints, along the airways were already operating in the v.h.f. band. Therefore the change from low frequency to v.h.f. would appear to be a step of normal progression.

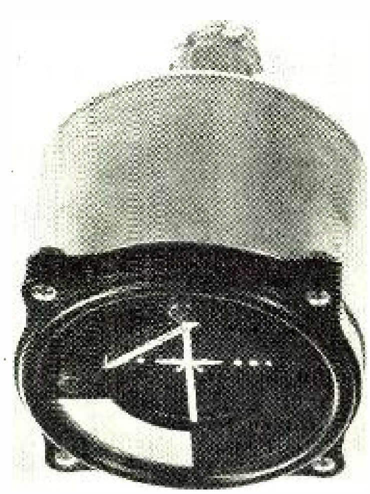
However, the inside story of the



Portable field detector. V.h.f. design permits more compact construction of radio equipment.

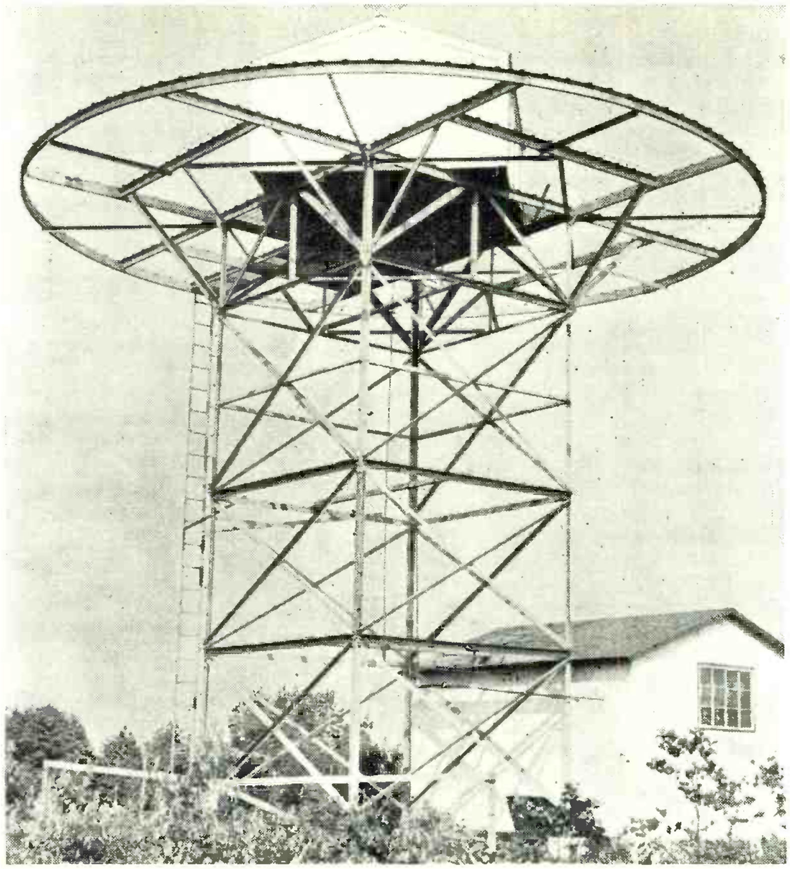


Horizontal loop antenna approx. 22 inches square.



Cross-pointer instrument employed with v.h.f. instrument landing equipment indicates position of aircraft in relation to runway.

Part of ground station equipment includes, as shown, the side-band generator and audio racks.



Antenna house and tower. Within the house are located five antenna loops. A wide apron effect is produced by steel wire mesh counterpoise.

highly scientific approach to the problem by CAA engineers makes fascinating reading even to laymen. Early-day reports, of 1939-40, contain a strong detective story flavor of a criminal about to be brought to bay. For example, notice the determined intent to explore every megacyclic avenue to track down the villain contained in the introduction to a report on Progress in Development of a Very-High-Frequency Radio Range, issued in 1940:

"For the past two years the Radio Development Section has been conducting numerous field tests directed toward the application of very-high-frequency to the radio range. First experiments on a 63-megacycle four-course radio range were very encouraging and were disclosed in a preliminary report in the early part of 1938.

"Immediately following these experiments similar apparatus was constructed for the purpose of investigating the 120-130 megacycle band which was allocated to the Civil Aeronautics Authority for radio ranges. Numerous flight tests were conducted on a frequency of 125-megacycles, using several different types of antenna systems to produce both two- and four-courses at Indianapolis, Ind., and Pittsburgh, Pa."

The report goes on to say that in these tests the transmitters used were the Type TXI, crystal controlled, which delivered 100 watts of output power. A conventional Class-"B" modulator was used in conjunction with a 110-cycle vacuum tube tone oscillator. To operate on 125-megacycles the neutralized driver stage was converted into a frequency doubler, the output of which was sufficient to excite fully the power amplifier at 125-megacycles. A modified Type AC-74 interlock relay was used to key the radio frequency transmission lines in the N-A "on-course" sequence.

To receive the 63-megacycles signals, a Type RUB, crystal controlled ground station receiver was modified. This receiver used a loaded coaxial line input circuit, two-stage intermediate frequency amplifier at 385 kc. with a 40 kc. band width, and a two-stage audio frequency amplifier. A vibrator type power supply unit supplied the necessary high voltage.

In all flight tests at 125-megacycles the aircraft receiver used was a superheterodyne, using tuned coaxial line input circuits and a tunable coaxial line radio frequency oscillator of high stability. The receiver had a tuning range of 60-130 megacycles and its stability was excellent after a warm-up period of approximately one minute.

In the ensuing months there followed exhaustive tests. The greater part of the experimentation and research was conducted at Pittsburgh where, due to mountainous terrain, much multiple or split beam trouble had been encountered. The results of these tests were in the main of a happy nature. All the problems were satisfactorily solved and corrective measures discovered. Several of the especially interesting cases follow:

Bends in Courses

In some v.h.f. range installations course bends were discovered. They were considered to be border-line cases of multiples where the scalloping of the patterns changed at increasing distances from the stations. Such scalloping is usually caused by reflections from buildings, wires, trees, and rugged terrain. And, whereas bends are very severe on the Pittsburgh low-frequency range, none were encountered in that area at angles of elevation below approximately 20° on the v.h.f. range, which leads to the conclusion that bends in low-frequency ranges are caused by conditions over which the engineer has no control. However, he can control the factors which cause bends on v.h.f.

Signal Flutter and Spurious Modulations

In all tests at 125-megacycles at Pittsburgh with both horizontally and vertically polarized arrays, a disturbing signal flutter or superimposed low-frequency modulation was observed in flights over the airport, the steel mills, and on passing mountain ranges. This was caused, of course, by reflections from the terrain over which the aircraft was flying. The flutter was most severe at low altitudes and diminished with increasing altitudes up to four to five thousand feet above the ground.

(*Continued on page* 155)

TRANSFORMER THEORY

By R. PAUL WEHRMANN

Instructor, AAFTTC

Important theoretical facts to know when designing your air- or iron-core transformers.

LITERALLY hundreds of different electronic circuits have been developed which incorporate the transformer in a great variety of designs and power ratings. If one looks at the standard broadcast receiver from the transformer viewpoint, the operation of such a circuit would be much more difficult if this simple component were not available.

An air-or iron-core transformer is used, with few exceptions, to couple the antenna to the grid circuit of the mixer tube. The i.f. stages utilize transformers to couple energy or to modify it to some new level. The audio power developed in the final stage is passed on to the loudspeaker with a transformer. Such widespread application has resulted in the total acceptance of this device as a necessary item in a great number of radio circuits, but the basic principles underlying its operation may not be understood clearly by the war-trained radioman.

Most "practical" men have rather vague ideas regarding the relation between a turns ratio and the various other features of the transformer. This discussion will be concerned mainly with the basic theory of transformer action and, through the use of several examples, will endeavor to clarify some of the more salient points encountered in the use of this type of stage coupling.

A good working definition of a transformer is "A simple electrical device which may be used to transfer energy from one circuit to another." The electro-magnetic process through which this transfer is accomplished depends largely on a closed circuit properly called self-inductance or, as it is more frequently used, simply inductance. Current flow in a closed circuit will produce magnetic lines of force which link with other sections of the conductor forming the circuit. The number of force lines (or the flux density) will, for a given value of current, depend on the inductive properties of the individual circuit. If a length of wire has a certain inductance when it is straight, this property can be increased somewhat by shaping it into a coil. When this is done more of the magnetic force lines around one of the turns can link with adjacent turns and, since inductance is a function of flux-linkage, this characteristic of the circuit is enhanced.

The inductance can be increased still further by adding an iron core to the coil since the magnetic field which surrounds the coil suffers less attenuation when the force lines pass through iron than they do when passing through air. Cores made of thin silicon-iron laminations can be used up to frequencies in the neighborhood of 1600 kc. Above this frequency hysteresis or magnetic eddy current losses become prohibitive and a powdered iron core is used.

Consider the circuit shown in Fig. 1. The transformer in this circuit will be considered "ideal" since it is assumed to have certain special features not found in the practical transformer. In this circuit the symbols have the following meaning:

E = the a.c. voltage applied to the primary winding

i_p = the current flowing in the primary winding

N_1 = the number of turns on the primary winding

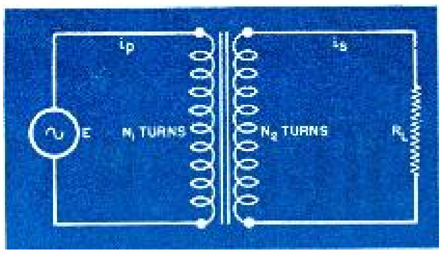


Fig. 1. Iron-core transformer.

N_2 = the number of turns on the secondary winding

i_s = the current flowing in the secondary winding

R_L = the load resistor across the secondary winding

The "ideal" transformer is assumed to contain only mutual inductance and to be completely lossless. The property of mutual inductance is defined by the relation—

$$M = \frac{F_s}{i_p \times 10^{-8}}$$

and

$$M = \frac{F_p}{i_s \times 10^{-8}}$$

where F_s is the flux linkages in the secondary produced by current in the primary, and F_p is the flux linkages in the primary produced by current in the secondary.

Two of the most important applications of the transformer are found in voltage transformation and impedance transformation. If the transformer in Fig. 1 has ideal characteristics, each turn of wire in the primary will link with all of the flux present and no power will be lost. Each turn of wire in this winding will have the same voltage induced in it and, since the turns are connected in series, the total voltage appearing across the winding will be the product of the voltage across one turn times the number of turns. Thus, the voltage across the winding may be considered proportional to the number of turns in the winding. If we apply one volt to a primary of 100 turns, 3 volts will appear across a 300 turns secondary.

If E is the primary a.c. voltage in the circuit of Fig. 1, the secondary voltage will be

$$E_s = E \cdot \frac{N_2}{N_1} \qquad (1)$$

and the secondary current

$$i_s = \frac{E \cdot N_2}{R_L \cdot N_1} \qquad (2)$$

Secondary current will tend to produce another component of flux in the core. However, in order to maintain the equality between the applied primary voltage and the induced voltage, a new component of primary current flows which is just sufficient to balance out the secondary current flux. The equation for this current can be developed by remembering

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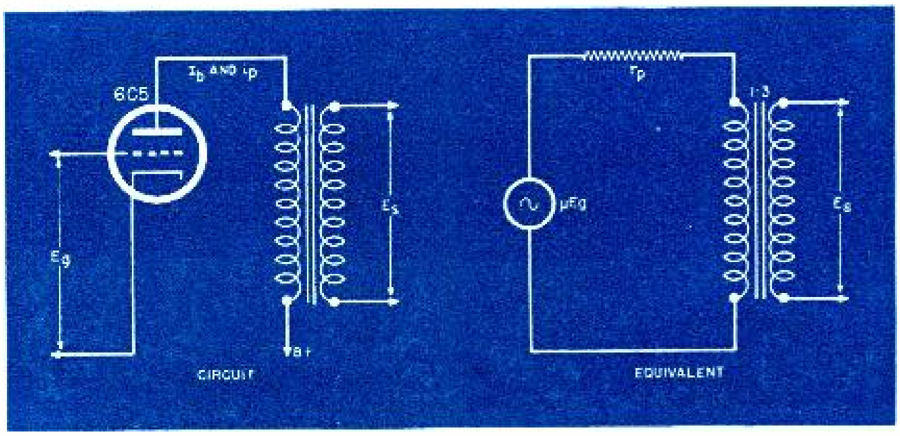
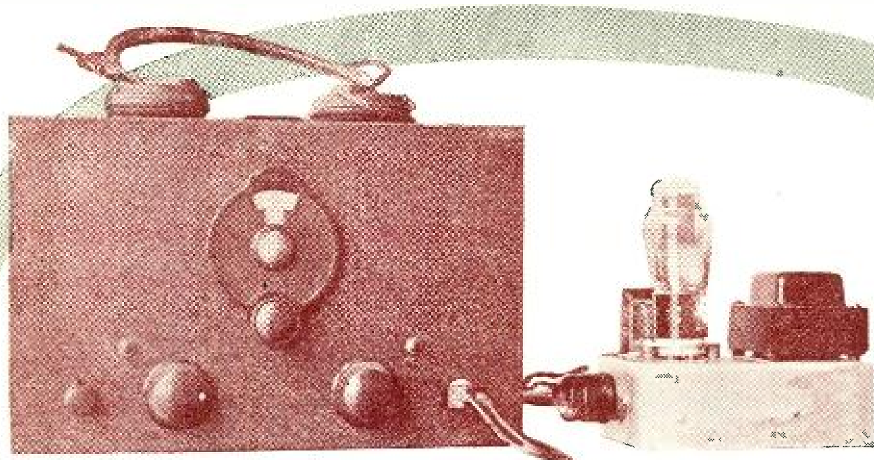
Fig. 2. Transformer-coupled 6C5 stage, showing actual and equivalent circuits.





The completed unit showing the receiver and power supply as two separate assemblies.

"Junk Box" SHORT WAVE RECEIVER

By
HARRY D. HOOTON,
W8KPX

The construction of a short-wave regenerative type receiver designed to operate between 15 and 150 meters.

THE author, like many other hams at the outbreak of war, sold his communications receiver and other amateur equipment to the U. S. Army Signal Corps. However, twenty years of radio experimenting are not to be lightly laid aside and before long the old urge to "build something" became unbearable. Due to the fact that radio parts were as scarce as the proverbial hen's teeth and those that were available were restricted to essential uses, the construction of even a simple regenerative receiver became a major diplomatic feat rather than an engineering one. Other hams were contacted and junk box parts exchanged with all of the dignified complications of an international peace settlement. However, we finally emerged with sufficient components to build a little three-tube receiver.

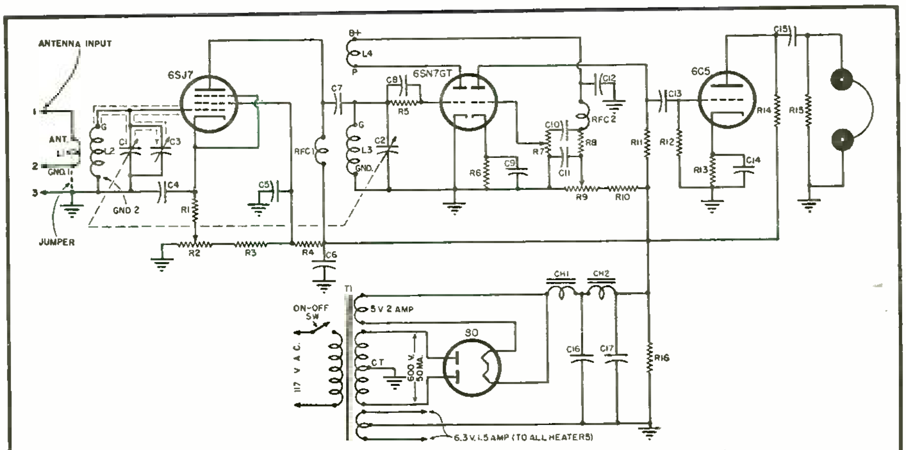
Table I. Winding data for r.f. and detector coils, to cover 2-20 megacycles.

R.F. COILS			
Range in Megacycles	No. Grid Turns	No. Primary Turns	Spacing "A" to "B"
20—9.5	7¼ t. #20 enam.	3¼ t. #30 d.c.c.	¾ inch
9.5—4.0	13 t. #22 enam.	6 t. #30 d.c.c.	1 inch
4.0—2.0	27 t. #28 enam.	9 t. #30 d.c.c.	1½ inches
DETECTOR COILS			
Range in Megacycles	No. Grid Turns	No. Tickler Turns	Spacing "A" to "B"
20—9.5	7¼ t. #20 enam.	4½ t. #30 d.c.c.	¾ inch
9.5—4.0	13 t. #22 enam.	6 t. #30 d.c.c.	1 inch
4.0—2.0	27 t. #28 enam.	9 t. #30 d.c.c.	1½ inches

All coils are wound on 1⅛ inch, 5-prong, ceramic forms. Tickler coil wound in same direction as detector grid coil, spaced ¼ inch from "cold" or ground end of grid coil.

As Fig. 1 and the photographs show, the circuit is very simple, consisting of a 6SJ7GT or a 6SJ7 tuned radio frequency amplifier, a 6SN7GT as a combination regenerative detector and first audio frequency amplifier, and a 6C5 as an output tube. The coils are of the plug-in type, three sets being required for full coverage of the range from 15 to 150 meters. The power supply is built up on a separate chassis in order to eliminate hum and noise in the high-gain audio amplifier system and to permit the use of "A" and "B" batteries if this is ever desired. The connection between the receiver chassis and the power supply is made by means of an 8-prong plug and socket. The receiver is designed especially for headphone operation although the output is entirely sufficient to give excellent results from a permanent magnet dynamic or other type of small speaker. If loud speaker operation only is desired, it is suggested that the 6C5 output tube be removed and a 41, 42 or 6F6 used in its place.

The construction of the receiver is not at all difficult; the only tools required are pliers, diagonal cutters, a soldering iron, and a screw driver. The chassis is made from a piece of 1/16 inch sheet aluminum cut and bent, as shown in Fig. 4, to form a chassis 11 by 7 by 2 inches. Holes are punched for the tube and coil sockets, as shown in the drawing, so that the sockets may be mounted directly to the chassis,



R_1—1000 ohm, 1 w. res.
R_2—5000 ohm, w.w. pot.
R_3, R_{11}, R_{15}—100,000 ohm, 1 w. res.
R_4—75,000 ohm, 1 w. res.
R_5—2.5 megohm ½ w. res.
R_6—800 ohm, 1 w. res.
R_7—½ megohm pot.
R_8, R_{14}—50,000 ohm, 1 w. res.
R_9—50,000 ohm, w.w., pot.
R_{10}—150,000 ohm, 1 w. res.
R_{12}—500,000 ohm, ½ w. res.
R_{13}—1000 ohm, 2 w. res.
R_{16}—10,000 ohm, 25 w. res.
C_1, C_2—Dual 140-µµfd. variable cond.
C_3—20-µµfd trimmer cond.
C_4—.1 @ 200 v. cond.
C_5—.1-µfd. @ 400 v. cond.
C_6—16-µfd. @ 450 v. elec. cond.
C_7—50-µµfd. mica cond.
C_8—100-µµfd. mica cond.
C_9, C_{14}—5-µfd. @ 25 v. elec cond.
C_{10}, C_{13}—.05-µfd. @ 400 v. cond.
C_{11}—1-µfd. @ 400 v. cond.
C_{12}—1000-µµfd. mica cond.
C_{15}—.25-µfd. 600 v. cond.
C_{16}, C_{17}—Dual 16-µfd. @ 450 v. elec. cond.
L_1, L_2—See text
L_3, L_4—See text
RFC_1, RFC_2—R. f. chokes 2.5 mh. 125 ma.
CH_1—Filter choke 15 henries, 50 ma.
CH_2—Filter choke 30 henries, 50 ma.
T_1—300-0-300 v.a.c. @ 50 ma., 5 v. @ 2a., 6.3 v. c.t. @ 1.5a.
Tubes—1—6SJ7, 1—6SN7GT. 1—6C5, 1—80

Fig. 1. Diagram of regenerative three-tube short-wave receiver. The power supply is constructed as a separate unit and, if desired, may be replaced by batteries.

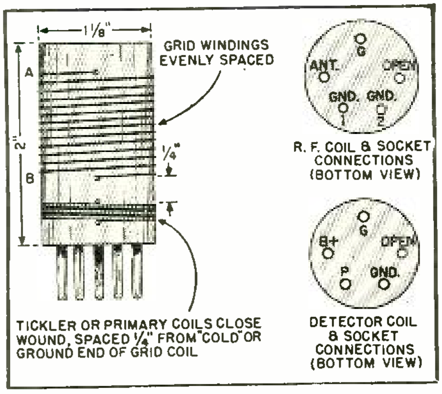


Fig. 2. Coil assembly showing proper position of the various coil windings.

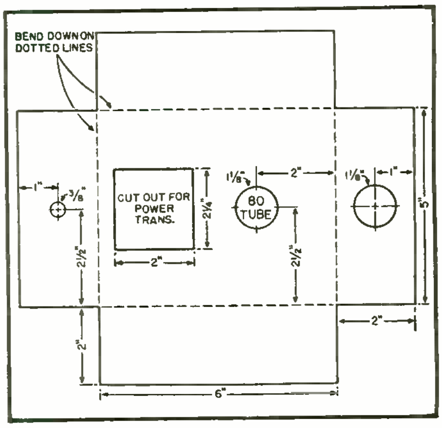


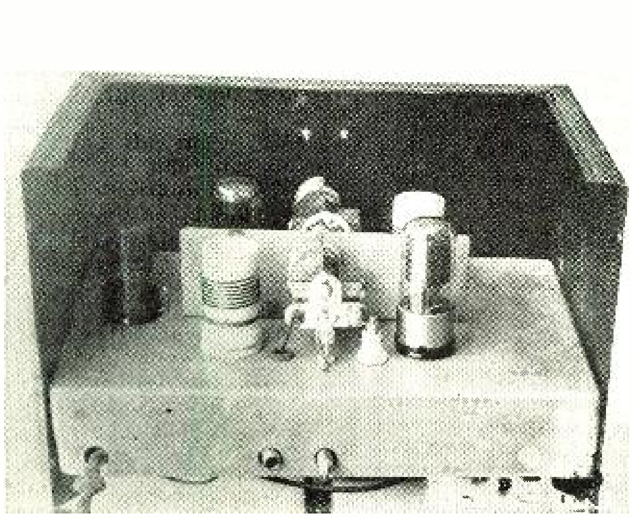
Fig. 3. Power supply chassis layout.

giving a much more attractive appearance to the finished receiver. All of the components in the receiver, with the exception of the main tuning condenser, the coils and the tubes, are mounted underneath the chassis and connect directly to the tube socket terminals with the shortest possible wiring. In most instances, the resistors and condensers are supported by their own wire terminal leads, no strips or other supports being required.

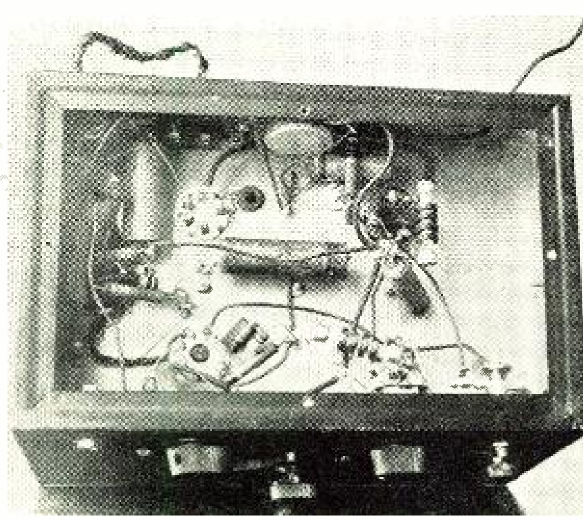
In order to obtain maximum efficiency and trouble-free operation from the receiver, a number of wiring precautions must be exercised. Due to the extremely high gain developed in the 6SJ7 tuned radio frequency stage, it is necessary to keep the wiring to the grid and plate circuits of both the tuned stages as short and direct as possible and well isolated from each other. Otherwise, severe oscillation will be encountered when the r.f. amplifier and the detector circuits are tuned to precisely the same frequency. It may be necessary to use shielded wire in the portions of the circuit indicated by the dotted enclosures in Fig. 1. Mount the r.f. bypass condensers as close as possible to their respective circuits and keep ground leads short and direct. All ground returns for each stage should be brought out to a single point and the several points connected together by means of a heavy copper conductor. The practice of terminating each ground or common connection directly to the aluminum chassis is not recommended. In the first place it is extremely difficult to maintain a good connection between aluminum and conductor, especially after the set has been in operation for some time, and, in the second place, eddy currents in the metal chassis will almost certainly cause instability and oscillation in the r.f. circuits, resulting in critical tuning adjustments and reduced efficiency. Use rosin-core solder and a clean, well-tinned, and *hot* soldering iron. Solder each and every connection, carefully sweating the solder into the joints. Use just

(*Continued on page* 88)

Top-rear view of completed unit showing proper position of component parts. Coil forms are of the plug-in type.



Bottom view of receiver. All wiring should be as short as possible and well shielded to prevent intercoupling.



0-300 VOLT REGULATED POWER SUPPLY

By GERALD W. DAVIS

This electronically regulated power supply will find wide application in the home or laboratory.

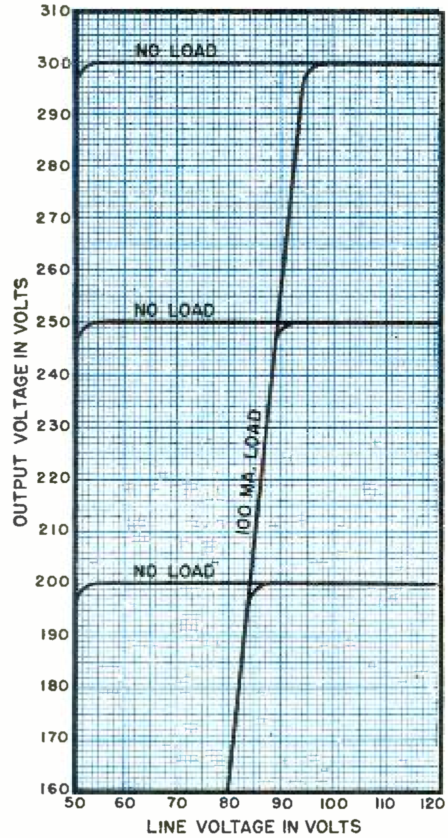


Fig. 1. Curves show variation of output voltage with changes in line voltage.

IN MANY applications of electron tubes, whether used in oscillators, receivers, measuring instruments, or any other type of electronic equipment, a variable regulated power supply is an extremely useful piece of equipment to have around. In addition to providing a constant source of voltage, the regulated power supply also has the beneficial effect of reducing the output ripple considerably, and if the proper constants are chosen, the impedance looking into the supply will be extremely low.

The electronically regulated power supply described in this article is really two power supplies operating off the same rectifier and filter components but otherwise independent of each other. Each supply can be adjusted from 160-300 volts without disturbing the setting of the other supply, and each output voltage will remain constant despite fluctuations of the separate loads.

If it is desired to go below 160 volts, then, by means of a switching arrangement, the two supplies are connected bucking each other and the resultant output is the difference between the two. This, therefore, gives us a range of 0-160 volts.

The theory of operation is as follows: A 6SJ7, which is a high gain sharp cut-off pentode, is connected in the circuit in such a manner that a change in the output voltage of the supply produces a change in the grid bias of the 6SJ7 and, thereby, a corresponding change in plate current of this tube. The plate current flows through resistors R_3 and R_4, the voltage drop across which is used to bias a pair of 807's which are connected in series with the d.c. output of the supply.

During operation, should the output voltage rise suddenly due to a decrease in load, a percentage of the change in output voltage is applied to the grid of the 6SJ7 which causes it to go more positive and therefore increases the plate current. This increased plate current flowing through R_3 and R_4 will bias the 807's more negatively. This increase of negative bias reduces the plate current, increases the effective plate resistance and consequently increases the voltage drop across the tube. The 807's therefore act automatically as a variable resistance in series with the load. The converse of the above is true if there is a decrease in output voltage due to increased load.

An RK60 was used for the rectifier due to the fact that a 1200 volt transformer was the only thing available. A 5U4-G rectifier could be used in conjunction with a transformer having a voltage of 550 volts either side of center tap. Anything less than 550 volts each side of center tap will not give 300 volts on the output.

The value of the transformer secondary may be calculated by working back from the output as follows: The output voltage is given as 300 volts. For satisfactory operation of the regulator, the drop across the 807's should not be less than 125 volts. The drops through the choke and rectifier at loads of 200 milliamperes will approximate 75 volts. This gives us a required d.c. voltage of 500 volts. The d.c. voltage is equal to $2/\pi$ times E max., where E max. is the peak value of the *a.c.* voltage of one side of the transformer secondary. Therefore, the r.m.s. value of each side of the transformer winding is equal to

$$E_{r.m.s.} = \frac{\pi E_{d.c.}}{2\sqrt{2}}$$

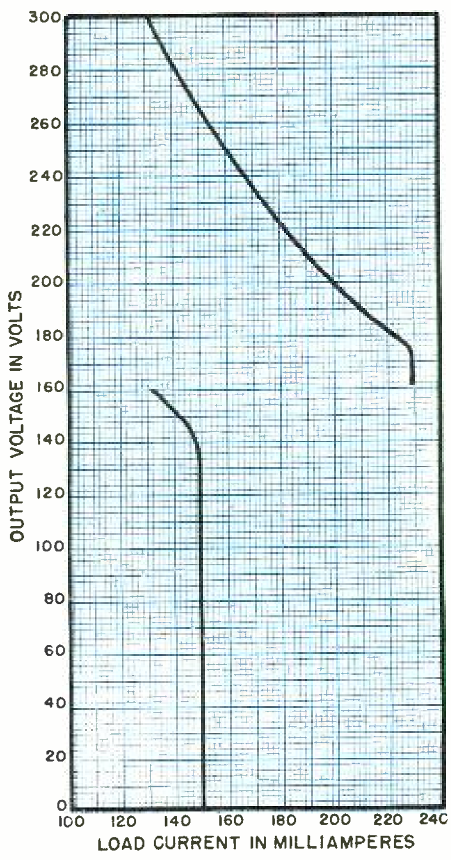
or 1.11 times the *d.c.* value. In our case, this would be equal to

$$E_{r.m.s.} = 1.11 \times 500 \cong 550 \text{ volts}$$

Condenser input could also have been used with a lower rated transformer. However, since the voltage regulation of a condenser input filter is inherently bad, the additional strain put on the regulator system will not produce as good results as with choke input.

★ ★

Fig. 2. Curves show the maximum current that can be drawn at any voltage without the regulator losing control.



The screen voltage of the 6SJ7's is taken off a bleeder network located across the output of the filter and which feeds the VR 75 at the same time. At no load conditions, and with the values shown, the voltage between screen and cathode should be approximately 75 volts. A higher voltage than this might cause the supply to be overcompensated. That is, there will be an increase in output voltage with rise in load. However, with a higher inductance rated choke than that shown in the diagram, a screen voltage of 100 volts will produce excellent results.

The net bias of the 6SJ7 is the difference between the cathode potential which is 75 volts above B— and the setting of the potentiometer on the output which is approximately 70 volts above B— when the system is stabilized. The 6SJ7 therefore operates at a net bias between —5 and —6 volts.

The resistors shown in series with the plates of the 807's are for the purpose of equally distributing the load through the tubes. The bias resistors of the 807's are purposely broken down into two equal resistors for purposes of reducing the voltage drop across them. Ordinary resistors are rated to withstand a voltage drop of approximately 300 volts. Since these resistors have to carry a much larger drop, it was thought best for safety's sake to use two of them.

The bias for the 807's could also have been taken off the output side of the circuit, but experiment indicated that better results were produced by taking this voltage off the input side. Similarly, the screen voltage of the 6SJ7's could also have been taken off the output side of the circuit. However, taking the screen voltage off the input side helps stabilize the circuit by virtue of the fact that should the line voltage drop tending to produce a drop in output voltage, the resultant lowered screen voltage of the 6SJ7 will reduce the plate current in the 6SJ7 which in turn reduces the bias on the 807. As indicated in the beginning of

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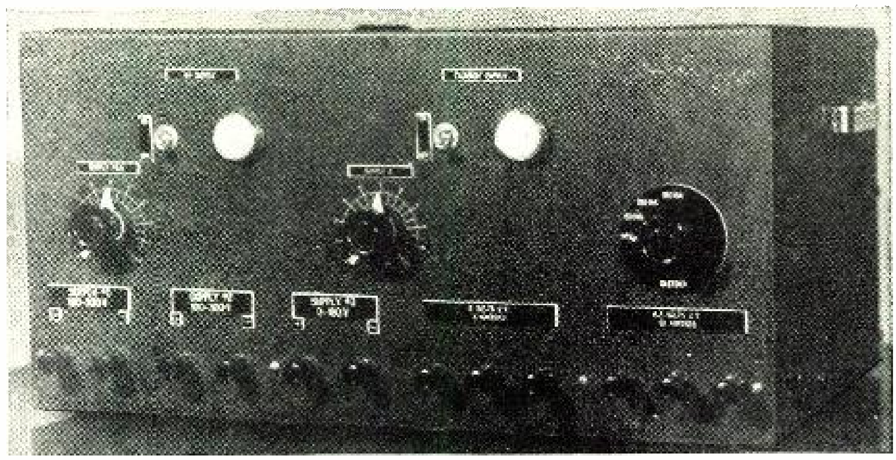
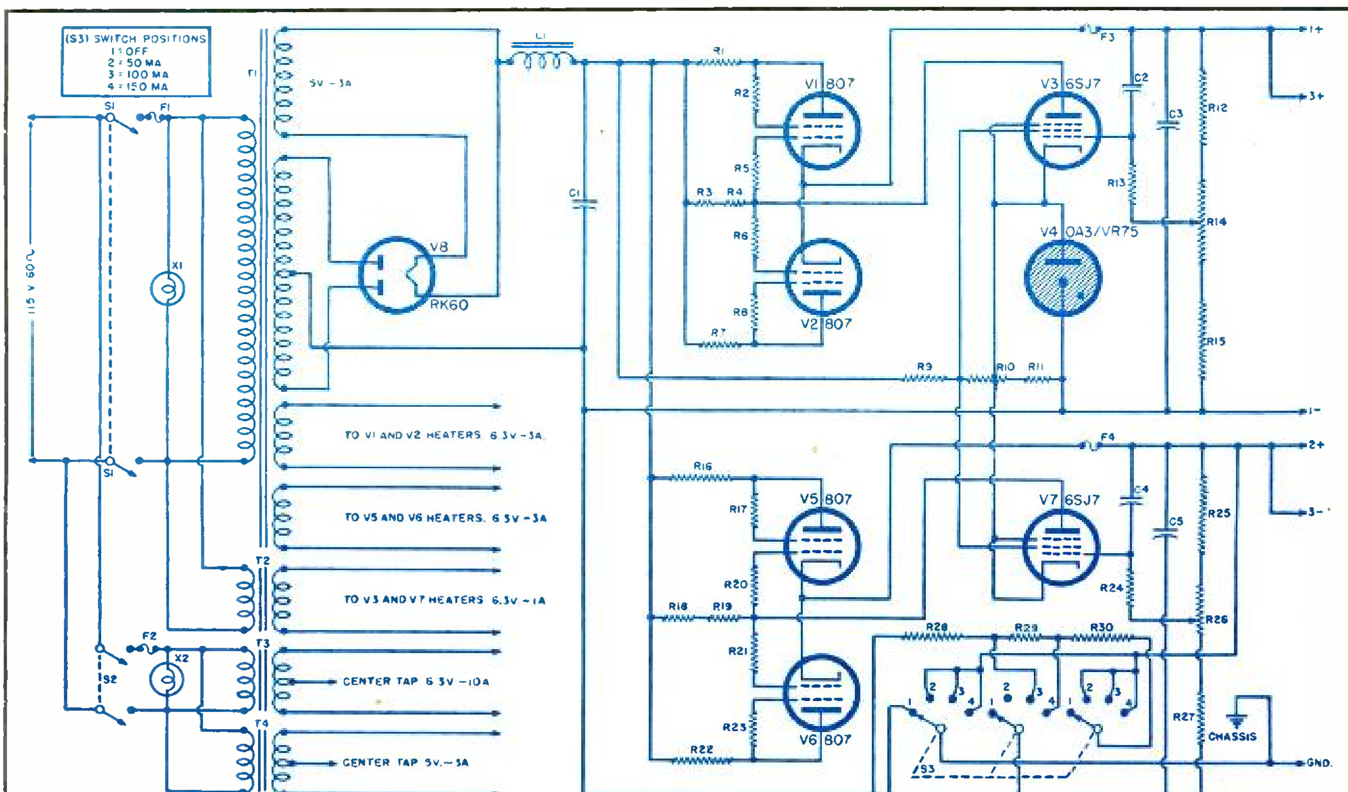


Front panel view of the completed instrument showing position of various controls.

Fig. 3. This supply provides a dependable source of voltages and currents within most commonly used ranges.



R_1, R_7, R_{16}, R_{22}—47 ohm, 2 w. res.
R_2, R_8, R_{17}, R_{23}—1000 ohm, 1 w. res.
R_3, R_4, R_{18}, R_{19}—270,000 ohm, 1 w. res.
R_5, R_6, R_{20}, R_{21}—100 ohm, 1 w. res.
R_9—47,000 ohm, 20 w., w.w. res.
R_{10}—10,000 ohm, 20 w., w.w., variable res. (adjust to 7000 ohms)
R_{11}—68,000 ohm, 2 w. res.
R_{12}, R_{25}—82,000 ohm, 2 w. res.
R_{13}, R_{24}—100,000 ohm, 1 w. res.
R_{11}, R_{26}—50,000 ohm, 2 w. pot.
R_{15}, R_{27}—33,000 ohm, 2 w. res.
R_{28}—1500 ohm, 25 w., w.w. res.
R_{29}—500 ohm, 25 w., w.w. res.
R_{30}—1000 ohm, 75 w., w.w. res.
C_1—4-µfd. @ 600 v. oil filled cond.
C_2, C_4—.1-µfd. @ 600 v. cond.
C_3, C_5—8-µfd. @ 450 v. cond.
T_1—600-0-600 v. @ 250 ma., 5 v. @ 3a., 6.3 v. @ 3a., 6.3 v. @ 3a. power trans.
T_2—6.3 v. @ 1a. fil. trans.
T_3—6.3 v. @ 10a., c.t. fil. trans.
T_4—5 v. @ 3a., c.t. fil. trans.
S_1, S_2—D.p.d.t. toggle sw.
S_3—4p. 3 deck sw.
L_1—8 henry, 250 ma. filter choke
F_1—3a. fuse
F_2—2a. fuse
F_3, F_4—3/8 a. fuse
X_1, X_2—110 v. pilot lamp
V_1, V_2, V_5, V_6—807 tube
V_3, V_7—6SJ7 tube
V_4—OA3—VR75 tube
V_8—RK60 tube

Practical RADAR

By
JORDAN McQUAY

Part 4. A complete analysis of the design and construction of antenna systems.

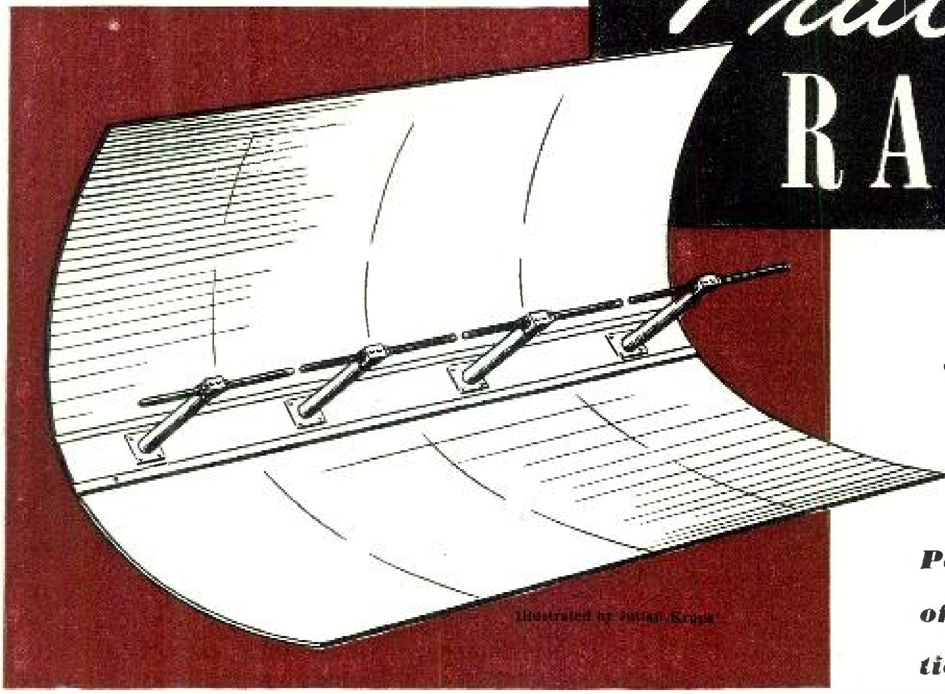


Fig. 1. Antenna used for transmitting u.h.f. pulses.

LIKE an invisible searchlight beam, pulsed u.h.f. energy from a radar set scans the air and land and sea in search of targets in light or darkness, in any kind of weather.

A constant barrage of exploratory pulses are radiated into space by the transmitting antenna and move within the confines of an extremely narrow beam. The pulses travel at the speed of light until they strike a target, when the r.f. energy is reflected and reradiated in all directions by the surface of the target. Some of this reflected energy reaches the radar receiver in the form of *echoes.*

After radiating each pulse, the radar transmitter is turned off and there is a quiescent, or "listening", period during which echoes can be recorded on a cathode-ray oscilloscope. Then another pulse is generated and the complete out-and-back cycle repeated—always allowing sufficient time for echoes to return from targets within maximum range of the set.

The determination of the range and direction of targets is based on the facts that radio frequency energy travels at a constant velocity (186,000 miles-per-second) and that the antenna system of the radar set is moveable and highly directional

Since the speed of the r.f. pulses is known, the range or distance can be found by multiplying the speed by one-half the time a single pulse requires to complete a round trip cycle. This time is measured electronically by a cathode-ray oscilloscope and translated immediately into terms of distance, in yards or miles.

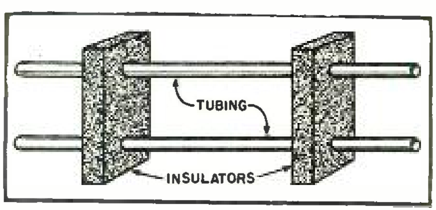
Knowing the range or distance, the physical position of the antenna system will give us two angular measurements; the azimuthal direction to the target (with respect to north) and the elevational direction (with respect to the horizontal plane of the earth).

This gives us sufficient information—range or distance, azimuth or bearing, and angle of elevation—to locate accurately the position of any target in space or on land or water.

In this process of precise and complex measurement, it's the function of the transmitting antenna to take the pulsed and powerful r.f. energy from the transmitter and radiate it into space in a highly directional beam. The transmitting antenna system is considered to include the transmission line from the transmitter to the antenna as well as the transmitting antenna itself.

Having previously explained the methods of generating powerful pulses of r.f. energy by the radar transmitter, we are now concerned with the medium of transporting the r.f. pulses to the antenna—transmission lines.

Fig. 2. Typical parallel two-conductor transmission line.



Transmission Lines

The important part played by transmission lines in u.h.f. circuits has already been discussed. We have seen how sections of transmission lines can be used as the "tank" circuit for a high-frequency oscillator, replacing lumped inductance and capacitance. Transmission lines are also widely used for impedance matching and measuring ultra-short wavelengths.

But the primary function of transmission lines is to carry energy from a source to a load—from the transmitter to the antenna system.

U.h.f. transmission lines are not basically different from those used at much lower operating frequencies and, for this reason, no attempt will be made to repeat lengthy, theoretical material which can be found in any good radio textbook.

However, we are very much concerned with certain aspects of basic transmission lines when employed at ultra-high frequencies of operation.

The higher the operating frequency, the more urgent is the need for considering the effect of both distributed and lumped inductance and capacitance, until we reach a point where such strange phenomena as metallic insulators and wave guides come into existence.

Regardless of the frequency of operation, however, the transmission line should have the smallest possible losses to insure a maximum transfer of pulsed energy to the antenna. The characteristic impedance of a transmission line must also be considered for optimum power transfer.

A common type of transmission line, efficient at the lower radar frequencies of operation, consists of two parallel conductors which are maintained at a fixed distance by insulated spacers or spreaders (Fig. 2).

Common forms of this type of transmission line use copper or similar metal tubing accurately spaced by means of ceramic, polystrene, or similar insulators. Characteristic impedances of from 180 to about 1000 ohms can be obtained.

In theory, at least, there will be little radiation from such a transmission line, because the currents in the two conductors are flowing in opposite directions. The field set up about one of the conductors is 180° out-of-phase with the field about the other conductor, and each of the opposing fields cancels the effect of the other—thus minimizing radiation.

At ultra-high frequencies, however, the ceramic or polystrene insulators lose much of their insulation qualities, and power is lost because of leakage currents across the surface of the insulators.

In such cases, the insulators can be dispensed with entirely and replaced with *stub supports;* a quarter-wave short-circuited section of transmission line (Fig. 3). Due to impedance reflection, the short-circuited end of the stub will appear as an extremely high impedance at the point where the stub is mechanically connected to the main transmission line.

In a similar way, matching stubs can be attached to any part of the main transmission line to properly match the transmitter to the line for maximum power transfer.

Rotating joints may be effected in such a transmission line by inductive coupling, two single-turn coils, electrically but not physically connecting the two sections of transmission line.

But when we require the transfer of extremely high u.h.f. energy, a number of difficulties are encountered in the use of open-wire transmission lines.

At ultra-high frequencies, any object near an open-wire transmission line (Fig. 3) will absorb some power from the line causing losses. As the frequency of operation is increased, these losses increase.

An open-wire transmission line is also inefficient for carrying high power u.h.f. energy, because radiation increases rapidly as the distance between the two conductors becomes greater. In other words, if the distance between conductors is more than 1/100 of a wavelength the losses due to radiation are much too great for efficient operation.

This, the spacing between any two conductors, is the biggest problem in u.h.f. transmission technique, because we require large spacing to prevent voltage breakdowns, and yet we want to eliminate all radiation from the line system.

Since u.h.f. currents tend to flow on or very near the surface of the conductors, the transmission problem is solved by using either a coaxial cable (concentric transmission line) or a new means of carrying u.h.f. waves from point to point—wave guides.

Concentric Lines

A coaxial cable or concentric line (Fig. 4) consists of a tube through which a wire or another tube of smaller diameter is run coaxially (having the same axis) with the outer tube. Usually beads of low-loss dielectric material are strung along the inner conductor and this line is crimped slightly to hold them in place.

Current flows along the *outer* surface of the center conductor and along the *inner* surface of the outer conductor. Therefore, the outside of the outer conductor may be grounded at any point. The cable may be bent, but abrupt angular turns are not always possible.

Copper tubing is generally used in the construction of u.h.f. concentric lines, using polystrene or similar disc insulators. The conducting surface may often be silver plated to reduce the inherent attenuation of such a coaxial line.

To prevent any frequency discrimination by the line due to distributed losses, only as many insulation beads are employed as may be structurally necessary. As the number of beads is decreased, insulation losses are no longer distributed but are lumped.

At higher frequencies of operation, where a quarter-wavelength is quite short physically, the usual type of insulating bead may be replaced by a metallic insulator (Fig. 5A), where a small extension is made at right angles to the main transmission line and a metallic support is fastened between the center conductor and the end of the extension. If the length of the support is equal to a quarter-wavelength and is short circuited, it presents a high impedance at the point where it is connected to the center conductor and, therefore, will absorb no energy or change the impedance of the main transmission line.

A similar arrangement can be made to effect a 90° angular turn in the coaxial line, as shown in Fig. 5B.

Since radar transmission lines must connect stationary transmitters with moveable antenna systems, some sort of rotating joint is required at some point along the concentric line. Coupling loops cannot be used as in the open-wire system, because the impedance of such a loop arrangement would be greater than the impedance of the concentric line.

The simplest type of rotating joint for coaxial cable is a friction joint, such as a slip-ring, so that r.f. energy can travel directly between the stationary and moveable contacts. However, a good electrical contact of this sort is difficult to achieve.

At extremely short wavelengths the losses in a concentric line become very great and a device known as a *wave guide* more efficiently transfers energy

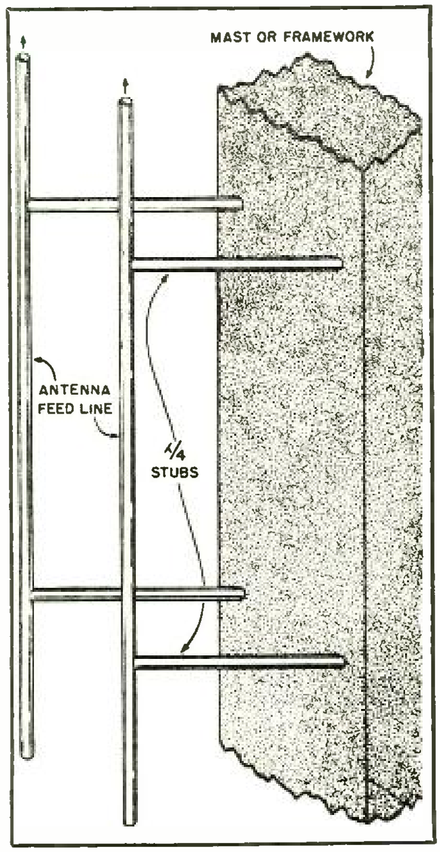


Fig. 3. Use of stub supports.

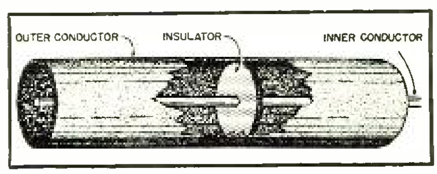
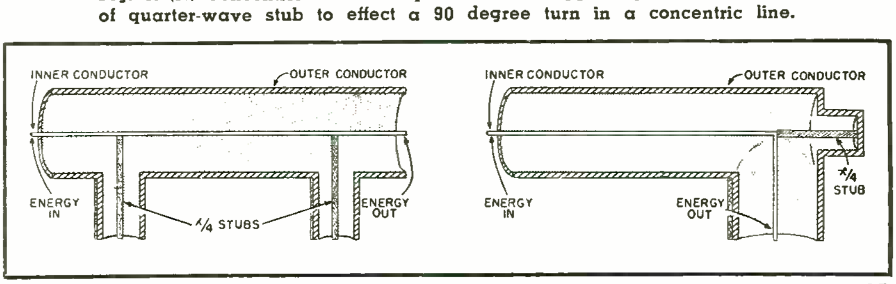


Fig. 4. Typical concentric line.

Fig. 5. (A) Concentric line with quarter-wave supporting stubs. (B) Use of quarter-wave stub to effect a 90 degree turn in a concentric line.



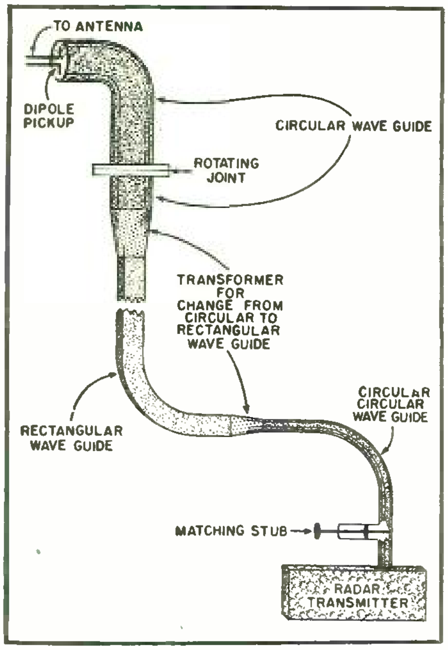


Fig. 6. Example of radar wave guide system.

GLOSSARY OF RADAR TERMS

Azimuth—Bearing or angular direction relative to true north.

Beam width—The width in azimuth of the pulsed r.f. energy beam.

Bearing—See Azimuth.

Blocking oscillator—Tuned-grid, tuned plate r.f. oscillator in which the grid circuit controls the pulse duration.

Carrier frequency—The ultra-high frequency at which a radar transmitter operates.

Cathode follower—Distortionless, impedance-matching, isolating stage.

Charged line—A pulse-shaping network which reflects a steep-sided rectangular pulse of a duration determined by the electrical constants of the line.

Clamping circuit—A circuit which holds either the positive or negative amplitude extreme of a wave form to a given reference level of voltage.

Cut-off limiting—Limiting action of an amplifier when operated beyond the point of plate current cut-off.

D.C. restorer—See clamping circuit.

Delay circuit—Network or circuit which introduces a time or phase delay of a wave form.

Differentiator circuit—A short time constant (RC) circuit and amplifier which produces an output voltage with an amplitude proportional to the rate of change of the input volage. A circuit used to sharpen a wave form. Sometimes called a peaking circuit.

Dipole—A half-wave center-fed radiating element.

Duty cycle—The fraction of a complete radar cycle during which energy is transmitted.

Echo—That part of the r.f. pulse reflected back to the radar set by a target.

Electronic timer—The component of a radar set that originates the pulse recurrence frequency, and synchronizes the operation of other components with the radiation of r.f. pulses by the transmitter.

Elevation angle—The angle of the target with respect to the radar set and the horizontal plane of the earth.

Envelope—The general outline of a wave form.

Gate—A rectangular wave used to switch a circuit on or off electronically during certain portions of the radar operating cycle.

Grass—Static or noise appearing as intermittent, minute interruptions of the oscilloscope time base.

Ground return—That part of the r.f. pulse reflected by the ground surrounding the radar set.

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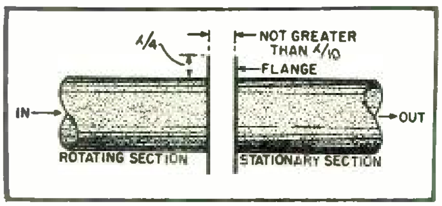


Fig. 7. A wave guide rotating joint.

from the transmitter to the radar antenna system.

Wave Guides

Electromagnetic waves can be guided from point to point in a radar set by means of a conductor which completely encloses the waves, known as a wave guide. The energy can be thought of as being radiated through the hollow space within the tube, rather than in or along conductors.

Although simple mechanically, the wave guide is one of the most complicated types of u.h.f. apparatus. The theory behind the operation of wave guides is extremely complex and lengthy, far beyond the scope of our practical discussion.

But, in general, it may be said that the efficiency of wave guides at extremely high frequencies of operation is far greater than that of the most perfect coaxial or concentric line. Since a wave guide uses no center conductor, all losses ordinarily associated with that conducting element and its insulating supports are completely eliminated.

Wave guides may be rectangular (Fig. 8A) or they may be circular. Neither will transfer energy at frequencies below a critical frequency value determined entirely by the dimensions of the guide.

The orientation of electric and magnetic components of a u.h.f. wave traveling through a wave guide is used to designate the "mode" of wave propagation. This mode of propagation has considerable effect on the losses which may occur and, as a result, only a few of the large number of modes are used. Certain modes determine the lowest wavelength of operation, usually about twice the largest dimension of a rectangular guide.

Energy is introduced into one end of a wave guide by means of a minute antenna, or several such antennas arranged in a tiny array. The arrangement of the antenna varies with the type of wave being propagated through the guide. At the receiving end, the wave guide may be terminated in another (receiving) antenna or in a horn (Fig. 8B).

Between the point in the radar set where energy is introduced into a wave guide and the point where the energy is applied to the antenna or radiating device of the set, the wave guide must be treated much as any other type of transmission line. Impedances must be matched, the wave guide may be required to bend at several places, and some type of rotating joint will usually be employed.

Circular wave guides are most easily adapted for rotating joints, since they are symmetrical in cross section. A typical rotating joint (Fig. 7) consists of an open "break" in the wave guide of any width up to about one-tenth of the resonant wavelength. Quarter-wave flanges are attached to the two facing portions of the wave guide so that r.f. energy is not diverted from the main path through the space of the hollow guide.

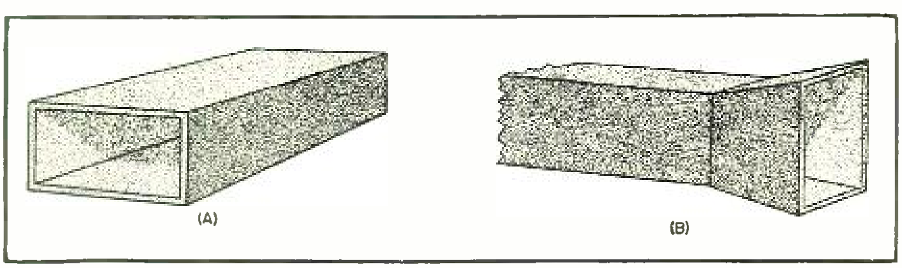
Both circular and rectangular wave guides may often be used in combination in the same radar set, to perform the myriad requirements—matching impedances, causing no change in wave polarization, and having one or more rotating joints. To illustrate this use, a complete wave guide system for a feasible but mythical radar set is shown in Fig. 6. Similar wave guide systems are often used in transporting energy from the transmitter to the radar antenna, over distances which may be as great as ten, fifteen, thirty, or more feet. Some systems actually change the polarization of the u.h.f. energy as it passes through the wave guides.

Expansion gaps, similar to rotating joints, are sometimes used to allow for physical changes in the metallic components of the wave guide system.

Transmitting Dipole

Pulses of u.h.f. energy, generated by the radar transmitter and carried

Fig. 8. (A) Rectangular wave guide. (B) Wave guide terminated in a horn radiator.



by the transmission line system, are radiated into space by any of several types of radar transmitting antennas.

From our previous discussions, we have learned that the electrical characteristics and physical appearance of transmitting antennas may vary widely. The physical size of the antenna is determined largely by the carrier frequency of operation and the degree of energy concentration in the radar beam.

But it is significant to note that practically all microwave transmitting antennas operate on the same basic principle; radiation of u.h.f. energy from one or more dipoles.

A radar dipole is a center-fed, half-wavelength conductor, sometimes known as a half-wave Hertz antenna or a half-wave doublet. It has maximum voltages of opposite polarity at either end of its length and zero voltage at its center. And it has maximum current at its center and zero current at both ends. Such a dipole functions independently of ground, and has a characteristic impedance of about 73 ohms.

When a *single* dipole is energized at its resonant frequency, the radiation beam pattern will be approximately that of a circle (Fig. 10A); this is what we would see when looking at the end of a horizontal dipole. When viewing the same dipole from the side, the radiation pattern would appear as a round doughnut, with the dipole rod sticking through its center.

There is essentially no directivity to such an antenna.

From our previous discussion, however, we know of the importance of a high degree of directivity of the radar beam. Radiated energy must be concentrated in one direction, and cancelled in all other directions.

To do this we may employ a *reflector* in conjunction with the same basic dipole. This reflector is like an ordinary conductor, slightly longer than a half wavelength of the operating frequency, and placed approximately one-quarter wavelength behind the radiating dipole. The reflector is not connected to the transmission line.

When the basic dipole is now energized, the radiation pattern will have a decided directivity *away* from the reflector, as shown in Fig. 10B.

Other directional effects can be obtained by using two or more antennas physically spaced and electrically phased so that radiation from each of the dipoles tends to add in one direction and subtract in unwanted directions.

There are many such types and arrangements of dipoles which can be used to produce almost any desired directional radiation pattern. A discussion of these many types is beyond the scope of these articles on practical radar, and theoretical information is contained in any of several textbooks on the subject.

It should be noted, however, that if the radiating dipole is mounted horizontally above the ground, the radio waves leave the transmitting antenna in a horizontal plane. For this reason we say the waves are horizontally polarized.

In the same manner, if the dipole is placed vertically, then the radiation pattern is turned through 90° and the radiated waves are then said to be vertically polarized.

The directivity of an antenna refers to the sharpness of its radiation pattern; the narrowness of the radar beam of pulsed energy.

By a suitable arrangement of dipoles and reflectors, it is possible for a radar transmitting antenna to have

(*Continued on page* 96)

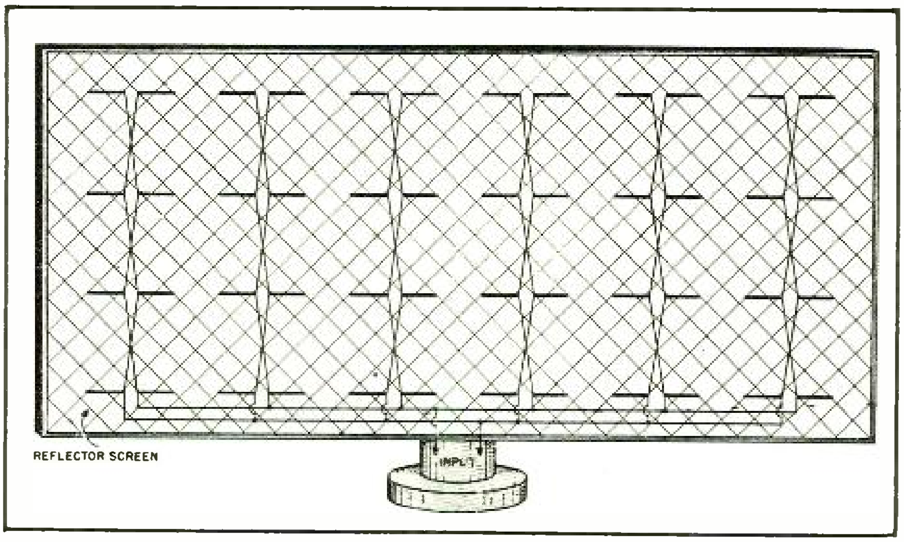


Fig. 9. An ordinary antenna array of stacked dipoles mounted in multiples of four.

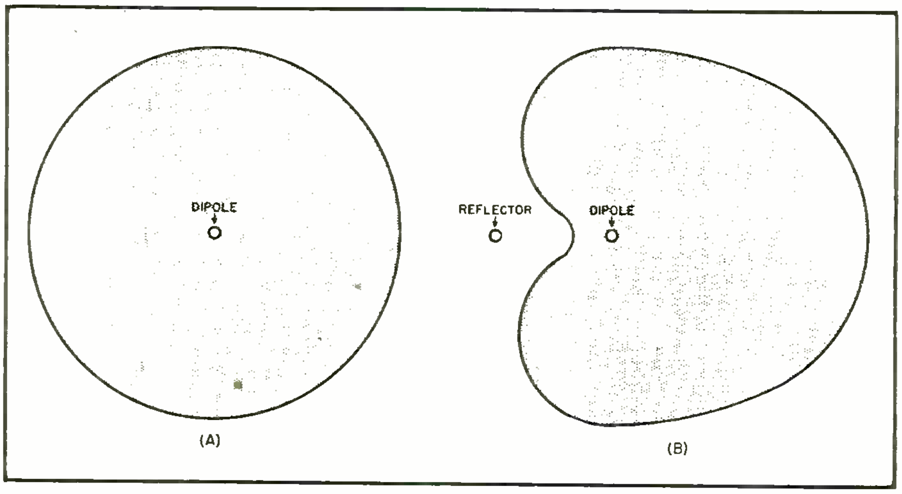
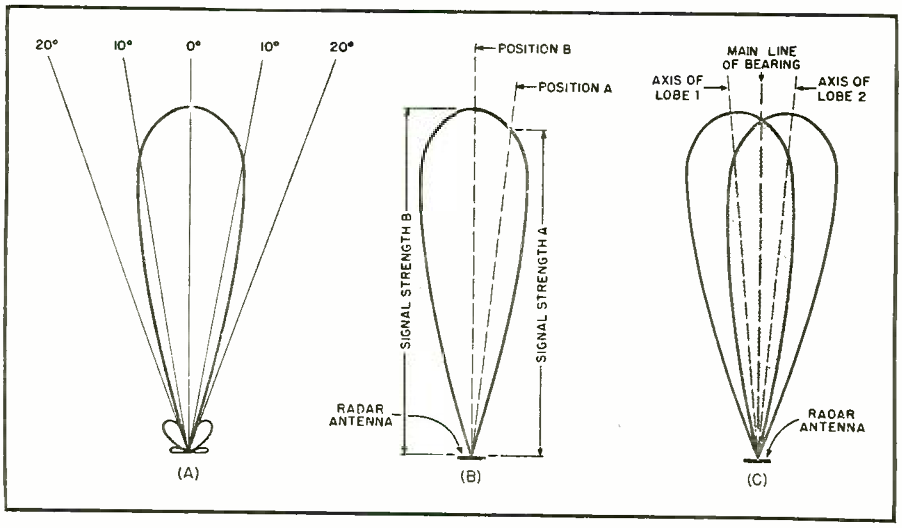


Fig. 10. Radiation pattern of (A) a basic dipole, and (B) a dipole with reflector.

Fig. 11. (A) Radiation pattern for a directive transmitting antenna. (B) Showing accuracy of a single lobe. (C) Radiation pattern of a double lobe.



LET'S TALK SHOP

With JOE MARTY

Eastern Editor, RADIO NEWS

THE opinion of most informed observers of the radio service field is that the serviceman is going to face a period of increasing competition in the very near future. Perhaps it will be well to examine some of the psychological sales factors that contribute to a successful operation. It is readily agreed by most observers that the average serviceman is so bound up in the technical and mechanical parts of his job that the main business and sales effort suffers. This is decidedly wrong. The same economic laws that apply to any other business, apply equally as well to the radio service business. This means that all departments of the business must be as carefully planned and operated as the service end. Advertising requires much study and work in order that the utmost value may be obtained from the investment in this phase of the business.

Merchandising methods and sales ideas should be carefully planned. Manufacturers' representatives should be consulted, as well as the jobber, and advantage should be taken of their superior sales knowledge and ability. Wherever possible, tie-in with manufacturer and jobber plans should be practiced. Cost figures of doing business should be carefully compiled and a budget adopted. This should be rigidly followed. The one point where most budgets break down is at the salary item. Many shops that are very strict about other items dribble money out of the bank or till for the owner's use in excess of that allowed by the budget. Rigid self-discipline in the matter of personal expenses is necessary to keep control of this item.

Store traffic is another factor in doing business which is overlooked. Remember that the higher rent necessary to maintain a nice location and showroom has to be borne by sufficient store traffic to make it worth while. Definite thinking and planning is necessary in the choice of items for sale in order to build up this traffic. Often sidelines not directly connected to radio prove profitable. Such items as paint, sheet music, and records to mention only a few, serve this purpose very well. An ideal situation is one where the traffic sales items take care of the additional cost of having a bigger and better location. This permits the service end of the business to carry only that part of the overhead which would ordinarily be charged to it.

Working Capital

Financing is another item in store operation upon which too little thought and planning is expended. A definite financial program based upon individual capital structure should be carried out. Many local banks are glad to extend counseling advice, if asked. The serviceman should avail himself of these opportunities. Veterans returned from the armed service have a great number of agencies open to them for financial advice and assistance. Bank connections are especially valuable in establishing credit and as an aid to future financial help if needed. Much financing of equipment and fixtures can be arranged for with the aid of the local banker and, in most cases, at less cost.

Personal customer contacts are the most important single operation of the small business man. It is here that the sale and profit is either made or lost. Inasmuch as 90% of the buying in any field is either done or influenced by women, a determined effort to know and apply the fundamentals of sales psychology is most necessary. Remember women always look at your clothes. Therefore dress neatly and, if possible, wear some sort of uniform coat when making calls. If it is necessary to work in the home, be sure you spread newspapers or some other floor covering to protect carpets from damage. Clean up carefully after you finish. Of course the best plan of operation is to remove the set for service in the shop. Do not be in too much of a hurry to get through with the job. Take time to test all the tubes, not just the ones which are obviously bad. Very often two or three tubes can be sold where you thought only one was needed. This increases your return per call. In most cases the greatest cost against a job is the time spent in getting there and back, and anything you can do to reduce this means a greater net return for your efforts. A thorough check of the aerial and ground, as well as a.c., connections usually enables you to prevent a call back which is unprofitable.

Complete itemized bills should be furnished, and the customer should be carefully told what was done and exactly what your guarantee covers. Many misunderstandings and lost customers come from a neglect of this small but important matter. Calls should be made as promised, and on time as much as possible, since most modern housewives plan their day's work. Any neglect on your part may build ill-will which will be reflected in your profits at the end of the year. Any delays in repair, due to circumstances beyond your control, should be carefully and completely explained to the customer.

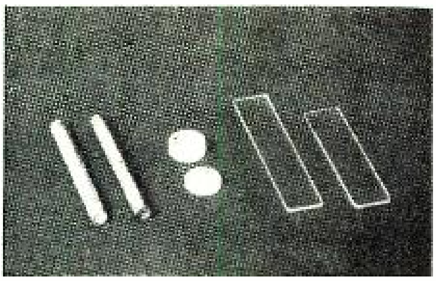
Many of the above remarks may seem like old stuff to many of our readers, but it is surprising how many basic fundamentals of business have disappeared during the war. With a return to a buyer's market, as well as a large influx of newcomers in the field, a restatement is particularly timely now. —30—

"I'm taking a correspondence course in radio repair!"

QUARTZ CRYSTALS Today and Tomorrow

By F. EARLE CLARK
Director, Crystal Research
Harvey-Wells Electronics

Fig. 1. Other applications of quartz are shown in the form of torsional quartz rods, pressure quartz discs, and optical wedges.



The quartz crystal—a more compact and efficient postwar unit—will be available to the ham at less cost.

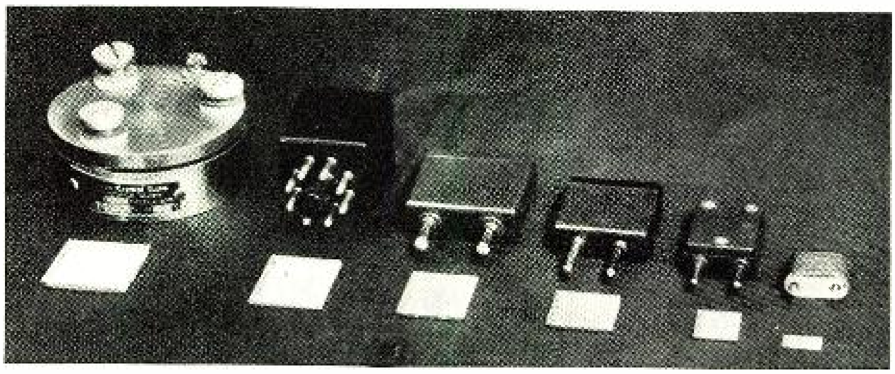


Fig. 2. The progressive stages of the development of quartz crystals made possible through the increasing knowledge of its physical and electrical properties.

EDITOR'S NOTE: *The uses made of quartz crystals today in their great constribution to World War II, is but a prelude to developments which will promote numerous uses tomorrow. They have proven themselves irreplaceable in the science of wire and radio transmission and reception, supersonics, measurement, and optics and will eventually become necessary to many other sciences. The development of quartz crystal products, as they are now, has been largely accomplished in the past three years, but future developments will undoubtedly be spread over a longer period of time. However, their possession of certain phenomenal properties makes these developments a natural eventuality.*

DESPITE the relative complexity and high cost of quartz oscillator plates, they have become one of the principal factors which make the American-made communication systems the best in the world. They have proven themselves indispensable to wire and radio transmission and reception because of three phenomenal properties which they alone possess. These properties are: first, the piezo-electric effect which stabilizes the frequency of an oscillator by coupling between the electrical circuit and the mechanical properties of the crystal; second, small changes in frequency over a wide temperature range when accurately oriented and dimensioned; third, uniformity of the density and elastic constants so that a plate cut at a given orientation always has the same frequency constant.

Although the piezo-electric effect in quartz was discovered sixty-five years ago, no practical use was made of it until after World War I. Professor Langevin developed a sonic depth finder at the request of the French Government, but it was not perfected until after the Armistice.

It employed several quartz plates, and was intended to be used for the detection of submarines. Instead it was used to record the contour of the sea bottom. Similar devices are being used in World War II for detecting subs, mapping the bottom of the seas, and training radar operators. A number of devices are being developed which employ the same principle but at different frequencies.

The tremendous crystal procurement program of the Allied Military Services caused the formation of over a hundred new manufacturers and their success is evident by the fact that, while the critical status of quartz oscillator plates was second only to map making at one time, it is now such that one third of these manufacturers are converting their plants to the manufacture of other war material. Much was learned during this feat of American industrialism by crystallographers, physicists, radio engineers, and the specially trained craftsmen who made the units. For example, crystallographers learned how to rid quartz of twinning and iron sulphide by special heat treatments. They learned also that the visible flaws commonly known as chuva, phantoms, blue needles, veils, and dentrite have no detrimental effect upon the performance of a finished quartz oscillator plate.[1] In fact, so much has been learned about natural raw quartz that some has been made synthetically which possesses the piezo-electric effect.

Physicists have learned how to prevent the aging of finished quartz oscillator plates by etching the surfaces which have been previously ground with abrasives.[2] They have improved processes for plating crystal surfaces with gold, silver, aluminum, copper, and nickel. New methods of mounting plates have brought into prominent use the CT cut plate for FM sets in tanks, the DT cut plate for automatic relay sets, the MT cut plates for FM broadcast sets, and the GT cut plate for frequency standards. The latter represents the ultimate in the control of frequency standards with quartz oscillator plates due to the fact that its frequency does not vary more than one part in a million over a 100° centigrade range of temperature. Its relatively high Q makes it less subject to any change due to minor variations in other circuit components.

It was learned that the radiation of x-rays, gamma rays, alpha particles, electrons, and deuterons have an effect upon the color and elasticity of quartz.[3] The frequency of a quartz oscillator plate irradiated with x-rays may be made to change as much as 3000 c.p.s. due to the resultant change in the elastic constants. The most common use of this recent development is the salvaging of plates which are slightly over the desired frequency.

X-ray diffraction units have been improved so that quartz orientation may be checked accurately within two minutes of a degree. Life of x-ray tubes has been increased to several

(*Continued on page* 145)

An Amplifier-Type Vibrating-Reed FREQUENCY METER

By
RUFUS P. TURNER
Consulting Eng., RADIO NEWS

Compact and reliable, this reed-type frequency meter may be designed into various kinds of electronic test equipment.

THE vibrating-reed type of frequency meter is not a recent innovation. It was a familiar instrument in Europe some years before its manufacture was begun in the United States. But until lately, the reed-type meter has been more widely known among electric power men than by electronic workers.

The various features possessed by the vibrating-reed meter make it suitable for certain types of electronic testing in which direct indication of an audio frequency is involved. Once obtainable only in electric switchboard and "large portable" sizes, these meters are available at this writing in the popular 3¼-inch round-face style so familiar to builders of radio equipment, and may easily be "designed into" electronic test equipment.

Operating on an electromechanical principle, the vibrating-reed meter requires no oscillator or trigger circuits. Among its leading advantages are its easy readability; its freedom from stray magnetic and electrostatic fields, vibration, and the effects of harmonics of signal voltage; its simple operating principle and attendant simple and compact construction; its lack of pointers, movable coils, and delicate jewels and pivots; its accuracy (at normal temperatures, plus or minus .3% on full-cycle increments; plus or minus .2% on half-cycle increments); its need of no temperature compensation in the common range of operating temperatures; and its independence of signal waveform. This type of instrument normally requires no adjustment in service. The manufacturers of vibrating-reed frequency meters catalogue a generous choice of scales and ranges. On the lower-frequency ranges, full- or half-cycle increments may be read—on the higher-frequency ranges, 5- to 10-cycle increments may be read.

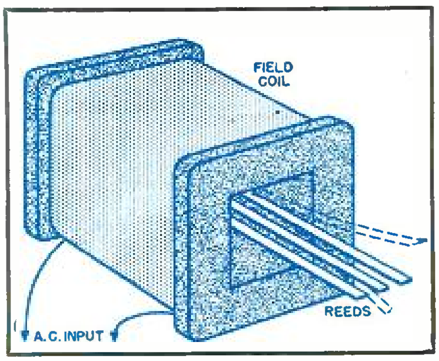


Fig. 1. Mechanical construction of the vibrating-reed frequency meter.

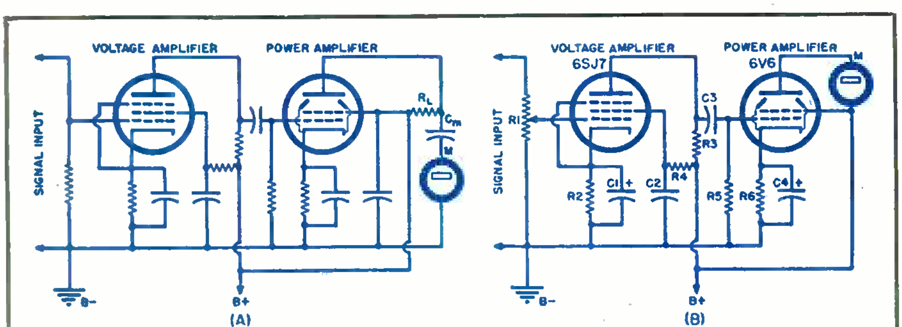
Heretofore, use of the reed-type frequency meter has been restricted to line, generator, and signal measurement on systems where the relatively large voltage and current required to operate the meter were available. Utility of the instrument is extended, in modern circuits, by prefixing a simple audio-frequency amplifier.

Operating Principle

The vibrating-reed frequency meter takes its name from its peculiar indicating medium—vibrating metallic reeds. The operating principle of this instrument is illustrated in Fig. 1. Several thin strips (reeds) of a magnetic metal, such as iron or steel, are mounted within the field of an electromagnet. Each of these strips is tuned to a different natural period of vibration, either by cutting to a different length (maintaining constant thickness) or by varying the thickness, while maintaining length constant. There are various methods of assembly. In one arrangement, the reeds are held by machine screws to one pole of the magnet core, while their ends are spaced close to the opposite pole.

If an alternating current is passed through the coil, the reeds will tend to vibrate because of the alternating electromagnetic field. If a number of reeds are included having natural vibrational periods near or equal to that of the current frequency, the one which vibrates with greatest amplitude is the one whose natural frequency corresponds to the frequency of the current. If the natural period of each reed is known, and a sufficient number of reeds are included in the instrument, it thus becomes possible to identify the frequency of a current in the magnet coil by observing which

Fig. 2. Suggested arrangements for connecting the meter in an amplifier. Two distinct types are shown: one where the d.c. plate current passes directly through the meter and the other where d.c. plate current is bypassed by a shunting network.



R_1—1 megohm pot.
R_2—1400 ohm, 1 w. res.
R_3—100,000 ohm, 1 w. res.
R_4—450,000 ohm, 1 w. res.
R_5—500,000 ohm, 1 w. res.
R_6—250 ohm, 10 w., w.w., res.
R_L—(See Text)
C_1, C_4—10 µfd. 25 v. elec. cond.
C_2, C_3—.1 µfd. 400 v. cond.
Cm—(See Text)
M—3¼" vibrating reed freq. meter, J-B-T Type 33-F

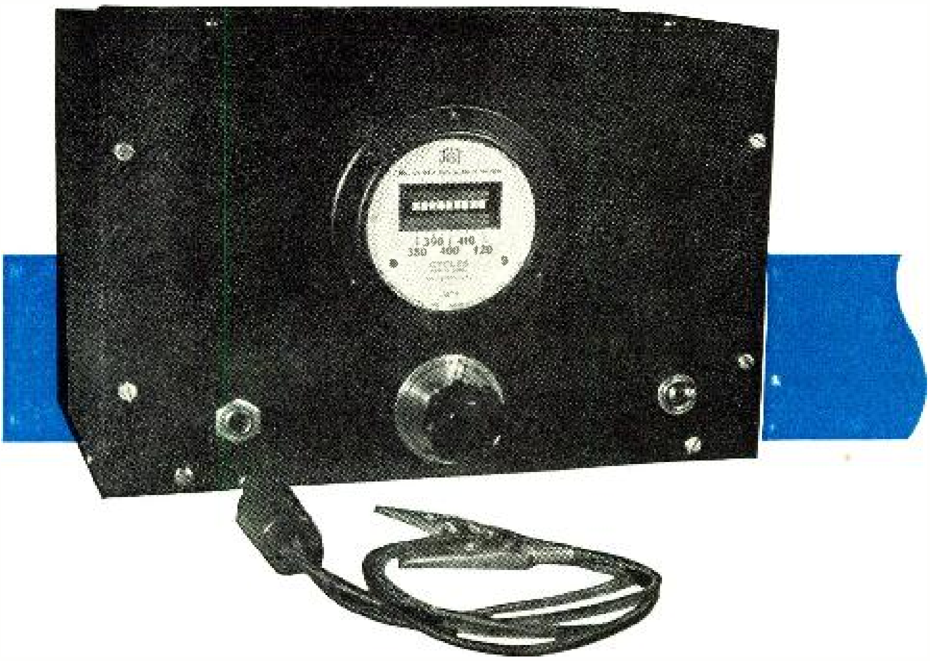


Fig. 3. Front panel view of the completed instrument confirms author's original intentions of a compact and easily constructed versatile test instrument.

of the vibrating reeds swings with greatest amplitude.

A disadvantage of this type of instrument is the comparatively large current demanded for operation of the electromagnet coil. This shortcoming limits the instrument in application, since in many modern test operations it is essential that the load presented by a test instrument be as low as possible. This is another way of saying that the input impedance of the instrument must be as high as possible. But this disadvantage may be eliminated by providing the reed-type frequency meter with an input amplifier of simple design. By this expedient, the instrument will then be provided with a very high value of input impedance, corresponding to the characteristic of the input grid circuit of the amplifier. It will then be usable for a wide variety of electronic testing in which a simple, direct indication of audio frequency is required. Among such applications are (1) measurement of line and oscillator frequencies, (2) measurements of audio signal equipment, (3) checking facsimile synchronizing signals, (4) checking the frequency of tuning forks, chimes, whistles, horns, bells, and similar equipment, and (5) resonance indication in various test instruments employing the beat-frequency principle.

Amplifier-Type Meter

The functional block diagram of Fig. 5 shows the simple operation involved in adding an amplifier to the reed-type meter. It is not necessary that this amplifier be an elaborate affair, as long as its gain is adequate to build up the signal voltage to a value sufficiently large to actuate the reeds. It is desirable to employ an input gain control, but, since operation of the meter is substantially independent of waveform, the usual precautions regarding fidelity and distortion need not be taken in this case. The reeds in a particular range are quite selective and (unless measurements are made in the vicinity of the power-line frequency) will not be affected by hum voltage and harmonics of the line frequency. The power supply accordingly may then be of a very simple design.

Suggested arrangements for the input amplifier are shown in Fig. 2. In Fig. 2A, a regular reed-type meter is employed. It is desirable to keep the d.c. component of plate current out of this meter, so connection is made through coupling capacitor C_m and load resistor R_L. Any tube combination may be employed which will supply desired gain and output voltage. Recommended combination is 6SJ7-6V6. Fig. 2B shows another arrangement. In this circuit, a special version of the reed-type meter is employed—one, available on order, through which the d.c. component of plate current may be passed. Connection is permitted directly in the plate circuit of the output tube. The author's instrument, shown in the photograph and in circuit schematic in Figs. 2B and 4A, employs a meter of the latter description—a *J-B-T* Type 33-F, 400-cycle instrument capable of operating directly in the plate circuit of a 6V6 or similar output tube.

Electrical Features

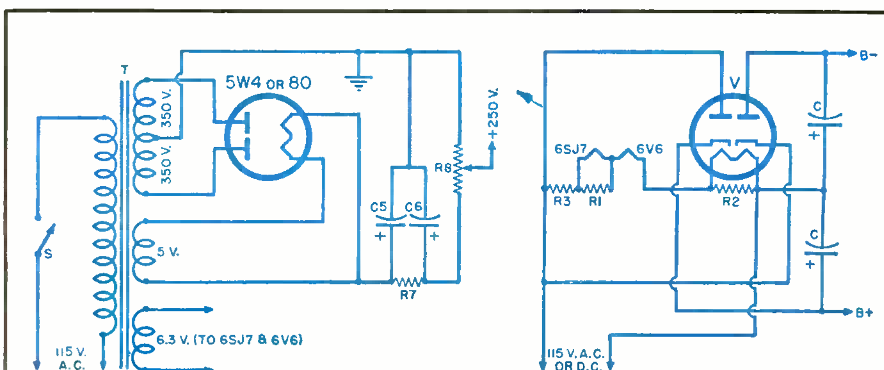
A complete schematic of the instrument is shown in Figs 2B and 4A. Jack input is provided for a signal or microphone. The input 6SJ7 is arranged for a gain of approximately 100 and is resistance-capacitance coupled to the 6V6 output stage. The frequency meter, *M*, operates between plate and screen of the latter. R_1, the gain control, is a 1-megohm potentiometer imparting very high input resistance to the instrument. The power supply embraces power transformer, *T*, a 5W4 or '80 rectifier tube, filter resistor R_7, filter capacitors, C_5 and C_6, and voltage divider resistor, R_8. A resistor instead of a filter choke is perfectly practical in this circuit and has been found entirely satisfactory.

An alternative power supply, comprising a standard full-wave, line-operated voltage doubler circuit, is shown in Fig. 4B. This arrangement will make a more compact and lighter weight instrument. However, it should be employed only when it is known definitely that the meter will not be used in conjunction with other instruments which likewise are "line-operated." This is a safety precaution, since the combination of instruments employing line-operated doublers or a.c.-d.c. power supplies leads to burn-outs of wiring and shocks to the operator.

In the voltage doubler power supply, the tube is a 25Z5 or 25Z6. The two filter capacitors, *C-C*, are each of 16 μfd. capacitance at 450 d.c. working volts. If 6SJ7 and 6V6 tubes are

(*Continued on page* 153)

Fig. 4. Two alternative power supplies that may be used. The author designed and constructed his instrument around the power supply Fig. 4A and amplifier Fig. 2B.



R_7—2500 ohms, 10 w., w.w. res.
R_8—25,000 ohms, 10 w., w.w., var. res.
C_5, C_6—8-8 μfd., 450 w.v.. dual electrolytic cond.

S—S.p.s.t. toggle switch
T—Power transformer: 350-0-350 v. @ 50 ma.; 5 v. @ 2 a.; 6.3 v. @ 2½ a.
R_1, R_2, R_3, C—(See Text)

PRACTICAL RADIO COURSE

By ALFRED A. GHIRARDI

Part 37. Covering the series-padder method of tracking the oscillator to the various preselector tuning circuits in present day superheterodyne receivers.

CONTINUING the discussion of the methods employed to maintain a constant frequency-difference (numerically equal to the intermediate frequency employed in the receiver's i.f. amplifier) between the frequency of the oscillator and that of the preselector tuning circuits, for all settings of the manually-operated receiver tuning control, the oscillator-padding method is the most widely used in practice for making the oscillator frequency correctly "track" the preselector frequency at the low-frequency end of the tuning band. This is an *electrical circuit* method.

Low-Frequency Tracking

When the oscillator padder method of tracking is employed, the receiver employs a gang tuning capacitor in which the oscillator and preselector tuning sections all have identical plate shapes, i.e., the same capacitance-variation characteristic. If the oscillator frequency is to be *higher* than the preselector (signal-circuit) frequency, an oscillator tuning coil with sufficiently less inductance than that of the preselector tuning coils is used. In addition, a fixed or adjustable capacitor (known as the *padder*) of specially chosen value is connected in series with the oscillator tuning capacitor.

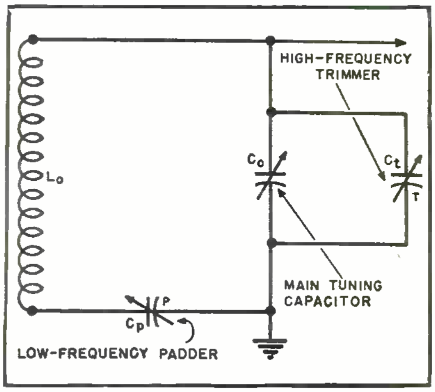
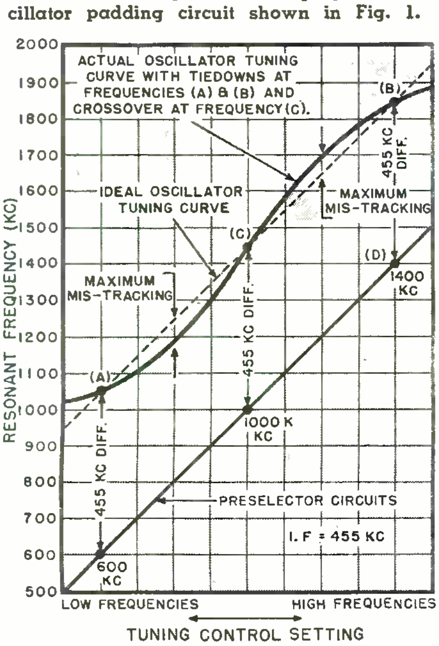


Fig. 1. Basic "padded" oscillator tuning circuit. Low-frequency padding capacitor C_p is inserted in series with resonant circuit. The oscillator tuning characteristic that will result is shown in Fig. 2.

Fig. 2. Typical oscillator-preselector tuning curves for the broadcast band of a 455 kc. i.f. superhet employing the oscillator padding circuit shown in Fig. 1.



The basic oscillator-padding circuit arrangement for one tuning band is illustrated in Fig. 1. Here, C_o is the main oscillator tuning capacitor, which is ganged on the assembly with the preselector tuning capacitor sections of similar size and plate shape. A small adjustable *trimmer* capacitor C_t of about ⅛ to ⅕ of its value is connected in parallel with either the oscillator tuning coil or with the tuning capacitor, to make it possible to adjust the oscillator frequency to bring it to the correct required value when the main gang tuning capacitor is set for a frequency near the *high-frequency* end of the tuning band (as explained in last month's lesson). For example, for the broadcast-band of a receiver this trimmer adjustment is usually made when the preselector circuits are tuned to about 1400 kc. This definitely "ties down" the oscillator frequency to the correct value for precise tracking at this high frequency (see points *D* and *B* on the oscillator and preselector tuning curves illustrated in Fig. 2).

We found in our preliminary discussion of the oscillator tracking problem (see Part 36 of this series in the August, 1945, RADIO NEWS), that when ganged tuning capacitors all having similar plate shapes are used and the oscillator tracking is tied down (made correct) at the high-frequency end of the tuning band, the oscillator capacitor will have progressively too *high* a capacitance *(oscillator frequency progressively too low)* as the low-frequency end of the band (capacitor plates fully meshed) is approached. It is possible to lower this capacitance by the simple expedient of inserting a capacitor (called the *padder*) C_p (Fig. 1), in *series* with the oscillator tuning capacitor. The capacitance of this low-frequency "padder" is made adjustable so it can be set to lower the oscillator tank circuit capacitance (increase the frequency) just enough to make the oscillator frequency track exactly the correct amount above the preselector frequency at any selected low-frequency point on the preselector tuning band. This, then, definitely "ties down" the oscillator frequency for precise tracking at this second point—a low frequency in the band (see oscillator tracking condition corresponding to point *A* in Fig. 2). Actually, if the oscillator tuning circuit has been properly proportioned, the oscillator circuit will also automatically track correctly at another frequency somewhere between these high-frequency "trimming" and low-frequency "padding" frequencies. This is called the "cross-over" point. It is illustrated by the oscillator-tracking condition corresponding to point *C* in Fig. 2, where the lower solid line represents the tuning frequency curve of the preselector circuits, the dotted line represents the ideal frequency curve of the oscillator (maintaining constant 455 kc. frequency-difference from that of the preselector), and the solid curve represents the *actual* frequency curve of the oscillator as realized in practice.

Examination of Fig. 2 reveals that the actual oscillator tuning curve which results is not quite perfect; absolutely correct tracking is attained at only three frequencies in the entire tuning band—at points *A*, *B*, and *C*. At the very lowest signal frequencies, the oscillator frequency runs too high, over the adjoining range (between *A* and *C*) it runs too low, then between *C* and *B* it runs high again, between *B* and the high-frequency end of the band it runs low again. However, with good oscillator design and carefully made oscillator tracking adjustments, the maximum deviation from perfect tracking can be held down to a value so small as to be of no practical consequence, provided the selectivity of the preselector section is not excessively high. The best average oscillator tracking is obtained when the three frequencies at which exact tracking occurs are so chosen that the maximum deviations of the tracking curve within the tuning range are small and all the same, as is the case in Fig. 2.

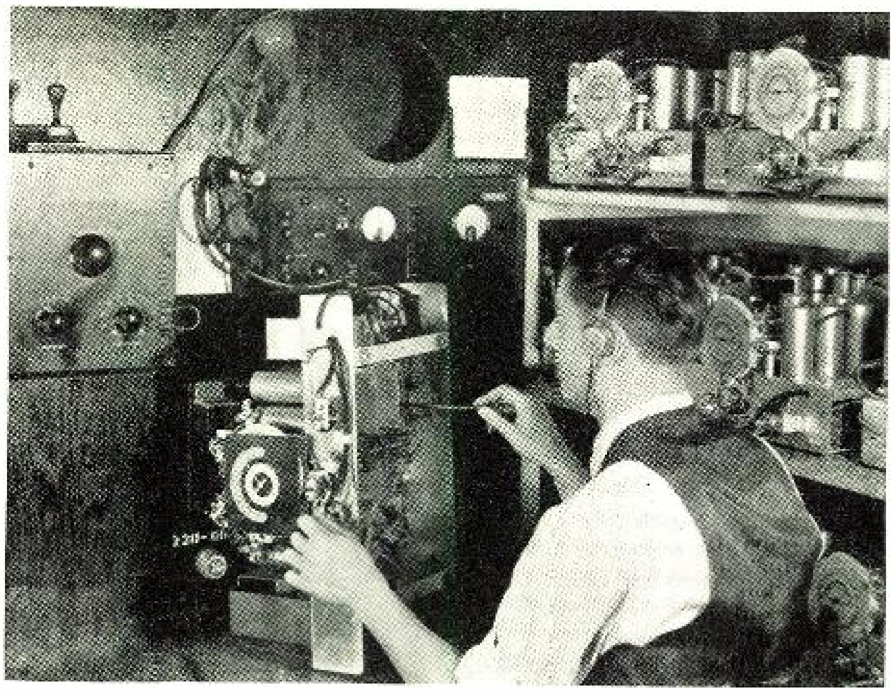
With the "padder" method, it is theoretically impossible to obtain perfect oscillator tracking at more than three frequencies. Two of them, the high frequency at which the oscillator is made to track correctly by adjustment of shunt trimmer capacitor C_t, and the low frequency at which the oscillator is made to track correctly by adjustment of series padder C_p may be arbitrarily chosen at the time the receiver is designed. The frequency at which the third, (point C) occurs is determined by the inductance of the oscillator circuit. The larger this inductance is with respect to the tuning capacitance, the *higher* the frequency at which this cross-over will occur.

Most receivers are designed so that on the broadcast band the cross-over (point C) occurs at a preselector frequency of approximately 1000 kc. (as is the case in Fig. 2) if the oscillator tracking is "tied down" at a preselector frequency of about 1400 kc. by means of the high-frequency trimmer and at 600 kc. by means of the padder. As the oscillator circuits of some receivers are intended to be adjusted at frequencies somewhat different from these, the manufacturer's instructions should always be consulted before making oscillator tracking adjustments on any commercial receiver.

Design of the Padded Oscillator Circuit

In superheterodyne receiver design engineering, the oscillator tracking design is now considered as one of the more or less cut-and-dried problems and is made simple by the use of formulas or design charts for determining the oscillator shunt trimmer and series padder capacities that will provide best tracking for a given set of receiver design specifications.[1]

It might be supposed that since the low-frequency padder is in series with the main tuning capacitor (see Fig. 1), adjusting it for proper oscillator tracking at the low frequencies would also greatly affect the previously-adjusted oscillator frequency and tracking at the high-frequency end of the band. Actually, it has only a small effect, for, since the padder capacitance necessary to produce good tracking is considerably larger than the minimum capacitance of the main tuning capacitor, its reactance at these higher frequencies is small compared with that of the main tuning capacitor. Accordingly, since its reactance is only a small fraction of the total capacitive reactance in the tuning circuit at these high frequencies, it affects the oscillator tuning only slightly at these frequencies. However, in order to correct any slight high-frequency "detuning" effect it might have, it is always advisable when making the tracking adjustments on the oscillator to repeat the adjustment of the trimmer and of the padder, readjusting the trimmer for correct tracking at the frequency at which it was first adjusted.



Technician shown adjusting the series padder for correct osc.-preselector tracking.

Depending upon the size of the padding capacitor C_p, the inductance used in the oscillator-tuning circuit may be the same as the inductance used in the preselector circuits, or it may have a smaller value. It is usually made about 20% smaller than that of the preselector tuning coils in order that the proper series and shunt capacitances may be chosen for the oscillator circuit to give minimum deviation from perfect tracking over the full tuning band.

The padder capacitance required to produce good low-frequency tracking for any given oscillator tuning coil inductance and tuning combination depends upon the osc.-preselector frequency difference that is to be maintained, i.e., upon the i.f. of the receiver. For example, for a particular commercial oscillator replacement coil designed to tune over the broadcast-band from 550 to 1600 kc. with a tuning capacitor having a maximum capacitance of 365 μμfd., the values of padder capacitance recommended to maintain correct low-frequency tracking for various osc.-preselector frequency-difference values (i.f.'s) are shown in Table I.

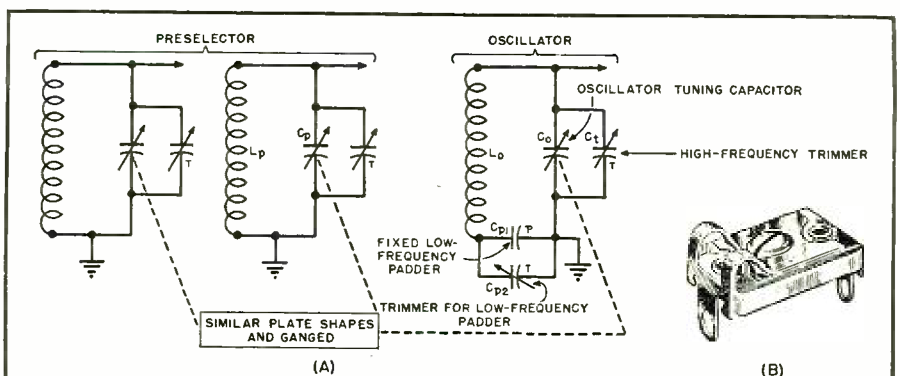
For Freq. Diff. (I.F.) of	Padder Cap. Required
175 kc.	900 μμfd.
262 kc.	686 μμfd.
370 kc.	500 μμfd.
456 kc.	350 μμfd.

Table I.

Notice that the greater the frequency-difference to be maintained (higher the i.f.) the smaller the value

(*Continued on page 143*)

Fig. 3. (A) Practical preselector and padded oscillator tuning circuit arrangement employed in many single-band receivers. (B) Typical mica compression-type adjustable padder capacitor. This particular unit has a capacity range of 3-35μμfd.



[1] Technical Discussion on Determination of Oscillator-Circuit Constants in Superheterodyne Receivers—*RCA Radiotron Company, Inc.*

By CARL COLEMAN

MANY of those now in the armed forces have written requesting information on getting into the merchant marine after the war. In recent issues we have had comments regarding the expected "after the war" conditions of the merchant fleet by men "in the know" from both the Radio Officer's Union and the American Communications Association.

First off, it will be necessary for the prospective postwar merchant marine radio operator to obtain a 2nd class radiotelegraph license, or one of higher grade, as issued by the Federal Communications Commission. A 1st class radiotelegraph license may be secured by those who are at least 21 years of age and who, in addition, have had at least one year experience at a radiotelegraph station open to public correspondence. The examination consists of code speed tests, both reception and transmission of international morse, at speeds of 16 and 20 w.p.m. (5 letters to the word) respectively, for the 2nd and 1st class licenses in code groups, and at the rates of 20 and 25 w.p.m. respectively, for the 2nd and 1st class in plain language.

Examinations for FCC licenses consist of questions from the following elements: (1) Basic law, provisions of law, and regulations with which every operator should be familiar. (2) Basic theory and practice, technical matters appropriate for every class of license except restricted radiotelephone operator permit. (3) Radiotelephone, additional matters, both legal and technical, including radiotelephone theory and practice. (4) Advanced radiotelephone, theory and practice applicable to broadcast station operation. (5) Radiotelegraph, additional matters both legal and technical, including radiotelegraph theory and practice. (6) Advanced radiotelegraph, radiotelegraph theory and practice of wider scope, particularly with respect to ship radio matters (direction finders, ship radiotelephone stations, spark transmitters, etc.). The examination questions in element 1 are to be answered in essay form. This examination consists of 10 questions, 10 per-cent will be allowed for each question answered correctly. Elements 2 to 6 inclusive comprise 10 pages of 5 questions each, totaling 50 questions. Two per-cent credit will be allowed for each correct solution. No credit for unfinished answers or if more than one answer is given. . . . Slide rule may be used; normal slide rule accuracy accepted. All answers in elements 2 to 6 may be given either by indicating the proper answer (in the multiple answer type questions) or by the solution of a simple mathematical problem, the drawing of a simple diagram, or the correction of an incorrect diagram, as required.

FCC's Rules Governing Commercial Radio Operators, part 13 of FCC Rules and Regulations and also the FCC Study Guide and Reference Material for Commercial Radio Operator Examinations (both can be procured from Superintendent of Documents, Wash.) should be obtained and studied. . . . There are also many good books regarding information relative to the passing of the various classes of licenses. For the prospective operator to become well informed about his new duties, he would do well to secure a copy of the "Marine Radio Manual" by M. H. Strichartz. It's about the most complete guide book for the newcomer in marine radio we have yet seen. After obtaining the necessary license, the next step, naturally, is to attempt to obtain a position. This should not be too difficult.

Most hiring after the war will be done through the local radio officers' unions (during the war, also by War Shipping Administration in order not to delay ships for lack of operators) and the prospective new marine operator would do well to first contact one of these organizations. . . . There are two major unions, both of which have offices in various coastal cities, the Radio Officers Union (AFL) with offices at 1440 Broadway, New York City (main office) and the American Communications Association (CIO), main office at 5 Beekman St., also in New York City. . . . Either of these (depending upon your individual union leanings) will advise you of their nearest office. . . . After reporting to the local union and joining up, your name will be placed on the "beach list" and, as men whose names appear on the top of the list are gradually assigned to vessels, your name will eventually reach the top and you will then be assigned to a ship. . . . As a rule, the local dispatcher in the union office will be able to give an approximate idea of the interval which will elapse before you will be assigned to a ship, as he is in constant contact with the various shipping organizations. The dispatcher at the various offices of the unions will be found to be an efficient, well versed fellow, an old time operator himself who "knows the ropes" and will be able to assist the new man materially.

"We'll pound on the pans when we come to the part we don't want you to hear!"

PLANS were recently completed to facilitate the resumption of normal news services of merchant shipping in the Atlantic and Gulf areas, it was announced by Robert W. Horton, public relations director of WSA. . . . The new regulations will permit relaxed censorship rules and publication of time schedules regarding arrival and departure of ships in these areas. Censorship restrictions still are in effect regarding troop ship movements, merchant ships bound for restricted areas, and secret installations aboard ships.

ADMIRAL R. R. WAESCHE, Commandant of the Coast Guard, addressed the annual meeting of the Maritime Law Association in New York a short time ago. This was the first public appearance of the Commandant since his promotion to the rank of full Admiral, the first officer ever to hold such rank in the Coast Guard. The Admiral stated, "It is now 16 years since the last International Safety Conference was held and, in the meantime, notable advances have been made in the scientific fields effecting safe navigation. The present war, with its emphasis on elec-

(Continued on page 142)

GENERATING R. F. at 600 mc.

By
WILLIAM MARON

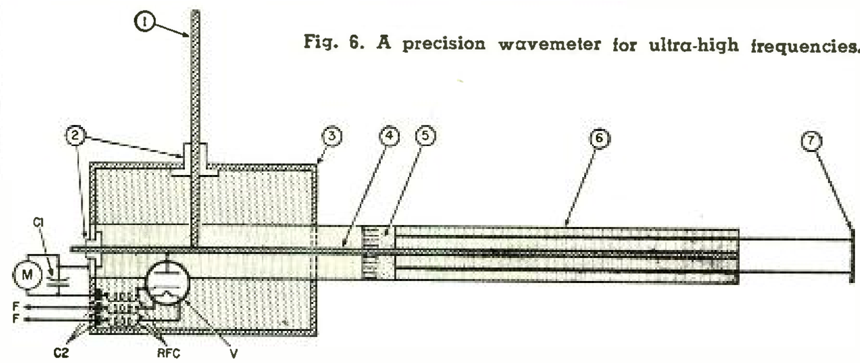


Fig. 6. A precision wavemeter for ultra-high frequencies.

C_1—100 μμfd. ceramic cond.
C_2—Cond. (see text).
F—Fil. connections (see text).
M—Low range microammeter
V—955 or 958 tube connected as diode or special u.h.f. diode
RFC—Radio freq. choke, No. 18 bare wire, 6-8 turns, 1/8" diam., spaced wire diameter.

1—Antenna
2—Polystyrene plugs
3—Housing, brass pipe 3" diam. (approx.) with brass end plates. Silver plated, if possible.
4—Inner conductor of co-axial tank.
5—Piston, adjusted by means of handle (7)
6—Outer conductor of co-axial tank
7—Handle for adjusting freq.

The design of several u.h.f. oscillators, operating in the vicinity of 600 mc. The u.h.f. region will become a must for many future radio services.

SINCE the beginning of the war, and even for some time prior, there has been an increasing migration to the high- and ultra-high-frequency regions.

Present day discussions, technical improvements, FCC allocation hearings, design reasons, and the like, indicate that the ultra-high-frequency regions are becoming a *must* for future radio services.

Although there are many text books written on the subject, most of these books give only a theoretical approach; the practical end has to be worked out for the individual application.

The following will discuss three oscillator circuits and mechanical layout, two different types of r.f. detecting equipment, and an interesting u.h.f. by-pass condenser, all designed for operation at 600 megacycles.

Why 600 megacycles? Simply because 600 mc. is the *optimum* high frequency limit of the acorn tube . . . and the acorn tube is the simplest tube to use in becoming familiar with u.h.f.

It may be well to first look at the by-pass condenser which is used in every circuit to be discussed and will, undoubtedly, find numerous other applications.

It must be borne in mind that it is *only* a by-pass condenser. The prime requisite in by-pass condensers for u.h.f. is that the leads be short *(non-existent leads would be better)* and large in diameter to keep the inductance down to a minimum.

Fig. 2 shows the construction of a novel by-pass condenser. It can be placed at the exact point where by-passing is required. A hole, the size being just large enough to admit the *shoulder* of a shoulder washer, is drilled in the chassis. Then the condenser is speedily assembled from the material indicated and in the manner shown in the drawing. The average capacity is about 25 μμfd. This is sufficient for 600 megacycles.

As a coupling condenser its use is contraindicated as the power factor is poor, using fiber shoulder washers and, furthermore, the type of construction does not lend itself well to coupling applications, as the chassis is used for the negative or ground plate.

Now coming back, Fig. 5A is a circuit for a simple 600 mc. oscillator. From a schematic point of view the circuit is self-explanatory. Actual construction is made on a piece of sheet brass or aluminum two inches wide and eight inches long, bent into a flat-bottomed "U." The parallel sides of the "U" are three inches long, making the bottom two inches. The "U" is used inverted and the acorn socket is mounted on the top, in the center; the tank extending vertically below, that is, into the "U."

Disc *(D)* is of brass, 1" in diameter, and is fastened to an 8-32 bolt an inch or an inch and a half long by soldering or clamping between two nuts. A guide for the bolt may be provided by soldering an 8-32 nut to the side of the "U" or by tapping an 8-32 hole.

The positioning of the disc should be so that it is parallel to the tank and overlaps equidistant on either side.

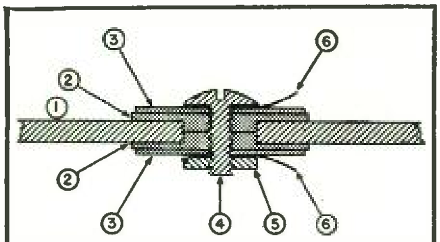
Coarse frequency adjustments are made by sliding *C* up and down the parallel-line tank; the disc enables the frequency to be adjusted gradually, giving a vernier effect. A lock-nut on the bolt should be provided for locking the disc, once the desired frequency is reached.

As sliding *C* and rotating *D* is a rather crude method for adjusting frequency, and in certain applications (as a local oscillator for a superheterodyne receiver) would be very difficult to work with, a modification shown in Fig. 5B is worked out.

The circuit is similar to Fig. 5A, but the disc has been eliminated and a variable condenser substituted for the fixed condenser *C* (Fig. 5A). Using the condenser mentioned in Fig. 5B, the frequency can be varied from 585 mc. to 670 mc. with practically linear power output throughout the range.

This oscillator was constructed in a small metal box 3" x 4" x 5". The tuning condenser is *firmly* mounted on four brass rods, the rods in turn are bolted or soldered to the bottom of the box. A metal subchassis is mounted above the condenser at the right height above the condenser to allow the tank to reach from the condenser to the tube socket.

All low frequency a.c. and d.c. wiring is kept above the subchassis; the RF is confined to the lower two-thirds of the box. A vernier dial mounted on the front, connected to the condenser shaft with an insulated (ceramic) coupling, completes the oscillator.



1—Chassis
2—Insulated shoulder washer
3—Brass washer
4—Brass bolt No. 6-32
5—Brass nut No. 6-32
6—Solder lug

Fig. 2. A novel by-pass condensor. It can be cut into the chassis at any desired position permitting short connections.

Parenthetically speaking, it is interesting to point out by using batteries on both plate and filament this oscillator has a note comparable to *crystal control.* Although there was a gradual frequency drift, it was caused by thermal changes; when the oscillator was placed in a constant temperature oven, the frequency remained absolutely steady. The only remaining frequency drift was caused by the batteries wearing down.

Fig. 3 illustrates a push-pull circuit. This circuit will be useful where a balanced output is needed or when necessary to obtain a little extra power over a single tube oscillator.

It was built into a metal box of the dimensions given for Fig. 5B. A metal subchassis is used to support the sockets, by-pass condensers, filament chokes, etc. Tanks *L*, L_1 are made of number 12 wire. Tubing would be better, but is very difficult to bend into the required shape without crushing.

Each side of each tank is one inch long from tube socket to the curved portion. Shorting bars may be used to change the frequency. However, it is best to prune the tanks until the required frequency is secured and left there.

A few words of caution about this particular circuit. The sockets, as already mentioned, are mounted on a metal subchassis with grid and plate of one socket facing grid and plate of the other. Unfortunately, with acorn sockets this arrangement places the grid of one socket facing the plate of the other and vice versa. The difficulty is overcome by putting one of the tubes in its socket *upside-down.* When this is done precaution should be exercised, when replacing tubes or whenever the tubes are removed from the sockets for any other reason, to put the upside-down tube in the socket wired for operation in this fashion. Putting the tube in right-side-up or into the wrong socket upside-down will result in applying high voltage to the grid, with consequent tube failure.

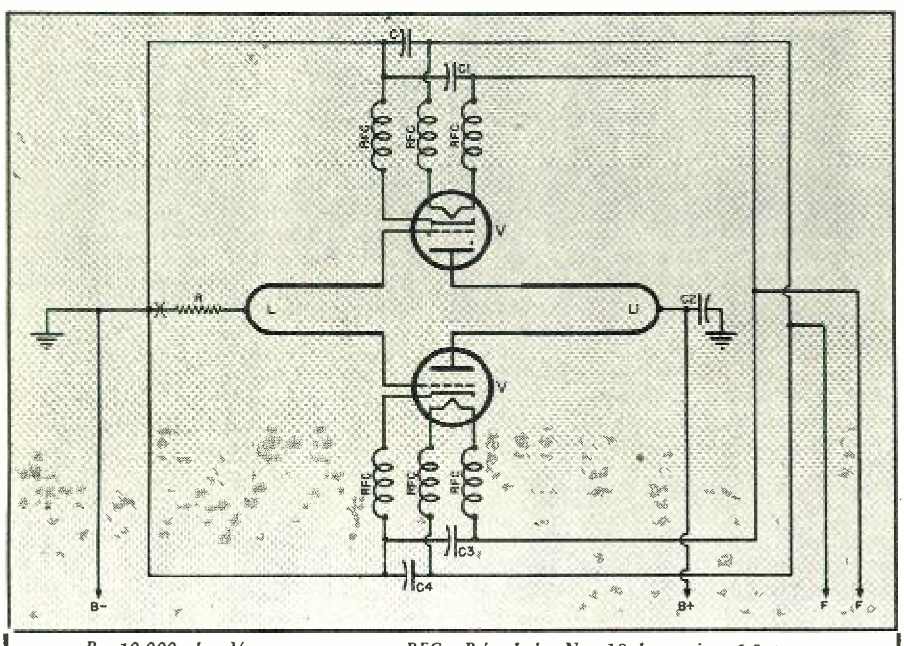
Oscillator Circuits Summary

The tube(s) used in any of the circuits (Figs. 3 and 5) may be a 955 or a 958. The 958 is extremely useful for portable operation as the filament requirement is only 1.25 volts d.c., *and can be operated without series resistance directly from a single flashlight dry cell!*

There may be a temptation to use a 9002 tube as it is physically easier to handle. Experiments have proved that its performance is inferior to the acorn and its construction does not lend itself to proper layout.

The plate voltage should be kept below 200 volts and the plate current limited to 10 ma. for the 955; 6 to 7 ma. for the 958.

Fig. 3. Diagram of a 600 mc. oscillator similar to that shown in Fig. 5 with the exception that it is push-pull in operation, thereby having greater output power.



R—10,000 ohm ½ w. res.
C, C_1, C_2, C_3, C_4—See text.
L, L_1—See text.
X—See text.
RFC—R.f. choke No. 18 bare wire, 6-8 turns, ⅛" diam. spaced wire diam.
V—955 or 958 tubes

Tube sockets used are *Hammarlund.* Other makes will do; however, the construction of *Hammarlund* sockets fits them into the mechanical layout as if they had been especially made to specification.

The spacing between the plate and grid lines is the space on the socket at the *point* where the plate and grid terminals are riveted to the ceramic.

The tuning condenser in Fig. 5B *must* be a Bud Tiny-Mite for the circuit to function properly. The only allowable change is the capacity of this condenser. Different capacities will only affect the total coverage (Δf).

The best way to take power from any of the oscillators is by means of a low impedance pick-up loop. Proper orientation will have to be found by trial and error.

Point *X* marked on Figs. 3 and 5 may be broken and an 0-1 d.c. milliammeter inserted for checking oscillation, loading, and other phases of operation. A plate current meter can also be used, but experience has shown the grid current to be a more useful indication.

Although the turns for the filament and cathode chokes are given, it is advisable to experiment somewhat with the number of turns. The turns giving the highest d.c. grid current should be used.

The circuit in Fig. 5B will find the greatest utility, especially when completely battery operated. Fig. 5A is useful as an initial encounter with u.h.f., while Fig. 3 is, generally speaking, good for specific applications only.

Having an oscillator operating in the u.h.f. spectrum there are two important factors to consider—strength of radiation and field pattern of the antenna, and the frequency of the emitted signal.

Fig. 4A illustrates a simple field strength meter, suitable for measuring radiation from an antenna up to a distance of 100 feet (with an acorn tube!). It is also useful for exploring antenna patterns, adjusting the antenna to proper dimensions, and for conducting other useful measurements.

The instrument consists of a fixed crystal detector, as a rectifier, connected to a low range microammeter. The lower the meter range, the more sensitive will the device be.

L, L (Fig. 4A), are quarter-wave dipoles. An adjustable sliding member made of a short piece of wire just large enough to fit snugly into the ends of the tubing, comprising the antenna, is used to adjust the antenna to the oscillator frequency. The switch is included merely to short-circuit the microammeter. Should the instrument be placed absentmindedly near the oscillator and then the oscillator turned on, the meter would be seriously damaged or burned out. The switch should always be closed unless the instrument is actually being used.

Fig. 4B shows a practical way to construct the field strength meter. A small metal meter case is used for housing the microammeter, switch, chokes, and by-pass condenser. As most meter cases are furnished with open backs, fitting a metal back is highly advisable.

The crystal may be mounted on top (as shown) or put inside and the antenna brought in through *high grade* feed-thru insulators. Maximum signal strength is indicated when the antenna is parallel to the transmitting antenna.

Incidentally, a half wave antenna for 600 megacycles is only 25 centimeters or about 10 inches.

Fig. 1 is a precision wavemeter for ultra-high frequencies; the *upper* frequency range is limited only by the resonant frequency of the diode used.

The construction of (6), (4), and (5) (refer to Fig. 1), comprising the co-axial tank, should only be undertaken in a well equipped machine shop and by a skillful machinist. The preciseness of the co-axial tank will determine the accuracy of frequency measurements, the retrace accuracy and last, but not least, the sensitivity.

To illustrate the last point (sensitivity) it will be noticed that the piston, (5), is equivalent to the shorting bar in Lecher wires. If it does not make *good* contact with both the inner and outer conductors there will be a loss in the voltage applied to the diode and a consequent loss in sensitivity.

Furthermore, if the entire construction is not mechanically rigid it will not be possible to use the wavemeter for determining unknown frequencies, as the calibration will be unreliable.

The actual construction is indicated in Fig. 1, although specific dimensions and detailed construction information are not included. However, several points that should be watched will be pointed out.

The tube should *not* be mounted in a socket and, as manufacturers do not recommend soldering to the pins of acorn tubes, the best and easiest solution is to remove the terminals from an acorn socket and to solder these terminals at appropriate points to hold the tube in place. Even the terminals should not be used full size as they are taken from an acorn socket, but cut down as much as possible.

The entire housing, especially the inner and outer conductor and the piston, requires silver plating for best results. The silver plating should be put on slowly in order to achieve a smooth, satiny finish.

The piston is slotted half way in, around the entire circumference, to aid in making good contact and still allow freedom of movement.

The antenna (1) is only a few inches long, just sufficient to pick up enough signal to get an indication of the meter. The piston is adjusted for maximum meter deflection.

A meter above 200 microamperes will be found almost useless.

It should be remembered that the further *in* the piston is put, the higher the frequency. Consequently, the tank should be made sufficiently long to accommodate the *lowest* frequency to be measured, without becoming unwieldy.

Another important consideration in making the co-axial tank is its diameter. While the diameter of the outside conductor may be chosen at random or for convenience the best *Q* results *when the radius of the outer conductor is 3.6 times as large as that of the inner conductor,* although this value is not very critical.

A 955 or 958 tube, connected as a diode, may be used with equal results. The use of a 958 will make the wavemeter complete in itself as a small penlight battery can be put in the housing to light the filament. Superior operation will be realized by the use of a special u.h.f. diode, 9004, also acorn construction.

Calibrating the wavemeter can best be done by using an ultra-high-frequency signal generator. Several manufacturers have made signal generators having a range well above 1000 mc.

In using a signal generator for calibration purpose it should be allowed to thoroughly warm up for at least two hours.

The wavemeter should be coupled as loosely as possible to the signal generator with adequate meter deflection. The handle is then pulled or pushed until the meter indicates that resonance with the signal from the generator has been established. It is advisable to start with the lowest frequency (handle pulled out) and work upward.

Although not shown in Fig. 1, a scale attached to the handle and going into the inner conductor can be provided for, directly upon which the frequency of each position is marked.

Several other methods will come to mind. In actually using this type wavemeter the calibration was merely made by measuring the distance from the handle to the beginning of the outer conductor and referring to a calibration chart, which had been prepared using the method already outlined.

Using one of the several oscillators mentioned, the field strength meter and the wavemeter, first hand information about ultra-high frequency can be secured and the experience will be found of value in the not too distant future.

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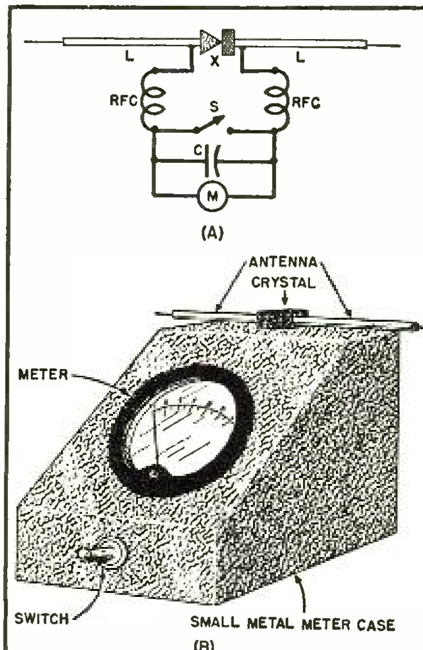
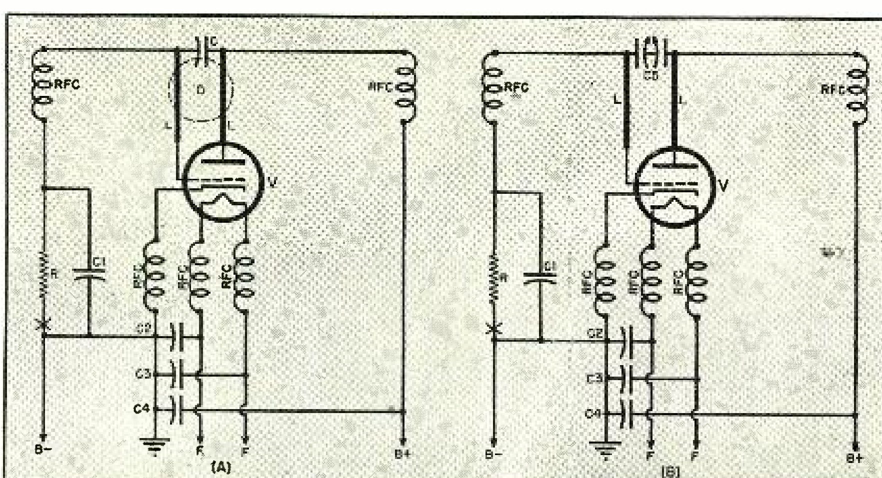


C—100-$\mu\mu$fd. ceramic cond.
S—S.p.s.t. sw.
M—Low range microammeter
X—Crystal
L—1/8" tubing, 1/4 wave length ea. (see text).
RFC—R.f. choke No. 18 bare wire, 6-8 turns, 1/8" diam., spaced wire diam.

Fig. 4. An efficient field strength meter. This instrument employs a fixed crystal detector as a rectifier connected to a low range microammeter.

Fig. 5. (A) Circuit diagram for a simple 600 mc. oscillator. By adjusting the position of disc "D" the frequency of the oscillator can be adjusted. (B) Circuit similar to that shown in "A" with the exception of a variable dual midget condensor C5 being used to adjust the frequency in place of condensor "C" and disc "D."



R—20,000 ohm 1/2 w. res.
C—100-$\mu\mu$fd. ceramic cond.
C_1, C_2, C_3, C_4—See text.
C_5—100-$\mu\mu$fd. per section—Bud Tiny-Mite
RFC—R.f. choke, No. 18 bare wire, 6-8 turns, 1/8" diam., spaced wire diam.
D—Disc. 1" diam. (see text).
L—1/8" tubing, 1" long ea.
X—See text.
V—955 or 958 tube.

SAGA OF THE VACUUM TUBE

By GERALD F. J. TYNE
Research Engineer, N. Y.

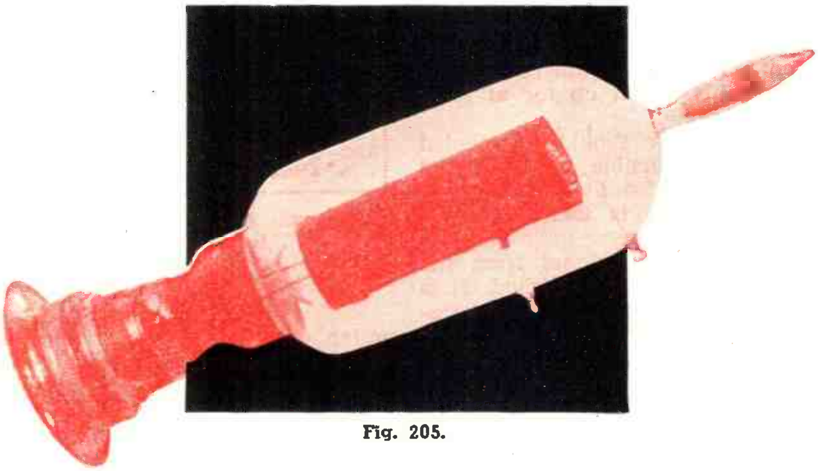


Fig. 205.

Part 19. Covering developments and applications of tubes in England from 1911 through World War I.

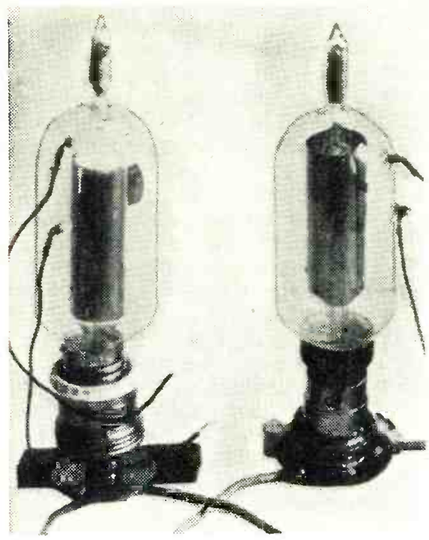


Fig. 206.

WE HAVE considered the evolution of the vacuum tube as a telephone repeater element in Great Britain. The early telephone repeater tubes engineered in Britain apparently were adapted from the radio art and were not developed primarily for telephone use. The early British radio tubes were of the gaseous type and seem to have been inspired largely by the work of von Lieben and Reisz in Germany. True, Fleming had obtained a sample of the de Forest Audion as early as 1907, but we have no records showing that he or any one else in Britain was activated by it immediately.

The first work in tube development in England seems to have been done about 1911 by Captain H. J. Round of the British Marconi Company. It appears to have been done in collaboration with Telefunken, probably as a result of the recently concluded Tele-

Fig. 207.

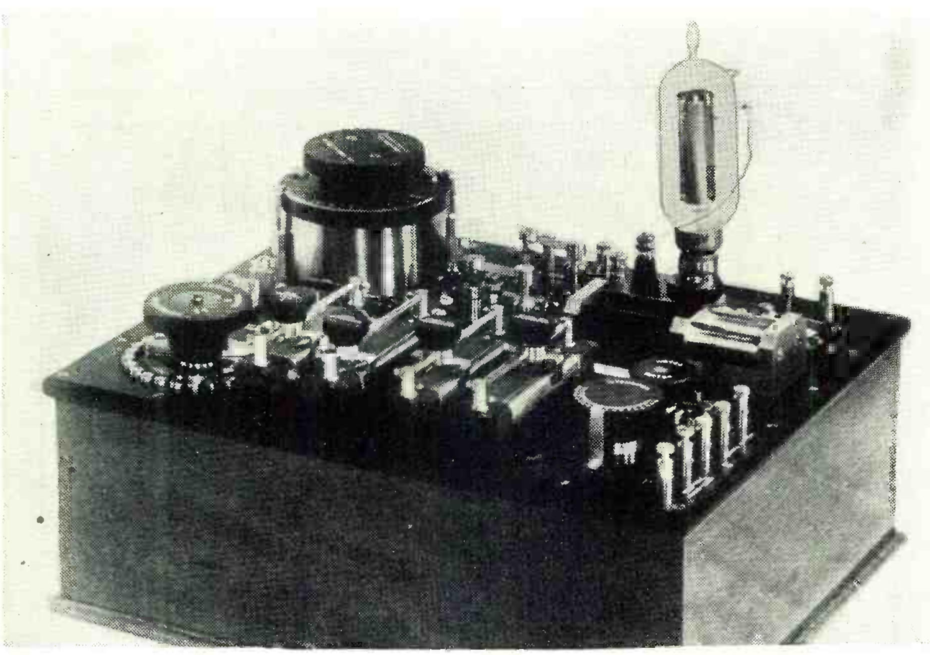
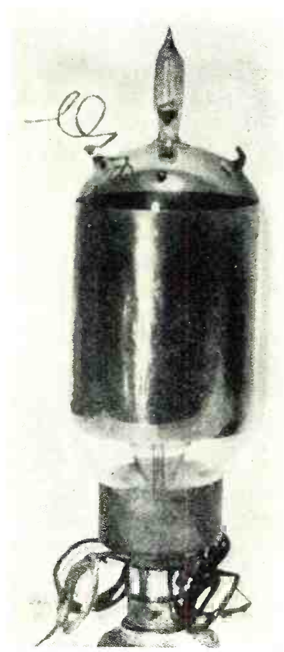


Fig. 208.



funken-Marconi patent agreement. Little has been published concerning Round's early work, hence it is difficult to trace with any degree of authority the evolution of the Round tube. Round speaks intimately of the work of Alexander Meissner of the Telefunken Company in an article on wireless telephone published in 1915,[283] but the article deals chiefly with circuits and applications, and no mention is made of the Round version of the LRS Relay.

The Round tubes differed from the Meissner version of the LRS Relay chiefly in details of design.[284] They were first employed by Round as high-frequency amplifiers, and later as oscillators as well. They were remarkably good amplifiers when operated under optimum conditions. The gain obtainable from the Round type "C" was equivalent to approximately three stages of the best "hard" tube of that time, the so-called "French" tube.[285] The Round type "C" is shown in Fig. 205.

The Round tubes were characterized by coated cathodes, wire mesh grids forming a practically complete enclosure for the filament, a long tubulation containing means for adjusting the vacuum, and cylindrical anodes with a large ratio of anode-filament to grid-filament distance. The filaments were usually of hair-pin shape, with the hottest part at the top. Round considered it necessary for stability of operation that the grid completely enclose the filament. If this were not done the inside of the glass bulb would become charged by bombardment from the filament. If the charge, so accumulated, produced an appreciable electrostatic field at the filament, it would be necessary to readjust the grid potentiometer to compensate. Hence, unless a completely enclosing grid were used this rather critical parameter would require frequent readjustment, an undesirable operating limitation.[286]

There were several types of Round tubes, of which the type "N" and type "T," the latter first produced in 1913,[287] may be taken as representative. Fig. 206 shows two versions of the type "N" and Fig. 207 shows the Marconi Type 27 Receiver with one of these tubes in use as a high-frequency amplifier. The Round type "T" is shown in Fig. 208. Fig. 209 is a view looking down on the type "T" (with the tubulation removed) and shows the internal construction.

The type "N" had a single lime-coated filament which took 3 to 4 amperes at 2 to 2.5 volts. It operated with 40 to 80 volts on the anode, and was used in the famous Marconi No. 16 Circuit, which used a carborundum detector. The tube functioned in this circuit as an r.f. and a.f. amplifier, the circuit being of the reflex type. A variant of the type "N" was the type "CA" shown in Fig. 210, which had an extremely fine mesh grid and operated with filament current of 2.5 amperes and anode voltages up to 200 volts.[288]

The type "T" also had two variants, one with coarse and one with fine mesh grid. One of these was known as the type "TN" and operated at 200 volts on the anode. There were three separate filaments, of the oxide-coated type, which were used in succession. The filament current was 4 to 4.5 amperes at about 6 volts. The type "TN" was used in the "Short Distance Wireless Telephone Transmitter and Receiver" made in 1914 by the British Marconi Company,[289] and shown in Fig. 211. It, like the other Round tubes, was manufactured by the Edison & Swan Electric Company.

The first actual use of the three-electrode tube in the British armed services was by Round, in December 1914, in a Marconi Direction Finder.[290] Many of the Round tubes were used by the Royal Flying Corps (later the Royal Air Force) in the earlier wireless sets for plane-to-ground communication during World War I. Discussing their use shortly after the War, one of the R.A.F. officers said:[291]

"The soft valves used in the early days were provided with a regulating device in the form of a pip containing a crystal of asbestos or other mineral. This when heated reduced the vacuum in the valve. It was the custom to heat the pip before a flight took place but it often happened that when in the air one found that the valve had become too hard to oscillate. In order to overcome the danger of applying a naked flame, a small electric heater was devised which could be placed over the regulating pip."

The Round tubes were used to a considerable extent because of their high gain and power handling capabilities in British communications equipment during the war. They were difficult to manufacture and required highly trained operators to utilize their capabilities. Concerning their

Fig. 209.

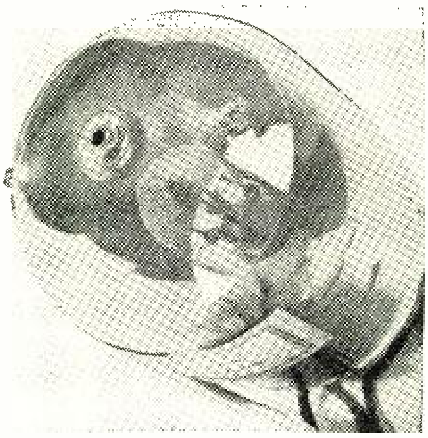


Fig. 210.

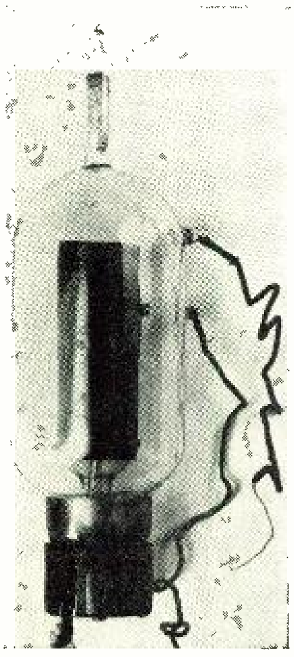
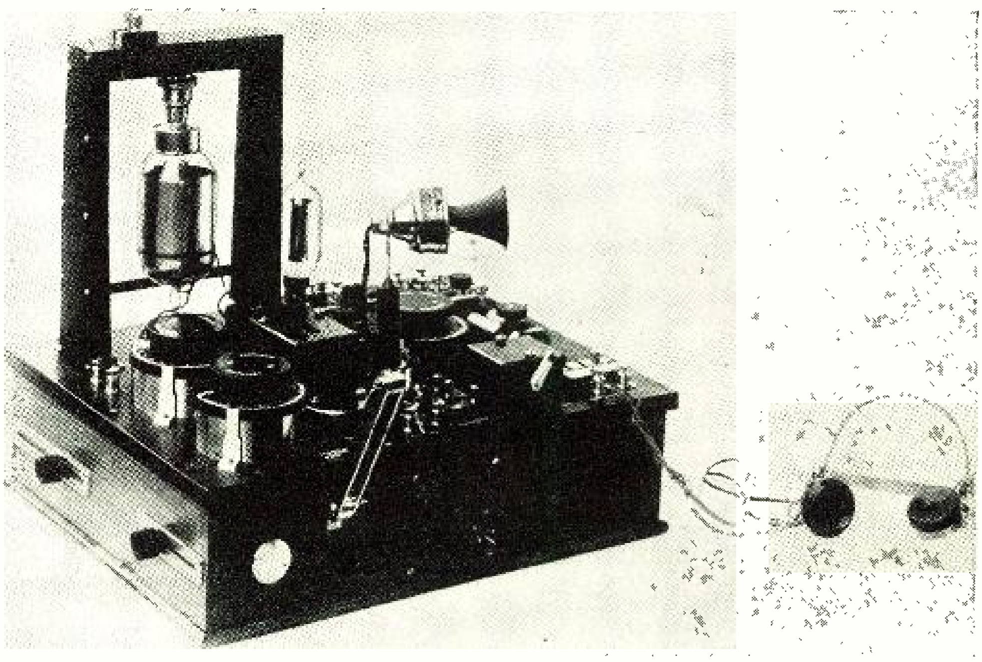


Fig. 211.



manufacture, Round once wrote:[292]

"I have mentioned that the production of valves at that time required special men. Even then it was a terrible process. Again and again we lost the knack of making good tubes owing to some slight change in the materials used in their manufacture. A thorough investigation was impossible, as all hands were out on the stations. On several occasions we were down to our last dozen tubes."

Another soft tube, used to a limited extent by the British armed services during World War I, was called the "White" valve. It resulted from work done at the Cavendish Laboratory, Cambridge, under the direction of Sir J. J. Thomson. The earlier experiments were by Wright and Ogden, but the later developments were by G. W. White, whence the designation.[293]

White worked for some time on the use of cold-cathode tubes and succeeded in making some which operated satisfactorily in wireless work.[294] These tubes were not as sensitive as those of the hot-cathode type although they did possess some advantages. No filament heating battery was required, and their action was not sensitive to small changes in the internal pressure.

Probably because of the increased sensitivity obtainable, White eventually abandoned the cold cathode and went to an incandescent cathode construction. A White tube of the type which came into practical use in 1916 is shown in Fig. 212. The filament is of oxide-coated platinum, operating with 2.8 amperes at 6 volts. The grid is a disc of perforated copper and the anode is of iron amalgamated with mercury. It operated at anode potentials from 25 to 75 volts. The base is of the bayonet type and the grid connection is made through the base shell. The anode connection is made to the knurled nut at the top of the tube. This tube was used in the Mark III Amplifier, which was designed by the British Signals Experimental Establishment for field use, and was first manufactured in 1917.[295] Two tubes were used in this amplifier, the second being a de Forest Audion. The amplifier, which is shown in Fig. 213, was of the high frequency type using regeneration, and was intended for use in connection with the Mark III Short Wave Tuner.

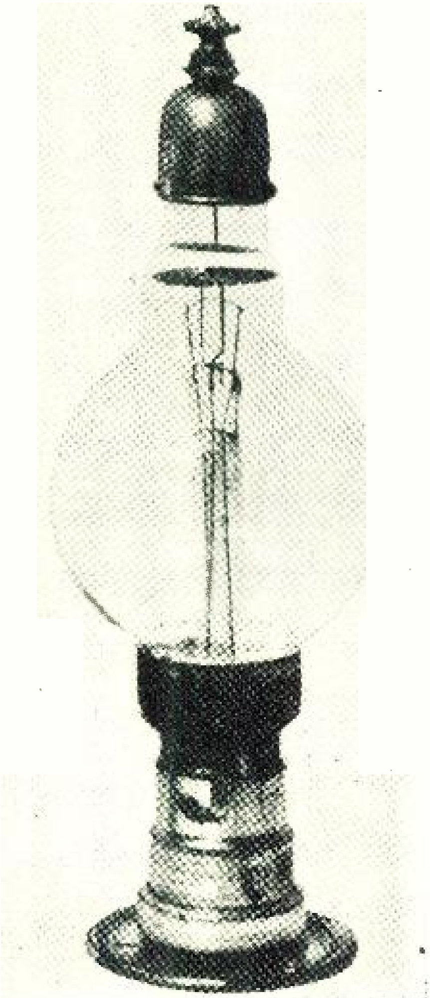


Fig. 212.

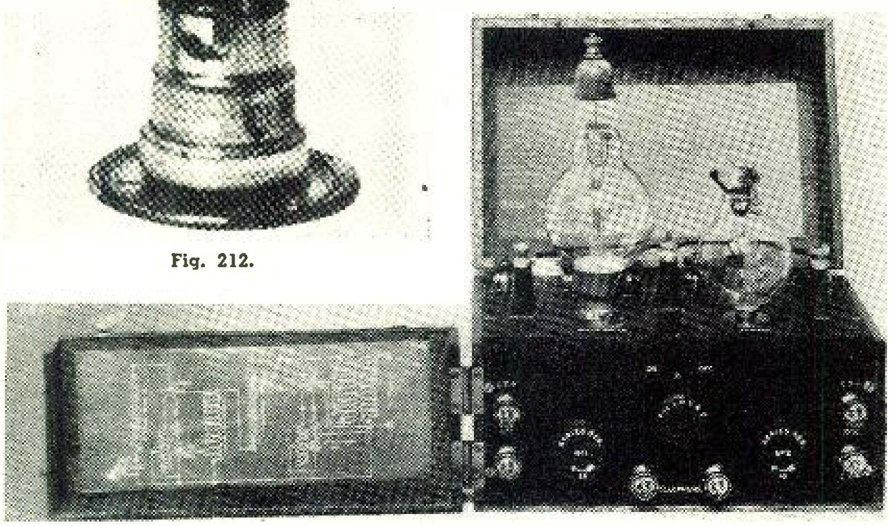


Fig. 213.

It will be observed that, measured by present day standards, the soft tubes made by Round and White were of comparatively large physical size, as was the original LRS Relay. This was necessary in the interest of stability of operation. Any attempt to reduce the volume of the tube meant an increase in the ratio of electrode area to the volume of the gas present, so that the variations in electrode temperature had a greater effect on the residual gas. The smaller the gas volume, the more erratic was the tube.[296]

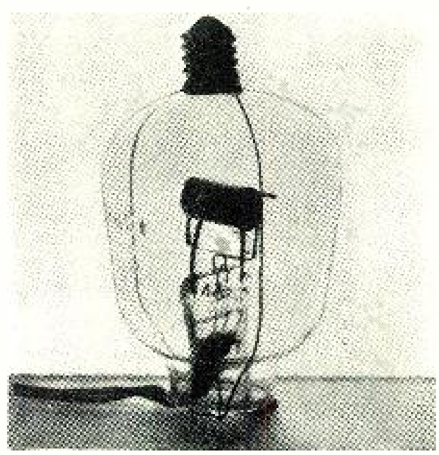
It was appreciated, even as these developments were carried out, that the high vacuum tube had great advantages in military work, because of the stability of its characteristics and the uniformity of the manufactured product. Yet the soft tube possessed such a high sensitivity that much development effort was expended in an attempt to make of it a stable, reliable device, which could be applied in military work, where the skill of the operator could not be guaranteed.

The manufacture of soft tubes was undertaken by the British Thomson-Houston Company at Rugby during the summer of 1916 and the first production was of the Audion type, but with much better life expectancy. Serious difficulties were experienced early in 1917, and as a result of investigation the Audion structure was abandoned and a soft tube similar in construction to the hard "R" tube was developed. This tube was known as the "R2 valve" and at first was nitrogen filled to a pressure of 0.06 mm. mercury. The pressure was measured during manufacture by measuring the width of the dark space in an auxiliary cold cathode tube. After development the specifications on this tube were released to several manufacturers, and the first quantity production was achieved by the Osram-Robertson Works of the General Electric Company, Ltd., in June of 1917.

Difficulties were encountered in maintaining the gas pressure, because of the absorption of nitrogen by the electrodes. Later R2 tubes were helium-filled to a higher pressure, about 0.6 mm. mercury. The manufacture of the helium-filled R2 was begun in September 1917.

The filament of the R2 tube was of drawn tungsten wire. It was 0.79 inch long and 3.3 mils in diameter. It operated at 1.1 amperes with a potential drop of about 3.3 volts. The anode was of sheet nickel, bent into the form of a complete cylinder, approximately 0.6 inch long and 0.35 inch in diameter. The grid was a helix of molybdenum wire of 16 mils diameter, wound with a pitch of 14 turns per inch, and the internal diameter of the helix was about 0.18 inch. The anode operated at 24 to 40 volts, and the grid bias was

Fig. 214.



adjusted by means of a potentiometer to the optimum operating value while in use. An R2 tube is shown in Fig. 214. This tube was made by General Electric (Osram), British Thomson-Houston, and Edison & Swan.

A modification of this tube, known as the R2A, manufactured chiefly by Marconi-Osram, was used in the British naval installations during the last years of World War I. It marked the final development of the soft tube in England. It operated under the same conditions as the R2 except that it had a somewhat narrower range of anode voltage, 28 to 38 volts.

Another soft tube used to a limited extent for aircraft work was known as the "Air Force Type D," and will be touched upon in a later installment.

Before leaving the consideration of soft tubes of British origin, mention should be made of one other. This is the so-called "NPL" valve, described by Stanley in 1919, in the following words:

"In this valve the plate was a thin sheet of circular metal; above this was the grid consisting of a perforated sheet of metal, beyond which was the bowed tungsten filament. This was a bad design; the grid was too heavy and the flow of electrons from the filament was not uniform along its length but was concentrated at the center. The design is now out of date.—"

Apparently this was a soft tube, since the characteristics given by Stanley show kinks ascribed by him to the presence of mercury vapor, and he records the presence of an amalgam of mercury on the anode. The author has never seen any mention of this tube except that referred to above. It may be possible the "NPL" was another designation for the White valve previously described. If the reader compares the description given by Stanley with the White valve shown in Fig. 212, he will see that if the White valve be mounted with its base uppermost Stanley's description reads rather well on it.

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(Continued on page 124)

Why RCA Metal Tubes Give You a Chance to Get the Largest Share of a Backlog Market for 60,000,000 Renewal Tubes

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- ★ *Easier servicing.*

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TECHNICAL BOOK & BULLETIN REVIEW

"TELEVISION PROGRAMMING and PRODUCTION" by Richard Hubbell. Published by *Murray Hill Books, Inc.*, New York. 203 pages. Price $3.00.

Since television promises to become one of the outstanding entertainment and educational media in our times, an authoritative book on the techniques of programming a television program was indicated.

Mr. Hubbell, who was one of the pioneers in the programming and production of television during the CBS experimental period, has prepared this book as a handbook for those charged with the responsibility of producing video shows. Mr. Hubbell has pointed out in the early chapters of his book that television must be considered as a new form of art rather than a rehash of audio radio, movies, or the theater.

Parts of the book are of genuine interest to the lay public as they present an over-all picture of the industry in its present state; however, there are several sections which are handbook material for cameramen, lighting engineers, and studio technicians. This material makes interesting reading for the laymen if only to furnish a working vocabulary of the television jargon, but its real value would be to the man behind the camera, the producer, and the man on the catwalk. For these technicians of video, this book should be a truly valuable source of tested techniques.

"SCIENCE TODAY and TOMORROW" by Waldemar Kaempffert. Published by *The Viking Press*, New York. 273 pages. Price $2.75.

This book is sheer fun. It is not intended to be an all-inclusive treatise on the subject of science nor has it any pretentions of being anything but a survey of what has been done in the scientific field and a prediction of some of the future marvels of science.

The material contained in the book is technically sound, but Mr. Kaempffert has managed to present his story in such an interesting manner, that the book is as enjoyable as a novel.

The author has contributed articles on science to many of the popular periodicals and the style which stood him in good stead in the Reader's Digest, the American Magazine, etc. has been carried over to advantage in this book.

He has treated a wide variety of related and unrelated material from medicine to astronomy, from rocket transportation to electronics. Because of the different types of scientific endeavor covered in this book, this text should provide a point of departure for students, businessmen, and others who would like their smattering of science in an easy-to-digest form.

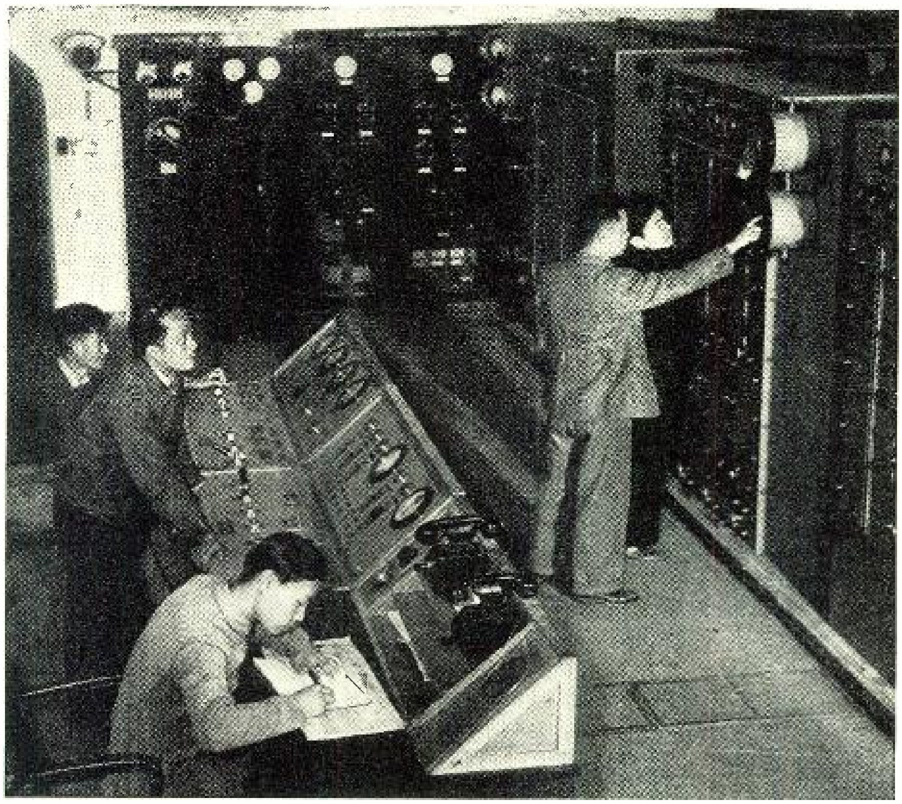
—30—

CHINA Looks Ahead in Radio

Revolutionary developments in radiocommunications and broadcasting that are planned for one of the world's most undeveloped areas—China.

By

DOROTHY HOLLOWAY



Radio station XGOY, 35,000 watter located near Chungking. Here, deeply imbedded in a rock cave, this vital communications equipment is safe from enemy bombing.

CHINA is looking forward to a "New Deal" in radio after the war. For, if present plans of Generalissimo Chiang Kai-Shek and his Nationalist Government are realized, we can look for a revolutionary development of both radiocommunications and broadcasting in China in the next ten years.

According to Dr. Penn Tsing-Yeh, Deputy Director of China's Central Broadcasting Administration, now in this country on a year's mission to study the American radio industry, "It is true China today is only in the Stone Age of radio. It is at least 25 years behind Western nations. But the Kuomintang, with the assistance of your government, is already moving ahead on a program to bridge that gap within 10 years of the peace."

What are these plans? Within ten years of final Jap defeat, New China plans to have 500 broadcast stations on the air, 18 million receiving sets in Chinese homes and an up-to-date network of long-distance radiophone and radiotelegraph circuits tying together its four million square mile area.

In terms of a look at China "before and after," the goals of Chiang Kai-Shek and of his close friend, Lieutenant General Yu Fei-Peng, Minister of Communications, are nothing short of startling.

As a start on its rehabilitation program, China estimates it will require some 77 million dollars worth of American import equipment in the first 18 months after the war. In September 1944, the Ministry of Communications sought from UNNRA a 39 million dollar allotment—half of its requirement—to be used principally in building a long-distance communications network, both radio and wireline, covering the inland provinces.

According to Dr. Penn, "Since 1939, Lend-Lease equipment, U.S. Army Signal Corps activity in China, and the needs of our own military forces have considerably strengthened the radiocommunications set-up in Unoccupied China. But we still have a long way to go. What is more important, a completely new start will have to be made in the occupied areas and other cities bombed out by the Japs."

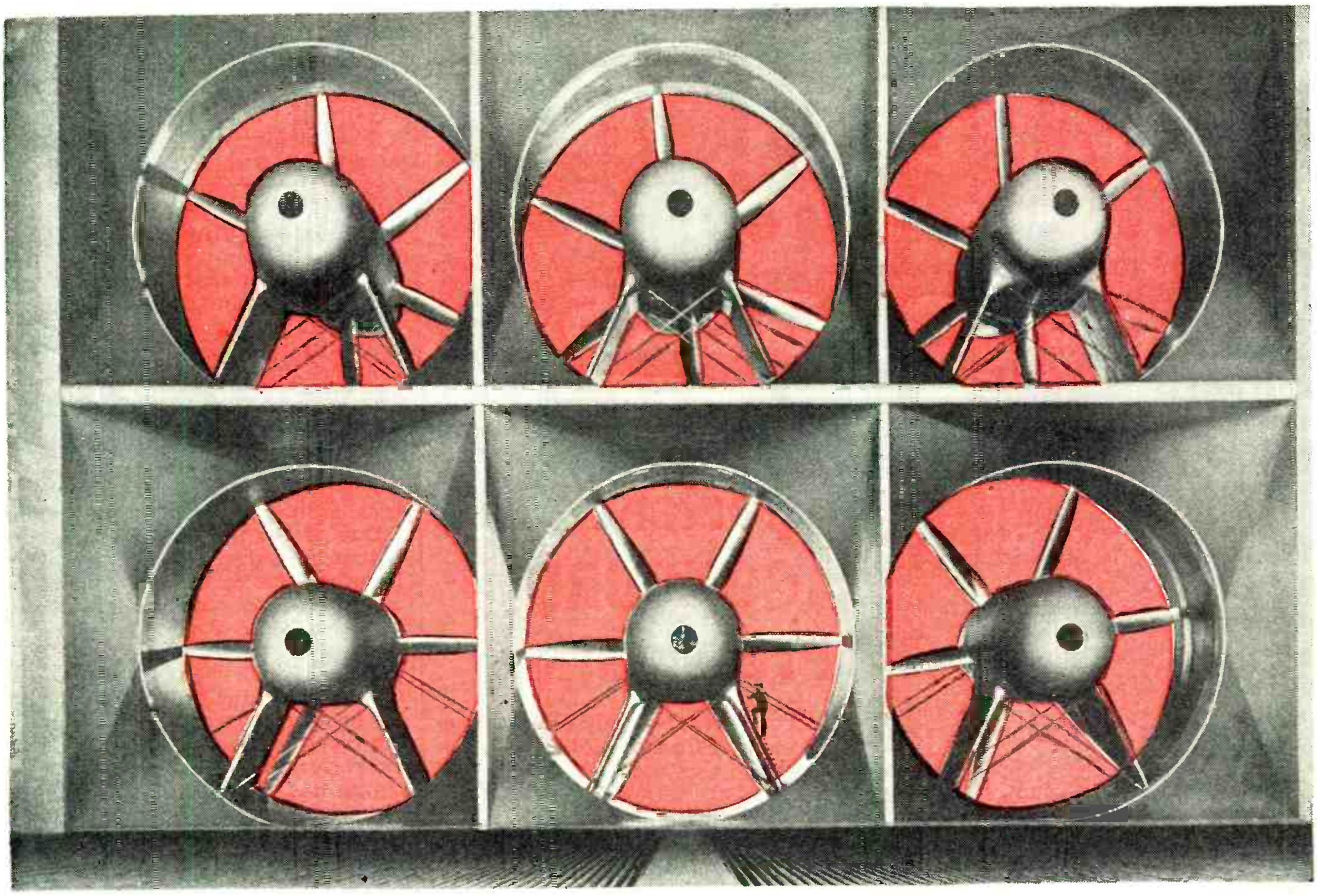
At the same time, the outbreak of the Sino-Japanese war in 1937 and the fall of Shanghai in 1938 completely routed commercial broadcasting in China. Now, a mere handful of government transmitters are working day and night to keep the 460 million Chinese up-to-date on the progress of the war.

"In broadcasting," Penn says, "China will not have much remodeling to do. She will be building a new structure from the ground up."

To get the technical know-how for this tremendous rehabilitation program, the Nationalist Government plans to send several hundred Chinese technicians to the United States for intensive training and at the same time to call on American engineering talent to lend a hand in Chinese industry.

One such training program, sponsored jointly by the Chinese government and our Foreign Economic Administration, will bring 1,200 Chinese technicians to this country for a year's apprenticeship in American factories and war industries.

Between 60 and 70 radio and communications engineers of all kinds—the first of a series of such groups—will arrive in the United States within the next month for training. All of them are graduates of Chinese engineering colleges with at least two-years' fulltime employment in Chinese war industry. The International Training Administration, a private organization in Washington, D.C., has arranged for their placement in the *Bell Laboratories, RCA, Westinghouse, General Electric* and several



how to tame 36,000 horsepower

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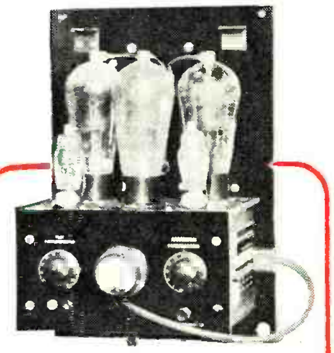
By making a complete study of the system, Westinghouse engineers were able to determine the proper regulator system to do the job. It turned out to be the small, compact electronic regulator shown at the right. By responding to minute changes in speed, it automatically makes the necessary adjustments—compensating for any fluctuations in power supply or changes in load. Thus, through the delicate sensitivity of electronic tubes, it is possible to tame 36,000 hp.

Accurate speed and voltage regulation is just one of the many practical applications of electronics perfected to meet wartime demands. You may want to know more about this or other electronic developments for your industry. Your nearest Westinghouse office is ready to provide full information . . . or write to Westinghouse Electric & Mfg. Co., P.O. Box 868, Pittsburgh 30, Pa. J-91071



THE ELECTRONIC REGULATOR

Through the sensitivity of electronic tubes, this device accurately regulates the speed by controlling the voltage on the "running" generator, despite fluctuations in power supply or changes in load. It has wide applications in continuous process industries, wherever accurate control of machine speed is essential to uniformity of product.

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Other programs, under private auspices or sponsored entirely by the Chinese government, are projected. One, worked out with the British, involves sending a much smaller group of around 20 radio engineers to London for a year's study of British manufacturing and broadcasting techniques. After their year abroad, all these trainees are expected to return to China and assume responsible positions as radio instructors and factory managers in war industry.

At the same time, officials of the Chinese Ministry of Communications and of the Central Broadcasting Administration, which functions under the Ministry, are planning missions to the United States to acquaint themselves with American manufacturing, broadcasting and regulatory methods.

One of the first official delegations is that headed by Dr. Penn Tsing-Yeh, Deputy Director of the Broadcasting Administration, long-time engineer with the *I. T. & T.* subsidiary in China and a graduate of the University of Communications in Shanghai — the Chinese equivalent of our own M. I. T. He has spent several months inspecting transmitter sites of our major radio networks, at OWI offices in Washington and New York and in the engineering department of the Federal Communications Commission.

Before returning to China in the fall, Penn will move on to Canada for a first-hand view of the operations of the *Canadian Cables & Wireless* subsidiary and will spend some time at the studios of the *Canadian Broadcasting System.*

With Penn, are H. K. Hsu, Program Director of the 17 government stations now on the air in China, S. T. Fan, government engineer in charge of station licensing, and F. C. Chien, another government engineer. Two of the Chinese engineers who set up the famous "Voice of Free China" shortwave transmitters in Chungking, are now in the United States on a similar mission.

To launch its postwar program, the Nationalist Government also expects to lean heavily on American engineering skill. Several hundred consultants are already in China in connection with activities of the Chinese War Production Board, set up by Donald Nelson last spring. The Kuomintang is considerably encouraged at the moment by the stand taken by Nelson and such men as Howard Coonley, former president of the *National Association of Manufacturers* and now an economic advisor to the Chinese Government, in urging all-out United States support of the Chinese industrialization program. According to Nelson, aid to China is "a sound business investment which will open new world markets in the Pacific."

Within China, the government is looking to the pitifully small but enthusiastic body of Chinese radio amateurs—now numbering about 2,500—to form the backbone of its training program. Two radio schools, staffed

by hams, have recently been put in operation in Chungking and Kunming to qualify radio operators. Other amateurs are being recruited by the Ministry of Education to set up radio courses in Chinese high schools as part of a required technical curriculum.

Chinese amateur activities are directed by a national organization, the Chinese Amateur Radio League, first established in 1940. When war broke out in 1937, hams had been earlier organized by the government into the Chinese Amateur War Service, or CAWS, a group "whose services are becoming increasingly valuable to China at war."

The new national organization, CARL, is assuming importance in Chinese postwar radio plans. For one thing, it operates a headquarters station XUOA in Chungking and 10 other branch stations in universities and villages throughout the unoccupied provinces. These stations work directly in the war and at the same time give Chinese hams, who have no equipment or funds for private stations of their own, a chance to get on the air.

China, though always handicapped by lack of equipment and money for equipment has always had an enthusiastic group of radio fans. In the early '20's, Chinese amateurs began to pool their resources and band together locally to get stations on the air. Our own American hams on the West Coast in the early days of radio recollect many calls coming through in the early morning hours between 6 and 9 A.M. on the 20 and 40 meter bands from excited Chinese amateurs "calling America" in their high-school pidgin English.

To stimulate interest in radio and encourage membership in CARL, the Chinese government recently set aside May 5 every year—opening day of the CARL annual convention—as Chinese Amateur Radio Day. CARL enjoys high prestige in China and includes in its membership the most highly qualified engineers in the country. For example, CARL's acting President is U. T. Hsu, former Vice Minister of Communications in the Kuomintang and K. T. Chu, who designed the first short-wave transmitter used in China, is Vice President.

The amateur group will be relied upon to give the strongest impetus to arousing interest in radio among Chinese youth.

Aside from its job of training, the Ministry of Communications is faced with almost insurmountable obstacles in the way of meeting its postwar goals. Just how tremendous the scope of this radio program is can only be understood in terms of how little China had before the war.

Because of her inability to get wirelines, China has had to rely almost exclusively on radio for its long-distance communications. While wirelines installations are proposed for shorter distance links, China will continue to rely heavily on radio for its domestic communications networks. Before 1937, only four of her widely-separated provinces were linked by radiophone circuits. Since the war and American military operations in China, from 10 to 12 times that number of intra-provincial circuits are in operation—most of them directly tied into the military communication system.

However, even if the present military network were made available to China after the war on a lease or outright purchase basis, it would be inadequate in terms of civilian needs, particularly in the remote, inland provinces. More important in Chinese plans for the postwar—more than 250 million Chinese, or twice the population of the United States, are in Jap-occupied or war devastated areas. The Nationalist government is working on the theory that most of the Jap-operated circuit in Occupied China will have to be destroyed in the process of reconquest and an entirely new system built to tie in with the circuits planned for, or already in operation, in Free China.

What little domestic radiotelegraph service existed in China prior to 1937 has also been considerably improved under the impetus of war. In the first war years from 1937 to 1939, the Japs seized some 200 radiotelegraph stations, but since then gains in the Free provinces have more than offset these losses, so that today there are probably more wireless stations than existed throughout China before '37.

Chinese engineers, looking for less expensive and more efficient radiocommunication techniques, are following closely recent experiments by *Western Union* and the *Bell System* in this country with the use of microwave radio beams for point-to-point communications. Facsimile transmission, heralded as a great advance in international message service, is also being studied by the Chinese for possible exploitation in domestic message service, although this undoubtedly will be a later development.

Chinese Broadcasting—Before and After

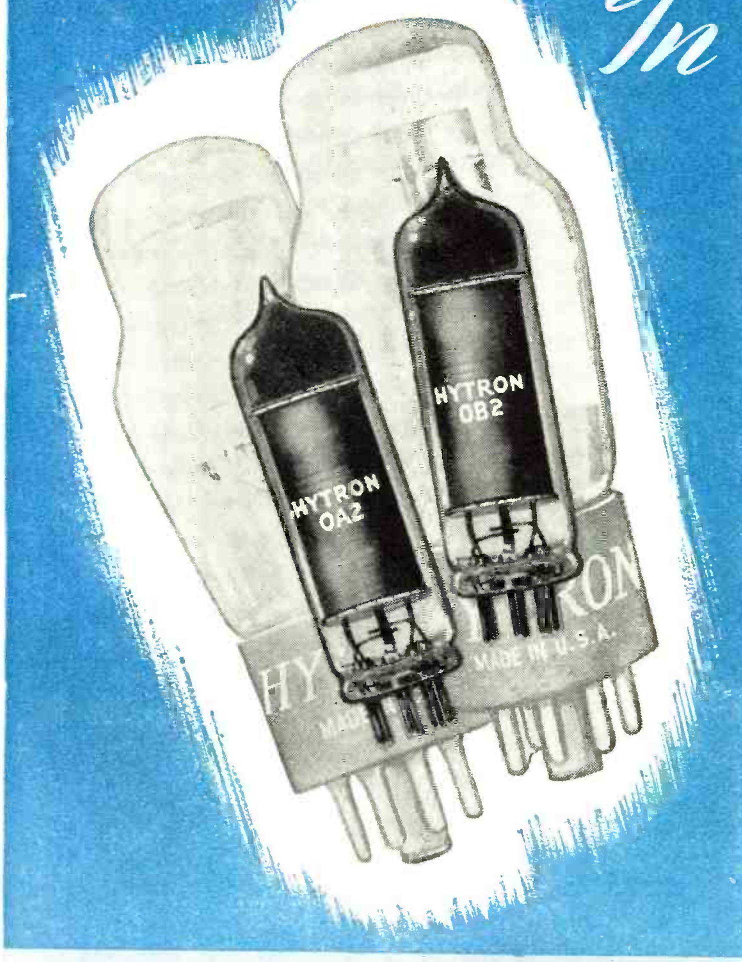
Rebuilding a broadcasting system has a priority second only to that of communications in the Ministry of Communications postwar planning.

In broadcasting, the number one problem, as the government sees it, is the manufacture and import of sufficient quantities of inexpensive receivers for use by the Chinese, particularly in the interior provinces.

Take the goal of 18 million receivers *in Chinese homes* within 10 years of the peace, for example. Never at any time before 1937 were there more than a million receiving sets throughout all China. And a sizeable percentage of these were owned by foreigners in the international settlements of the wealthy, commercial centers—Shanghai, Canton, Hankow, Tientsin, Hongkong—and not by the 460 million Chinese inhabitants. Probably not one in a thousand Chinese outside

(*Continued on page* 147)

TWO NEW GASEOUS VOLTAGE REGULATORS *In Miniature*



The list of Hytron's customers for the standard OC3/VR105 and OD3/VR150 reads like the social register of electronics. Proved quality products, these Hytron tubes are found literally by the millions in military radar, communications, and electronic equipment.

Now in space-saving miniature bulbs, the new Hytron OA2 and OB2 offer the same careful engineering design, rigid control of processing and assembly, and adherence to tight factory specifications which have made the standard Hytron regulators famous. Life and performance of the miniature OA2 and OB2 equal those of the standard tubes, except that maximum operating current is 30 ma. for the miniatures. Construction is both simple and rugged. Note, for example, use of both top and bottom mica supports and the heavy stem leads. Compare the characteristic data given. Consider the possible space economies. Order your engineering samples today.

COMPARATIVE DATA

HYTRON MINIATURE AND STANDARD GASEOUS VOLTAGE REGULATOR TUBES

TYPE	PHYSICAL CHARACTERISTICS				AVERAGE OPERATING CONDITIONS			
	Max. Length (inches)	Max. Diam. (inches)	Bulb	Base	Supply Voltage† (min.)	Operating Voltage (approx.)	Regulation $E_{30}-E_5$‡ (volts)	Operating Current* (ma.)
OA2	2⅝	¾	T-5½	7-pin Min.	185	150	2	5–30
OD3/VR150	4⅛	1 5/16	ST-12	6-pin Octal				5–40
OB2	2⅝	¾	T-5½	7-pin Min.	133	108	1	5–30
OC3/VR105	4⅛	1 5/16	ST-12	6-pin Octal				5–40

†Sufficient resistance must always be used in series with the tube to limit current through it as follows: OA2 and OB2, 30 ma.; OD3/VR150 and OC3/VR105, 40 ma.
‡Regulation (either positive or negative polarity) is defined as the difference in voltage when the current is varied from 5 ma. to 30 ma.
*Operation for extended periods of time at low current will temporarily increase regulation of tube.

OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES

HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS
PLANTS: SALEM, NEWBURYPORT, BEVERLY & LAWRENCE

BUY ANOTHER WAR BOND

WHAT'S NEW IN RADIO

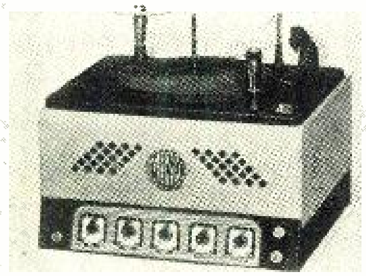
New products for military and civilian use.

The products described herein are available, in most cases, only through high priority ratings. It is suggested that readers apply for further information on company letterheads, stating full details as to priorities available.

NEW AMPLIFIER

A new record changer-top amplifier has been developed by the *Mark Simpson Mfg. Company* of New York.

This unit, known as the MA-35RC,



has a frequency response of from 50 to 10,000 cycles. The amplifier can be used with a microphone or phono input.

With a tapped output on 2, 4, 8, 15 and 500 ohms, the amplifier has a possible output of 35 watts with a power consumption of 130 watts. On microphone, it has a gain of 125 db. while the phono supplies a 78 db. gain.

This model has a changer-top cover and mechanism. It plays twelve 10-inch records or ten 12-inch records. It is equipped with an Astatic LP-6 Low Pressure Cartridge with a permanent stylus.

Details of the unit will be furnished upon request to *Mark Simpson Mfg. Company,* 188 West 4th Street, New York, New York.

NON-INDUCTIVE RESISTORS

Instrument Resistors Company of Little Falls, New Jersey, has announced the development of a new line of non-inductive resistors designed for use where light weight and compact size are important.

These resistors are designated as Types RL and SL and are said to function under adverse atmospheric conditions or heavy overload without premature breakdown. The accuracy of the unit is retained throughout the life of the unit, according to the manufacturers who subject each resistor to a voltage breakdown test of three times the rated working voltage.

Types RL are rated at ½ watt, maximum resistance of 500,000 ohms. The unit is ½" in diameter by ½" long, drilled for 6/32 screw clearance. The Type SL is similar to the RL except the maximum resistance is 1 megohm and the size is ½" in diameter and 15/16" in length. Both types of resistors are furnished with standard tolerance of ½% while tolerances up to 1/10% are available at higher cost.

Full details of this line of resistors will be furnished upon request to *Instrument Resistors Co.,* 25 Amity Street, Little Falls, N. J.

MOUNTING CLIP

A capacitor mounting clip which requires no tools for assembly is being announced by *P. R. Mallory and Co., Inc.,* of Indianapolis.

The company lists the advantages of the unit as low price, small space requirements, and the simplicity with which the capacitor may be attached.

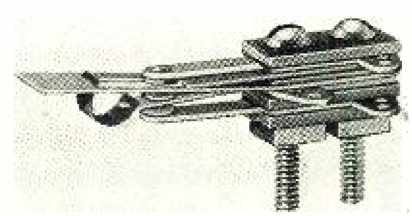
This clip, originated by *Mallory* and manufactured by the *Prestole Division* of *Detroit Harvester Company* of Toledo is available in five sizes from ⅝" to 1⅜".

Additional details of application will be furnished by *P. R. Mallory and Co., Inc.,* Indianapolis 6, Indiana.

OPEN BLADE SWITCH

A new small-sized, open blade switch is currently being offered by *Acro Electric Company* for applications requiring a compact and long-lived single pole switch.

The unit is constructed with Beryllium Rolling Spring, with over-all dimensions which are approximately 21/32" x 10/16" x 23/64". The contact arrangements are for normally open, normally closed, or double throw circuits. Because of its construction, the means of actuation is provided by the user. The standard operating pres-



sure at the end of the blade is only 3 to 6 ounces. The unit is rated 15 amperes at 115 volts, a.c.

Further details will be forwarded by the manufacturer upon request to *Acro Electric Company,* 1363 Superior Avenue, Cleveland 14, Ohio.

PORTABLE KV METER

Shallcross Manufacturing Company of Collingdale, Pennsylvania, has added a new portable kilovoltmeter to its already extensive line of these instruments.

The new #759 has five ranges that provide 1, 2, 5, 10, and 20 kilovolts d.c. at full scale. The accuracy of the built-in meter is ±2%.

Several new features are incorporated in this instrument including a reversing switch which makes it unnecessary to change the connections to the terminals of the kilovoltmeter if the polarity is reversed. Binding posts are available so that an external meter may be used if full scale accuracy better than ±2% is required. The resistance multiplier section is carefully

adjusted with 0.1%, so that, if required, more accurate meters may be used with the external connection. This permits the individual taps of the multiplier to be used as accurate high resistance standards.

Details of this instrument will be furnished upon request to *Shallcross Manufacturing Company,* Collingdale, Pa.

RAILROAD SPEAKER

A new type of reproducer, designed especially for railroad use in intercommunication work, has been announced by *Jensen Radio Mfg. Co.*

Known as the Type NJ-300, this unit has proven acceptable in tests conducted in locomotive cabs and trains, due to its ability to over-ride the surrounding high noise levels.

This reproducer consists of the Type NF-300 unit enclosed in a special railroad-type cast aluminum case. The unit is capable of withstanding shock and vibration as well as prolonged exposure to smoke, dust, and the elements. Three holes in the base provide for mounting in any position. Provision is made for installation within the case of a hermetically sealed impedance matching transformer. Heavy duty, railroad type binding posts are readily accessible by the removal of the special screw-

ONE PURPOSE ... *the improvement of capacitors*

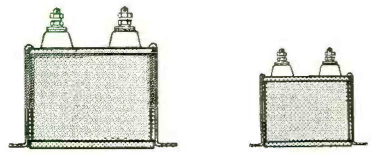
C-D never relaxes in its determination to improve capacitor design and to develop new and better materials and processes of manufacture. The C-D Type TJ series is typical of improved capacitor engineering.

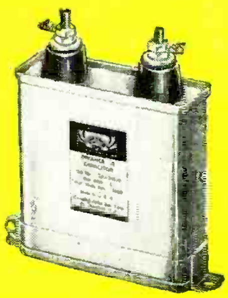
Where a lot of capacitance must be packed into little space, there is no better capacitor for high voltage filter applications than the C-D Type TJ, containing the Dykanol impregnant.

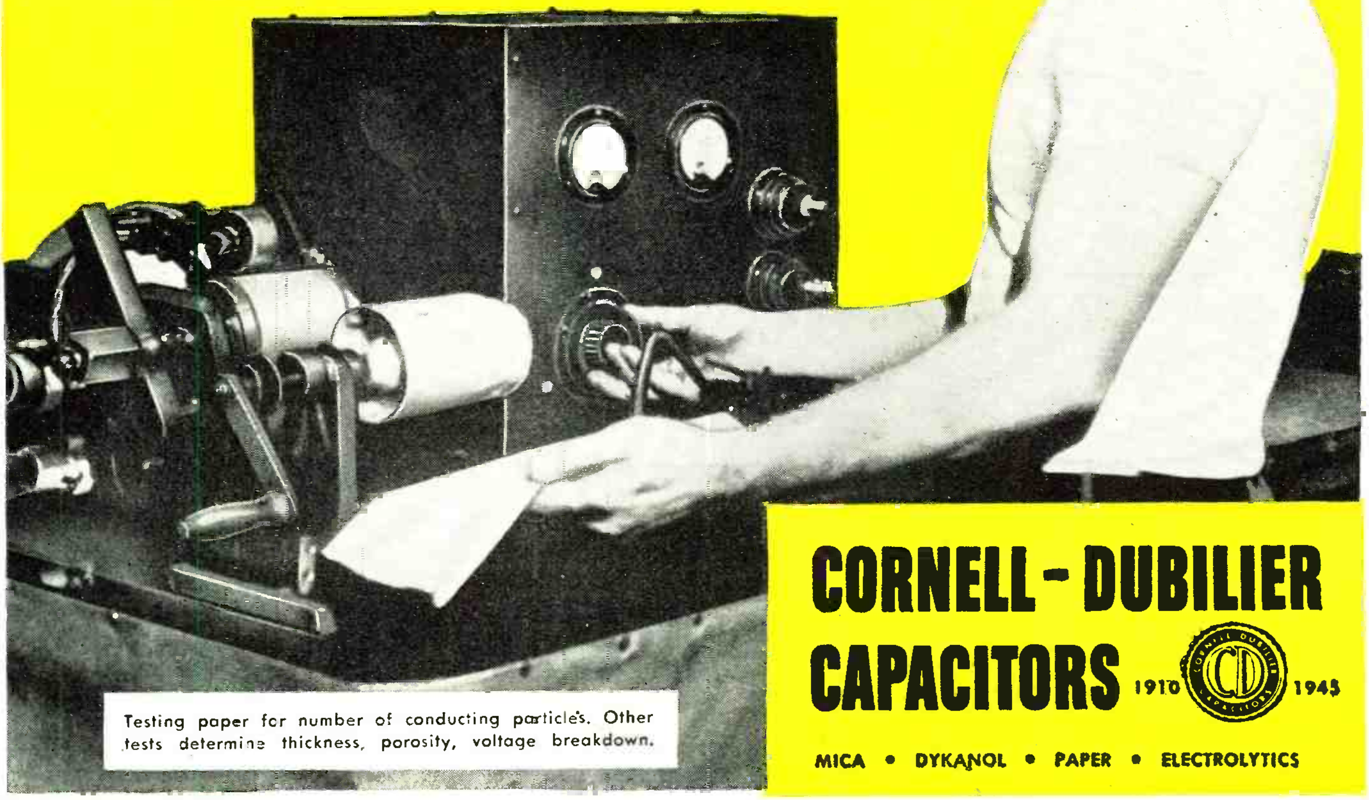
Dykanol "G", due to its chemical stability, allows operation at higher temperatures. It also permits the use of maximum paper thickness for a given size container, with a high factor of safety due to low voltage stress. Insulation resistance is five or more times as high as in capacitors using organic oil impregnants. On the larger sizes of the Type TJ series, the sturdy porcelain terminals withstand extremes of heat and cold and are practically unbreakable.

Look to Cornell-Dubilier for the extra quality and dependability that is engineered into every capacitor—the result of C-D's 35 years of capacitor specialization. Cornell-Dubilier Electric Corporation, South Plainfield, N. J. Other plants at New Bedford, Brookline, Worcester, Mass. and Providence, R. I.

Comparative size of capacitors for same voltage stress using two types of impregnants.







Testing paper for number of conducting particles. Other tests determine thickness, porosity, voltage breakdown.

CORNELL-DUBILIER CAPACITORS 1910 1945

MICA • DYKANOL • PAPER • ELECTROLYTICS

type dome condulet cover. The complete reproducer may be removed quickly from the mounting surface and disassembled for periodic overhauls.

The voice coil impedance is 12 ohms

nominal value and the power handling capacity for speech is 10 watts.

Further details of the Type NJ-300 Reproducer will be forwarded upon request to *Jensen Radio Mfg. Company,* 6601 S. Laramie Avenue, Chicago, Illinois.

RADIO-TELEGRAPH KEY

A new radio-telegraph key, Patent No. 2,329,531, the Melehan "Valiant," is being introduced by *Melehan Radio* of Huntington Beach, California.

This key is of radically new design, which design permits the sending of both dots and dashes automatically. Speeds in International Code in excess of seventy words per minute have been attained by the use of this key, or approximately seventeen and one-half dots and/or dashes per second.

The key is available in de-luxe and standard types, both models being identical in design and operation. Finish on the standard model is black or gray crackle-finish with brass machined parts, chromium plated. The de-luxe model is complete chromed.

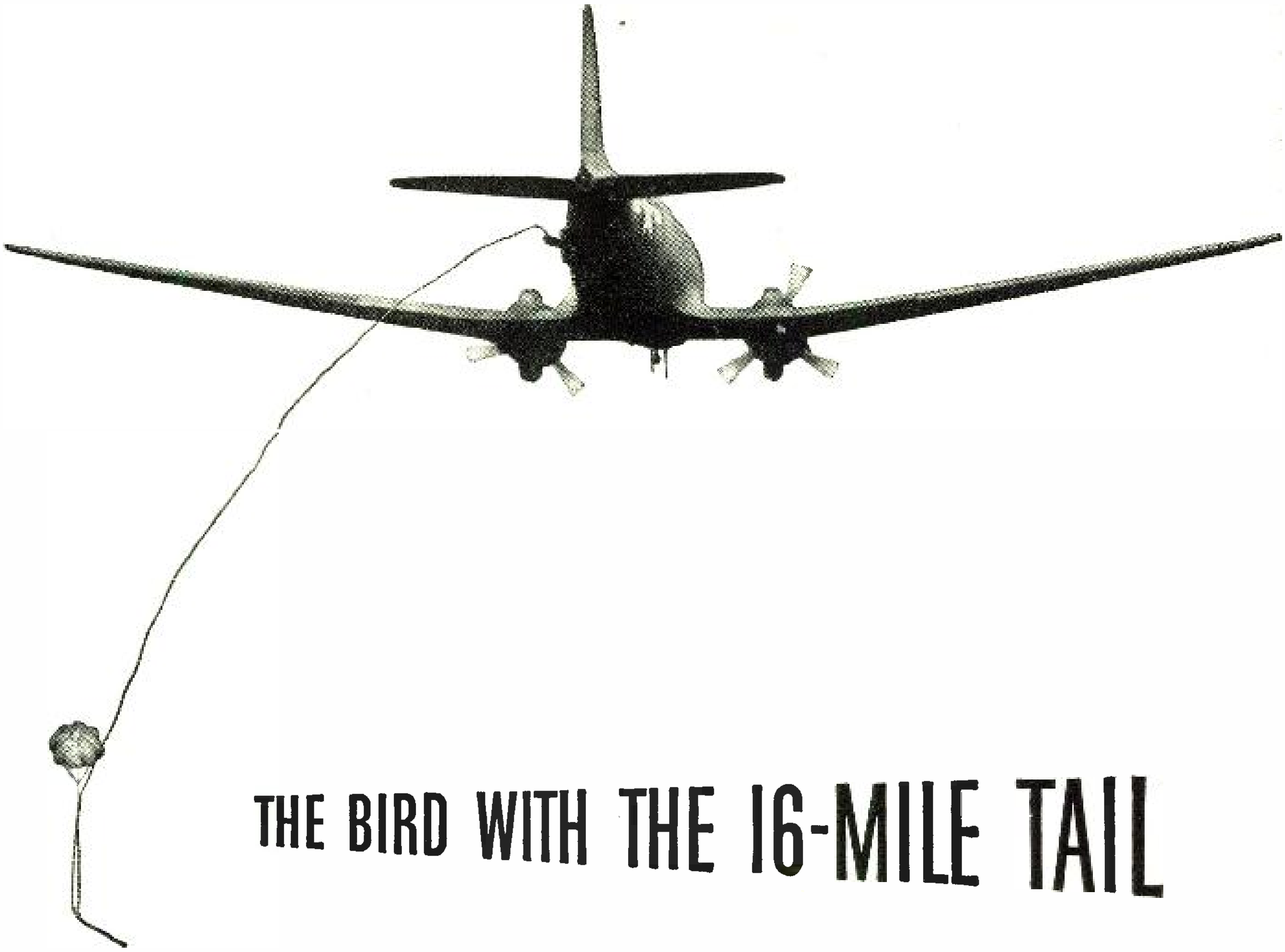
Details of this key will be forwarded upon request to Melvin E. Hanson, *Melehan Radio,* 821 Main Street, Huntington Beach, California.

PROTECTED SWITCHES

A new switch which has been designed specifically for applications in damp or wet locations where dirt, dust, and fumes are present is now being offered by *Robert Hetherington & Sons, Inc.*

Two methods are used in making these switches, the one incorporates a bellows on the plunger end of the switch and the other carries a rubber boot over the plunger.

In temperatures down to forty degrees below zero, the rubber boot has proven satisfactory under many con-



THE BIRD WITH THE 16-MILE TAIL

The wire you see with the parachute on the end of it is a telephone wire, being payed out from a C-47 cargo plane.

Bell Telephone Laboratories, working with the Air Technical Service Command of the Army Air Forces, developed this idea. It will save precious lives and time on the battlefield.

A soldier throws out a parachute with the wire and a weight attached. The weight drops the line to the target area. From then on, through a tube thrust out the doorway of the plane, the wire thrums out steadily — sixteen miles of it can be laid in 6 2/3 minutes. Isolated patrols can be linked quickly with headquarters. Jungles and mountain ranges no longer need be obstacles to communication.

This is in sharp contrast to the old, dangerous way. The laying of wire through swamps and over mountains often meant the transporting of coils on the backs of men crawling through jungle vegetation, and in the line of sniper fire. It is reported that in one sector of the Asiatic theater alone, 41 men were killed or wounded in a single wire-laying mission.

Bell Telephone Laboratories is handling more than 1200 development projects for the Army and the Navy. When the war is over, the Laboratories goes back to its regular job — helping the Bell System bring you the finest telephone service in the world.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for the Armed Forces at war and for continued improvements and economies in telephone service.

ditions. However, where hydraulic fluids and gasoline or other solvents are present, or where the switch will meet extremes of heat and cold, the metal bellows is recommended. Most of the switches in the line can be made "environment proof" according to the engineers of the company. The bellows or boot is held on one side of the panel and a lockwasher is on the other side.

Switches for both industrial and aircraft use can be furnished with total movement of 7/16". All switches are completely sealed, back and front, and are made for a.c. or d.c. All contacts are double break type, solid silver.

Further information on these new switches will be forwarded upon request to *Robert Hetherington & Sons, Inc.*, Sharon Hill, Pa.

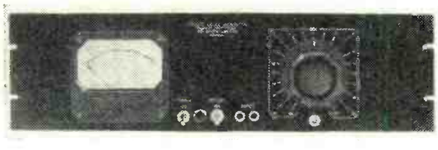
VOLUME LEVEL UNIT

The Daven Company has announced the production of a new Volume Level Indicator for low-level indication.

Known as the *Daven* Type 920, this unit was designed primarily for use across balanced lines although it permits either side of bridged lines to be grounded.

The unit is mounted on a panel for use in a standard relay rack.

The Volume Level Indicator consists of a copper-oxide type indicating meter adjusted for deliberate pointer ac-



tion, a meter zero adjusting control and heavy-duty meter range control, variable in steps of 2VU, 100 to 130 volts, 60 cycle a.c. power supply with voltage regulator to adjust for normal supply variations.

Specifications include a range from −20 to +20 VU at 0 VU reading, an extreme range of from −40 to +23 VU, including full meter scale; a standard reference level of 1 mw. into 600 ohms and a frequency variation of less than 0.2 db. between 30 and 15,000 cycles.

Further information on this indicator will be furnished upon request to *The Daven Company,* 191 Central Avenue, Newark, New Jersey.

UNIVERSAL MICROPHONES

Universal Microphone Company is announcing the production of two of their prewar microphones which have been completely redesigned and restyled.

The Model 808 velocity microphone has a sensitive element consisting of a thin 5 millimeter ribbon, powered with four rugged magnets for added field strength and dependability.

The bi-directional response of the 808 makes it particularly adaptable for use with stage presentations, orchestras, recording and public address systems indoors. The absence

of sound pickup at the sides of the 808 reduces the feedback problems of most installations.

The impedance of the unit is 40,000 ohms, for operation direct to grid of the tube; the frequency response is from 40 to 10,000 c.p.s. and the output level is 63 db. below one volt per bar.

The second type of microphone is the 204-TA, dynamic handi-mike. This model will be available in both carbon and dynamic types with a variety of switches and circuit, seven models in all.

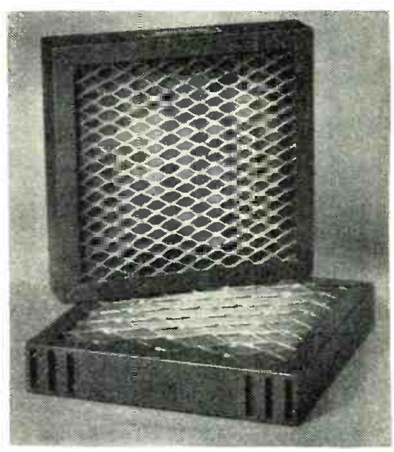
The impedance is 35-50 ohms; frequency response is from 200 to 7,000 c.p.s.; the output level into 50 ohm input; 44 db. below 6 milliwatts for 100 bar signal.

Details of these units may be secured from *Universal Microphone Company,* Inglewood, California.

TRANSMITTER FILTERS

An improved type of blower motor filter for radio transmitters has been designed by the *Badger Corporation* of Milwaukee.

This unit is a washable, permanent



type of filter constructed of expanded metal. This new filter is particularly effective in keeping dust particles out of radio transmitters, according to the manufacturer. The filters are partic-

ularly recommended for use with airport radio transmitter systems, as well as for loud speaker application in radio studios.

Complete information on these filters may be obtained by writing to the *Badger Corporation,* Milwaukee 12, Wisconsin.

NEW SOLDERING IRON

Hexacon Electric Company of Roselle Park, New Jersey, has announced the development of a line of electric soldering irons for operation off the batteries of trucks and planes.

These irons are now available, on rated orders of AA-5 or better, in 100

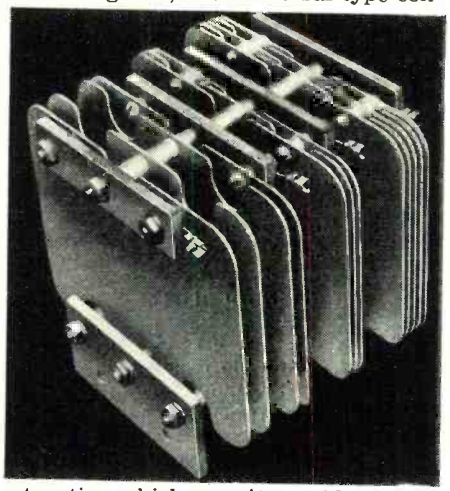
or 200 watt sized wound for either 12 or 24 volts. All irons are available with either 6 or 12 foot cords, and with the conventional plug cap or battery clips. The irons have damage-proof, hexagon-shaped barrels, which protects the element from mechanical injury, and scale-resistant element cores which prolong the element life.

Details regarding these Hexacon soldering irons will be forwarded upon request to *Hexacon Electric Company,* 119 W. Clay Avenue, Roselle Park, New Jersey.

CAPACITORS

Technical Radio Company has added a new line of capacitors which incorporate from one to four sections. Designed originally for the output section of a pi-network, these multiple capacitors eliminate the need for mica-type units.

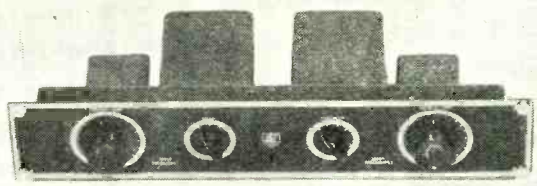
Typical capacities include 20, 40, 120, and 230 $\mu\mu$fd. Mycalex insulation is used throughout. Other features include; all sections common on one side, typical spacing of .080", aluminum plates and spaces and brass mounting feet, and universal type con-

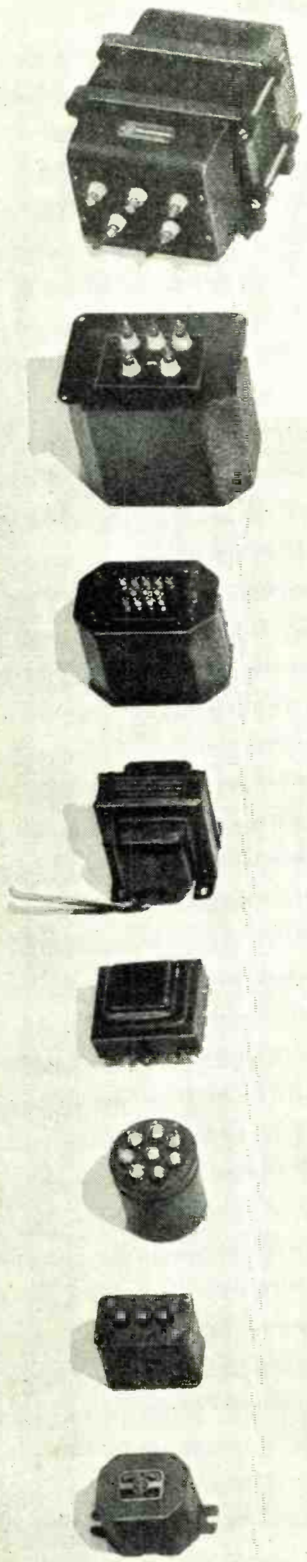


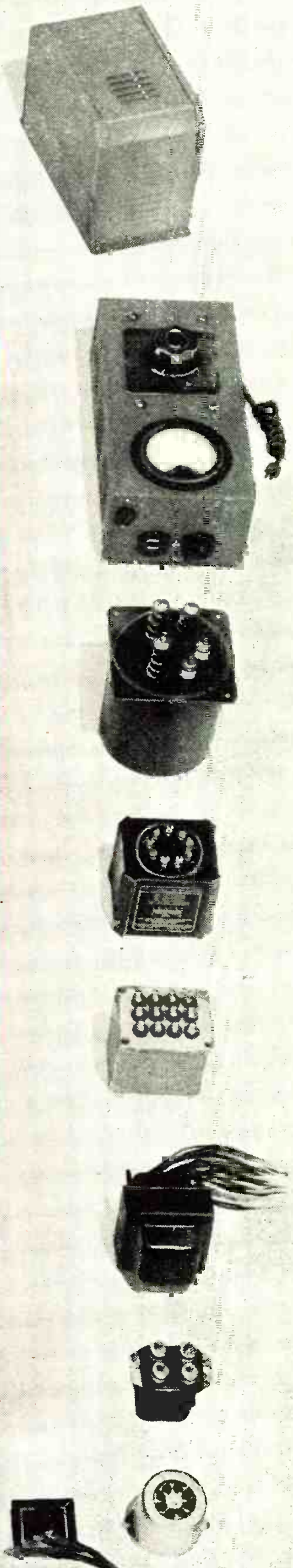
struction which permits a wide variety of spacings and capacities.

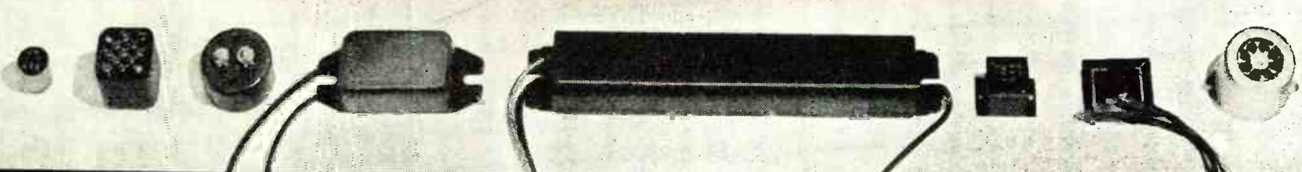
These units are currently available for civilian applications. Details will be furnished upon request to *Technical Radio Company,* 275 Ninth Street, San Francisco.

(*Continued on page 92*)









Modernizing INTERNATIONAL TELEGRAPHIC COMMUNICATIONS

These proposed changes would eliminate inconsistencies that exist today in the telegraphic communication industry.

By C. B. HARRISON

ONE of the greatest banes of the telegraphic communication industry is the tariff system which consists of a maze of telegraph rates, many of which are inconsistent, overlapping, conflicting, and inequitable.

Short wave radio telegraphy, which has made direct circuits of almost any length practical, has greatly changed the whole aspect of rate making. This fact could be taken advantage of in the adoption of a new method of rate charging and division of tolls that would be vastly superior to the present method.

It is quite likely that telegraphic communication will be used to a greater extent in the coming years than ever before and it would indicate a lack of foresight and progressiveness on the part of this industry if it did not give serious thought and consideration to any practical ideas that would save time and simplify operations, in order to more adequately meet the new telegraphic requirements of a more closely associated business and social world.

There has been much talk of plowing under the whole present maze of telegraph rates and instituting a simplified system but apparently no plan has ever been advanced that would make this feasible. It is quite improbable that an equitable system of non-exchange of receipts could ever be worked out for this industry, which has been a wishful thought for many years, but it would be feasible and practical to institute a new system of simplified rates and a new method for the distribution of receipts which the author would like to offer for the consideration of the telegraphic communication industry.

This new system, if adopted, would make international rates uniform throughout the world, would afford all handling companies like compensation for like services rendered, would eliminate all unfair competitive underselling practices, would dispense with all present complicated tariff sheets, and would greatly simplify the work of bookkeeping and accounting departments. It would remove all of the inequities and conflictions existing under the present system and would be so simple and reliable that almost any departmental employee at any point along the route of a telegram could instantly compute the division of tolls for the carrier in question, the preceding carrier, and the succeeding carrier without once having to refer to a rate table.

Thorough consideration has been given to possible improvements in the art of telegraphic communication and probable new requirements to meet modern conditions, including air mail competition, and in line therewith would reduce the whole tariff system to a mere four basic rates and cover the entire world in only two rate zones. The first zone would extend six thousand statute miles from any telegraph office, as computed at the equator of a specially designed communications map of the world on Mercator's projection, and the second zone would include all parts of the world beyond the first zone. The deferred telegram and night letter would be abolished and compensated for in greatly reduced ordinary telegram rates and the institution of the lettergram.

The communications map would begin at the international date line and extend eastward to the same line and, for all rate-finding purposes, need not extend north any farther than the northern tip of the mainland of Russia and south any farther than the southern tip of South America and could, therefore, be approximately twice as wide as it is high, of any size decided upon. Depicted on the map would be only the political boundary lines with their respective names, large principal cities, a six-thousand mile scale as computed at the equator, a simple table of four rates to be hereunder explained, and a cross-index key for the purpose of ascertaining the geographical location of points of destination when this recourse was necessary.

Copies of this map could be run off economically and would be distributed

Table 1. Suggested changes in signals that would simplify telegraphic communications.

Proposal No. 1.—Abolish the joined AS, SN, and KA signals as presently assigned, substituting therefor, the commonly used unjoined letters MO, OK, and ATN respectively and convert the AS, SN, and KA signals to the numerals 1, 9 and 0, respectively.

Present signals	Units	Proposed signals	Units
1. .----	9	1. .-...	6
9. ----.	9	9. ...-.	6
0. -----	10	0. -.-.-	8
Transmission time required	28	Transmission time required	20

A saving of more than 28.5 per cent in tape and transmission time; obviates the necessity of manipulating consecutive dashes; makes these numerals more easily distinguished between during atmospheric disturbances; brings all of the numerals within the 8-unit, 16-pin limitation, thereby making it possible to dispense with the seventeenth, eighteenth and nineteenth perforating pins and their many connecting parts and the tenth and eleventh feed-hole punch pins of radiotelegraphic keyboard perforating machines.

Proposal No. 2.—Abolish the present signals for the period and comma and substitute therefor the following proposed signals:

Present signals	Units	Proposed signals	Units
Period. .-.-.-	9	Period. ..-.-	7
Comma. --..--	10	Comma. ..--.	7
Transmission time required	19	Transmission time required	14

A saving of more than 26 per cent in tape and transmission time in radiotelegraphic operation; more than 16.5 per cent in tape and transmission time in cable operation; brings these two important signals within the 8-unit, 16-pin limitation, and makes the new combinations, IK and UN respectively, easily accessible to the right hand leaving the left hand free to operate the combination key when these two signals are not incorporated as keyboard members.

Proposal No. 3.—Abolish the present signals for the colon, apostrophe, and parentheses and substitute, therefor, the following proposed signals:

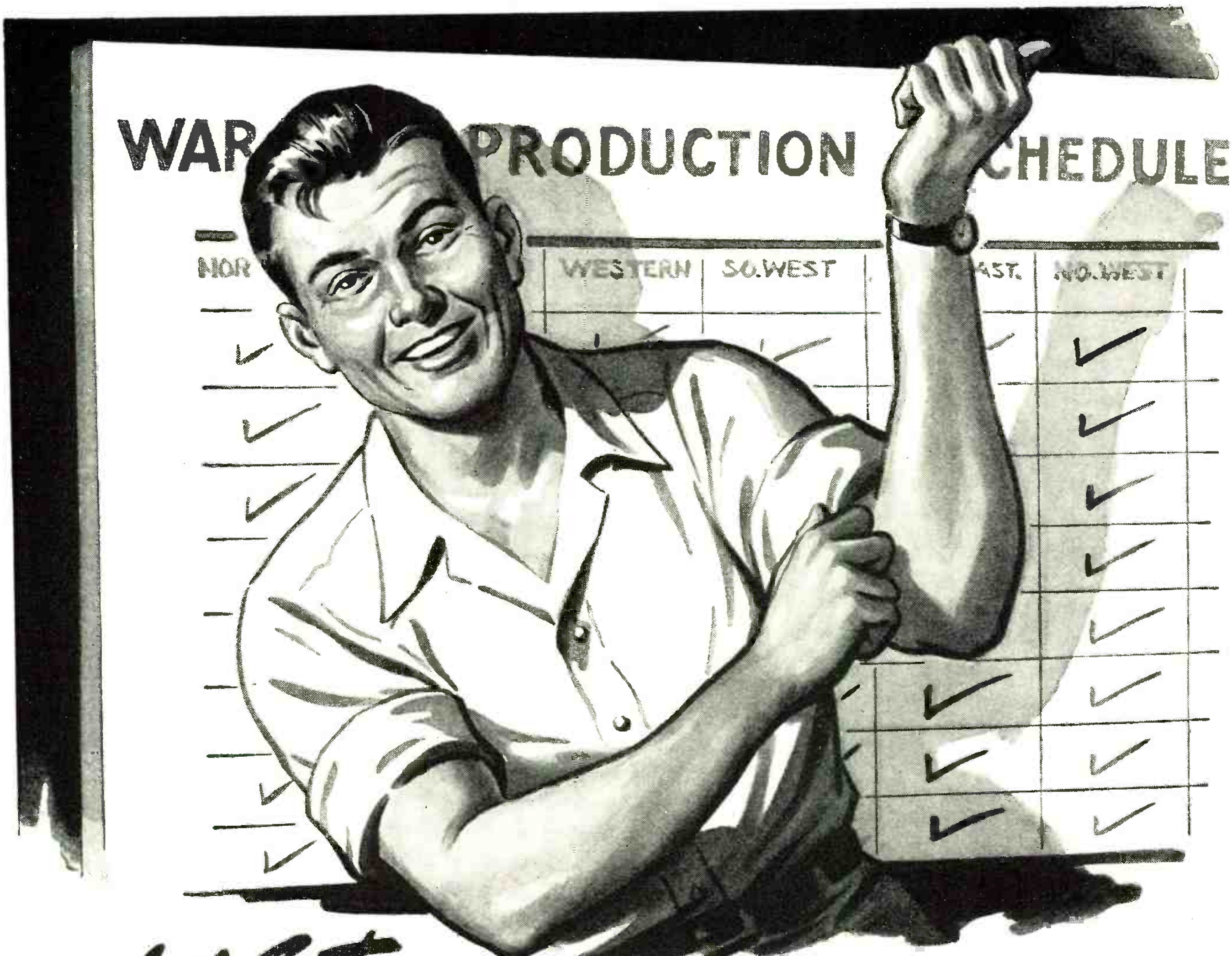
Present signals	Units	Proposed signals	Units
Colon. ---...	9	Colon. -.-...	8
Apostrophe. .----.	10	Apostrophe. .---.	8
Parentheses. -.--.-	10	Parentheses. -..-..	8
Transmission time required	29	Transmission time required	24

A saving of more than 17 per cent in tape and transmission time in radiotelegraphic operation; more than 5.5 per cent in tape and transmission time in cable operation, and brings every signal of the International Morse Code within the 8-unit, 16-pin limitation.

Proposal No. 4.—Designate the revised parenthesis (joined DD) as the starting mark and adopt the following additional signals:

	Units		Units
Ending parenthesis mark. ..-..-	8	Semicolon. -.--.	8
Opening quotation mark. .-..-.	8	Paragraph signal. -..--	8
Closing quotation mark. ..-.-.	8	Exclamation mark. .-.--	8
Number sign. ...--.	8	One em dash. -...-.	8
Ampersand. .--..	7		

These additional signals would afford Morse coverage, with consistent and likely signals, of all remaining marks and signs commonly used in the "written word." The exclamation mark and one em dash would be for use in broadcasting press reports.



All Set FOR PEACETIME PRODUCTION

FOR several months, we've been telling our friends in the trade that we of Eastern have completed our post-war plans and policies—have perfected the new line of Eastern sound equipment. Our peacetime production schedules are set up—BUT, we think winning the war is more important! We're still going all out on our war work, building quality units for the Army Air Forces and the U. S. Navy. However (as of this writing), we're standing by for Uncle Sam's okay to start our peacetime production. For detailed information on Eastern's post-war line, fill out and mail the Coupon today! Eastern Amplifier Corporation, 794 East 140th Street, New York 54, N. Y.

EASTERN AMPLIFIERS

This is Your Ticket

for complete information on our post-war line and the details of our proposition.

EASTERN AMPLIFIER CORPORATION, Dept. *-
794 East 140th St., New York 54, N. Y.

We are ☐ JOBBERS, ☐ DEALERS, ☐ A SERVICE ORGANIZATION, ☐ SOUND SPECIALISTS. We're definitely interested in your post-war line, your policy, your proposition. Mail us complete information, without obligation.

COMPANY NAME ....

ADDRESS ....

CITY ....................ZONE..........STATE....................

INDIVIDUAL ....TITLE....................

Zone	"A"	"B"	
Telegram rates (T)	.16	.32	10 word minimum charge.
Lettergram rates (L)	.06	.12	30 word minimum charge.

Table 2. The zone rates listing the rates per word, using U.S. monetary system.

to all telegraph offices, which offices in turn would draw their respective zone boundary line, being guided by the scale of miles appearing on the map. By circling any point in the world with a zone boundary line at the proposed equatorial distance of six thousand miles, it will be found that a great majority of countries will fall wholly within one of the two zones and that, therefore, it would be unnecessary to refer to the cross-index key to ascertain applicable zone rates except in those few countries through which an office's zone line cut and then only in the case that the point desired was not shown on the map. Considering the fact that the great majority of international traffic is between principal cities, it will be seen that the likelihood of having to often refer to the cross-index key would be greatly minimized.

When an occasion did arise wherein it was necessary to determine the approximate location of a point of destination this would be accomplished by referring to the *official list of telegraph offices* provided that in a new edition of this publication a cross-index key was added to the listings. If the cross-index key symbols were spaced at one hundred miles, the location of a point of destination could be accurately determined to within fifty miles at the greatest possible discrepancy and the odds would be greatly against a point of destination falling within fifty miles of an office's zone boundary line. Copies of the *official list of telegraph offices* would be needed only at main and divisional offices as at present and when necessary for a branch or line office to know the exact location of a point of destination the information could be obtained by telephone or circuit note in just a few minutes by merely asking the main or divisional office to "zone Samarovsk Russia," etc., and the reply could be just as brief.

In Table 2 the zone rates, listing the rates per word for the two basic classifications of service and using the United States monetary system for convenience, are not intended to specify rates as they are used mainly for the purpose of detailing the proposed system.

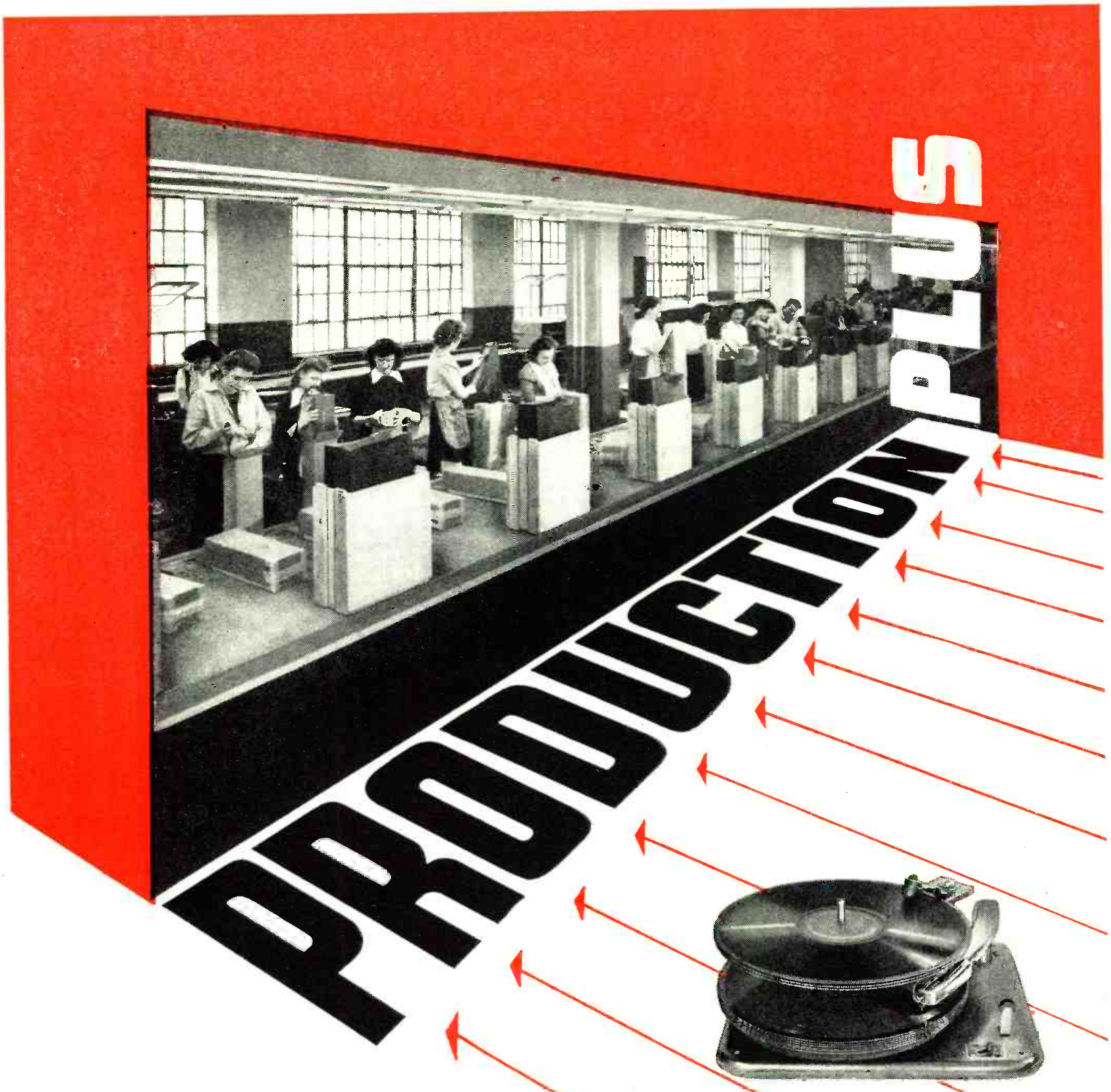
The urgent telegram rate would be double the telegram rate; the ordinary press rate the same as the lettergram rate; the urgent press rate double the lettergram rate, and the minimum word charges identical. Lettergrams would be subject to deferment in favor of telegrams up to midnight local time, but on the other hand, may go straight through if traffic conditions permit.

Short-haul customers would benefit by the reduced rate on ordinary telegrams and the new function of the lettergram but would be denied the deferred telegram privilege. However, long-haul customers would benefit to a much greater extent. The discrepancy in benefits is due to the fact that it costs communication companies, today, just about as much to handle a telegram a few miles as it does a few thousand miles.

The practice of handling "code" telegrams at a discount as is done in the Extra European system is quite unfair to communication companies when it is considered how much the sender saves in wordage and the fact that they require extra time and handling due to the necessity of being collated in the interest of accuracy.

The division of tolls would be extremely simple and would merely consist of the country of origin crediting itself with fifty per cent of the tolls on both paid and collect traffic, all relaying carriers in any intermediate country, dominion or colony, ten per cent each, and the country of destination the remainder.

After a country of origin had credited itself with fifty per cent of the tolls, four relaying carriers and the



At Detrola Radio, the pouring forth of hundreds of thousands of salable units when the starting gun booms will not be enough. The radio receivers, automatic record changers and other fine-featured products from our plants must blend service and beauty . . . express ingenuity even in details such as engineered packaging for safer transit . . . all to serve America's foremost merchants.

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Detrola Radio

country of destination could share equally in the remainder of the tolls and in the exceptional case of a sixth or seventh relaying carrier being involved the fifth carrier would merely credit itself with fifty per cent of the available tolls and the following carrier fifty per cent and so on. It is quite unlikely, however, that more than two or three relaying carriers would ever be involved in the handling of any one telegram in view of the great distances now reached on a single transmission. In those few countries where the international and domestic carriers are separately operated the international carrier would credit itself with sixty per cent and the domestic carrier with forty per cent of the country's share of the tolls on both outgoing and incoming traffic, except in the case of intermediate relaying when each would receive ten per cent.

The following two examples will make the division of tolls clear and point out how very simple the matter of abstracting would be. Say that an eighteen-word telegram was filed in Birmingham, England, and destined to Washington, D. C., U. S. A. Washington being in the first or "A" zone in relation to Birmingham, Birmingham would simply mark the check "18 TA" which would indicate that it was a telegram and destined to a zone "A" destination. The zone "A" rate for telegrams being $.16 per word, the total charges would then be $2.88. (United States money in this example). The English carrier, or carriers, would credit themselves with fifty per cent, or $1.44, and since there were no relaying carriers involved, there would be left $1.44 for the United States carriers, or $.86 for the international carrier and $.58 for the domestic carrier.

A final example would be in the case of a 30-word lettergram being filed in Paris, France, destined to Rio de Janeiro, Brazil, and routed via New York, U. S. A. Paris would mark the check "30 LB" indicating that the classification of service was a lettergram and that Rio was in zone "B" as related to Paris. The lettergram rate for zone "B" being $.12 per word, the total charges would then be $3.60. The relaying carrier would initial itself into the check and the check would arrive in Rio reading "30 LB AIT" indicating that there was one intermediate relaying carrier, being "AIT" in this case which let's say stands for American International Telegraph Company in order not to take liberties with the initials of any existing company.

Since the country of origin would always credit itself with fifty per cent of the tolls, and each relaying carrier in intermediate countries ten per cent, the check would indicate that sixty per cent of the tolls had been consumed and that, therefore, forty per cent was left for the Brazilian carrier, or carriers. Broken down this would amount to $1.80 for the French carrier, or carriers; $.36 for "Aitco" and $1.44 for the Brazilian carrier, or carriers. Had there been two relaying carriers, each would have initialed itself into the check and the check would then have indicated that seventy per cent of the tolls had been consumed and that there was only thirty per cent left for the Brazilian carrier, or carriers, or $1.08.

Using the above lettergram, for example, the procedure for abstracting, if forwarded as a paid lettergram, would be as follows: Paris would credit itself with fifty per cent, or $1.80 and would credit "Aitco" with the remaining fifty per cent, or $1.80; "Aitco" would debit Paris with fifty per cent, or $1.80, credit itself with ten per cent, or $.36 and credit Rio with the remaining forty per cent, or $1.44; Rio would credit "Aitco" with sixty per cent, or $2.16 and itself with the remainder, or $1.44. If forwarded collect, Paris would credit itself with $1.80, debit "Aitco" with $1.80; "Aitco" would credit Paris with $1.80, itself with $.36 and debit Rio with $2.16; Rio would credit "Aitco" with $2.16 and itself with the remaining $1.44.

This may appear to be inadequate compensation for relaying carriers but these same carriers when evolving into countries of destination would gain by the fact that a preceding relaying carrier, or carriers, each received only ten per cent of the tolls thus leaving a larger percentage of the proceeds for the country of destination. Another line of thought is that it would be more equitable for a country picking up or delivering a telegram to share in the proceeds to a greater extent than a country through which it merely transited.

In the interest of simplicity it would be sensible and expedient to institute a flat marine and ship-shore rate of, say, $.22 a word for telegrams and $.08 a word for lettergrams to or from a ship anywhere in the world, in which case the check symbol could be "ST" and "SL" respectively and always computed at $.22 and $.08 per word. By considering a telegraph station aboard ship as a country of origin or destination, as the case may be, and any intermediate ships or countries relaying carriers, the same routine as used in international point-to-point service could be applied to this service and would greatly simplify matters as compared to the present system.

The fact that customers of international and ship-shore telegraphic services are obliged to spell out most punctuation marks and, in other ways, use a language peculiar only to the telegraphic communication industry is a deterrent to using the telegraph for routine correspondence. This inconsistency should be corrected and the public advised that it may write its telegrams in its own language, punctuate as it pleases, and that no charge will be made for marks and signs when used purely as punctuation. It is distracting to receive a message reading, "Ship quote I unquote beams and quote T unquote bars on order stop Advise shipping date." It would be much more business-like and not distracting if received reading, "Ship 'I' beams and 'T' bars on order. Advise shipping date."

American domestic companies corrected this inconsistency several years ago and the system of free punctuation adopted by them has proven itself to be practical, sans confusion, a great saver of transmission time, and to cause little loss of revenue. This system could be readily adapted to international traffic with a slight modification and, if the adherents of each system would meet each other sort of half way, it would be possible to institute a system of universal word evaluating that would save uncountable minutes of delay and "anguish" caused by off-checks and indecision.

The slight modification needed would consist merely of removing the number sign, ampersand, and monetary marks from the digit family and, although transmitting them joined up to the word or figure group as written by the customer, count them as separate words and not multiple checked. When a telegram reached a station whose equipment did not accommodate a number sign, ampersand, or the proper monetary mark, these would be separated from the figure group or word, attached and spelled out in the language of the country making the substitution (if not known in the language of the telegram) and the check would then need no revising. For example, *C&M* would be counted as three words and not multiple checked and where the equipment did not accommodate an ampersand it would become *C and M* but still be three words. £25 would become *pounds 25*, *#1234* would become *Number 1234*, etc.

If the period, comma, colon, semicolon, apostrophe, hyphen, fraction bar, question mark, universal quotation mark, parentheses, and paragraph signal were adopted as standard transmittable marks and signs and incorporated on the keyboards of all telegraphic equipment there would still be left the upper case of five keys on standard five-unit page printing telegraph machines for a bell and four internal requirements which may, or may not, include a number sign, ampersand, and monetary marks. It would be possible, in most languages, to include all of these marks and signs on tape printing telegraph machines and typewriters since there are more keys available than on page printing telegraph machines.

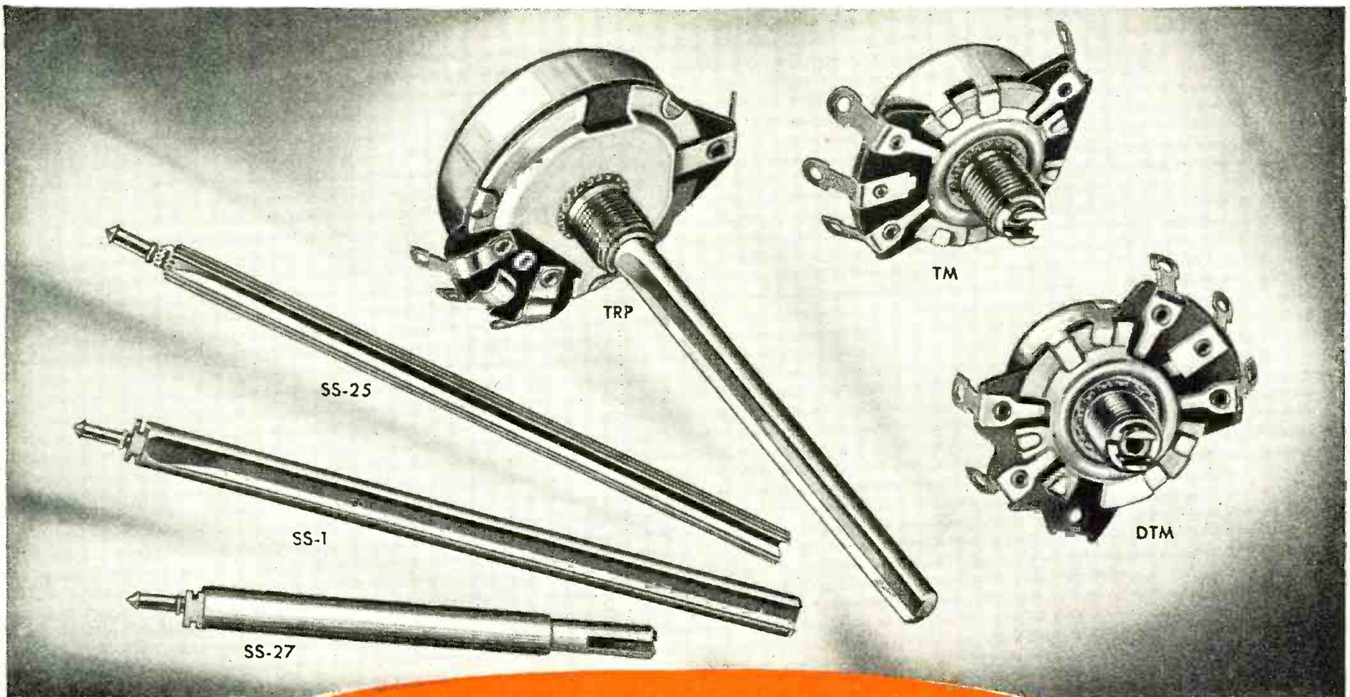
Another simple but important reform would be to reverse the rule and place the chargeable words in the denominator instead of the numerator. This would be much handier because it is customary, in writing, to always start at the left and not the right side and then go back and fill in on the left side. For instance, it would be much easier to count the actual words in a telegram, mark these down at the beginning of the available space which is often quite limited, draw the slant and then, after checking through the second time for multiple words, add the doubles or triples.

Compounding words for the purpose of evasion should be discountenanced and only dictionary compounds permitted. Words like "sixhundred," "thirtyseven," "lettercredit," etc., are each two words in any language.

In some offices from which several countries are worked, operators and clerks are kept in a confused state of mind due to different methods of procedure on different circuits. It would save the time of a shift to the upper case, a shift back to the lower case, a line-feed, and a line of space on telegraph blanks if companies not now doing so would adopt the following procedure in transmitting telegrams: include the *number, origin, check, date,* and *filing time* all on one line.

Some companies address service messages: "Blackville Whiteville" meaning from Blackville and destined to Whiteville, while other companies do likewise but mean destined to Blackville and from Whiteville. It is human nature to look for an address and a signature on any kind of a telegram and the best procedure, therefore, would be to address and sign service messages the same as any telegram and avoid mistakes and confusion.

The institution of a system of free punctuation would necessitate the adoption of additional Morse signals and as Morse operation will likely remain for a number of years, especially



MALLORY REPLACEMENT CONTROLS

(TAPPED)

TO retain the original tonal characteristics of a radio, tapped replacement controls must duplicate the electrical operation of the original controls. That's exactly what Mallory tapped replacement controls do—*duplicate*, not approximate or imitate!

Mallory provides a tapped control for nearly every replacement need—yet the total number of types is small. This is due to the use of Mallory Universal control shafts! With these shafts and controls, you suit the part to fit the job.

There are 27 plug-in shafts for use with Mallory TM (Tapped Midget) and DTM (Double Tapped Midget) controls. Thirteen are exact mechanical replicas of shafts now widely in use—the remaining fourteen need only be cut to length. Where required shaft lengths are three inches or less, the Mallory TRP (fixed shaft) control replaces large originals using set screw or spring type knobs.

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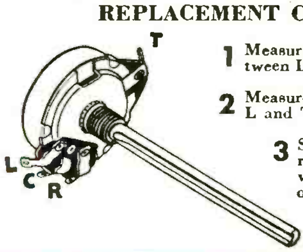

1. Measure overall resistance between L and R on old control.
2. Measure Tap resistance between L and T on old control.
3. Select Mallory Tapped replacement control having values nearest both those of the original.

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MALLORY
APPROVED PRECISION PRODUCTS

VIBRATORS • VIBRAPACKS* • CONDENSERS
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ALSO MALLORY "TROPICAL"* DRY BATTERIES, ORIGINALLY DEVELOPED BY MALLORY FOR THE U. S. ARMY SIGNAL CORPS, NOT PRESENTLY AVAILABLE FOR CIVILIAN USE.

*Trademarks

in the mobile services, it would be well worth the time and effort to not only adopt several new signals but also to revise eight incongruous signals now existing in the International Morse Code and thereby save on transmission time and material. No signal should exceed a length requiring more than eight units of circuit time for transmission because it complicates certain mechanisms.

Three of the signals that need revising are numerals and it may be considered quite dangerous to revise them. The remaining five are punctuation marks and could be revised with very little confusion. The numerals are the *one, nine* and *naught.* These three signals require excessive tape and time for transmission, are unwieldy and difficult to execute for most radio operators transmitting with hand keys or semi-automatic transmitting devices due to the large number of consecutive dashes involved which are tiring and difficult to manipulate, and are extremely hard to distinguish between during electrical disturbances due to their great similarity.

Furthermore, these three very inconsistent signals are the sole reason for having to incorporate three additional punch-head perforating pins with their many connecting parts and two additional feed-hole punch pins in radiotelegraphic keyboard perforating machines. This is a fact for the reason that no other member of the conventional keyboard requires a complement of more than sixteen pins for perforation and nine feed-hole punch pins, whereas the numerals *one* and *nine* require a complement of eighteen punch-head pins and ten feed-hole punch pins, and the *naught,* nineteen punch-head pins and eleven feed-hole punch pins.

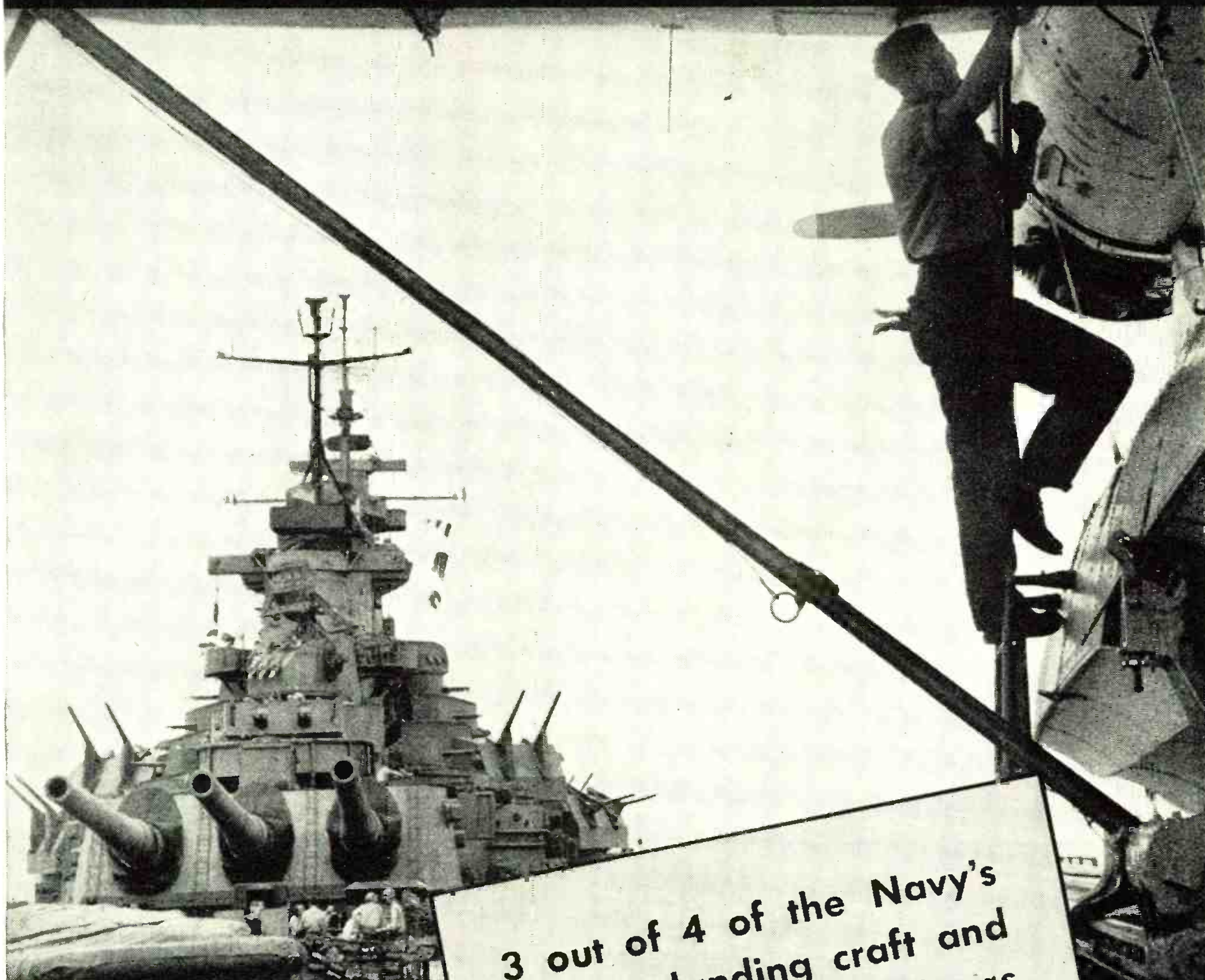
There are three signals officially recognized in the International Morse Code that are superfluous and practically worthless under their present assignment which, coincidentally, would be "naturals" for these three numerals. They are the joined AS, SN, and KA signals. The AS signal means "wait" and so do the separated letters MO. The SN signal means "understood" and the universally known signal "OK" means the same thing. The KA signal, meaning "attention" has greatly fallen into disuse, and the universally recognized abbreviation "ATN" for attention is quite commonly used and immediately attracts attention.

Two more glaring inconsistencies are the signals for the period and comma. Although these two punctuation marks are used in telegraphic transmissions to a greater extent than other punctuation marks, the signals for these marks are excessively long, the period equalling the numerals one and nine and the comma equalling the naught in length. Neither is a member of the conventional keyboard of radiotelegraphic perforating machines and the period is generally built up by striking the "A" key three times and the comma by striking the "M I M" keys which combinations are the best attainable due to all two-letter combinations being too far removed from each other for speed or comfort. Both are converted signals and have an unholy sound to old operators who have to think two ways every time they hear them or see the undulator markings.

There are only four remaining signals of the International Morse Code that require more than eight units of circuit time for transmission and, therefore, a complement of more than sixteen pins for perforation, none of which is presently a member of the conventional keyboard. They are the colon, apostrophe, parenthesis, and underline signal. The underline signal is seldom used and could be forgotten. However, the colon, apostrophe, and parenthesis marks are extensively used in telegraphic transmissions and should be shortened to meet the eight-unit, sixteen-pin limitation, thus making it possible to incorporate any letter, numeral, punctuation mark, or sign as a member of the keyboard of radiotelegraphic perforating machines if suited to the needs of any carrier and yet require but sixteen perforating pins and nine feed-hole punch pins, not to mention the great saving in tape and transmission time that would be afforded thereby.

The proposals (shown in Table I) are revisions and additions to this famous old code, made in the interest of speed, adequacy, economy, and com-

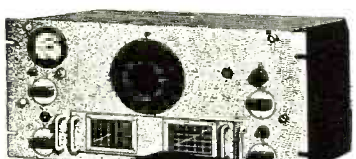
NATIONAL RECEIVERS ARE THE EARS OF THE FLEET



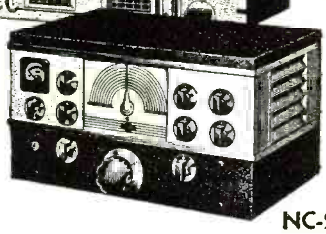
OFFICIAL U. S. NAVY PHOTOGRAPH

3 out of 4 of the Navy's ships — landing craft and larger — use receivers designed by National.

The OS2U "Kingfisher" observation scouting plane provides eyes for the battleship's muscle. Radio provides the indispensable link. It has to be reliable.



HRO



NC-200

NATIONAL COMPANY

MALDEN MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD fort and are based on thirty-one years' experience and service with twenty-eight telegraph companies.

It would be a constructive move on the part of delegates to the next international telecommunication conference to give official sanction to these additional marks and signs in the interest of adequacy and international uniformity regardless of the fact that they would not be applicable to international telegraphic correspondence under present regulations. They are greatly needed at the present time to facilitate the movement of non-check press transmissions by saving much transmission time and making it possible to release received "copy" in ethically punctuated form so that telegraph editors would not have to strike out spelled punctuation marks and insert the proper marks.

The proposal to distinguish between opening and closing marks is prompted by the fact that receiving operators often forget whether they are opening or closing marks and, with no time to stop and consider the matter, often "misplace" them.

The proposed additional signals as well as the proposed new signals for the period, comma, colon, apostrophe, and parenthesis marks, are all new signals and not conversions and, therefore, would become familiar sounds and undulator markings and become unconsciously associated in just a few days with the marks and signs to which they are assigned. This depends, of course, on the amount of code handled in a day's work.

No combinations of dots and dashes were used in any of the proposed revisions or additions that would conflict with the Arabic, Greek, Russian, or Turkish Morse alphabets, nor any of the accented letters of the French, German, Scandinavian, or Spanish languages.

No mechanical alterations would be necessitated in perforating machines except the replacement of the *one*, *nine*, and *naught* selecting bars by new ones which would be inexpensive and require but little time and effort to install. This replacement would leave the seventeenth, eighteenth and nineteenth signal-hole perforating pins and their connecting parts inoperative and the tenth and eleventh feed-hole punch pins unnecessary, all of which could be dispensed with in assembling new machines. The present lengthy feed-throw which often causes mutilated feed holes under rapid operation would be shortened by 30% in the case of the *one* and *nine* and 20% in the case of the *naught*, with the revision to these three numerals.

—30—

Through popular demand, "International Short Wave" will again appear as a monthly feature, starting with the October issue of this publication. Follow RADIO NEWS for up to the minute facts on world-wide short-wave.

For the Record

(*Continued from page 8*)

has been with the Signal Corps since shortly after the outbreak of the war. He has been engaged in highly specialized work. His wartime experience has brought him even closer to problems facing the radio serviceman. Considered to be one of the outstanding authorities in the country, we know that John's column will be eagerly awaited. His articles are scheduled to re-appear in an early issue. Welcome home, John.

OUR amateur readers will be glad to know that Ray Frank W9JU has returned from his leave of absence. Ray will devote his energies and know-how to material of primary interest to the ham. Ray has been engaged in specialized work for Uncle Sam and has returned with some mighty interesting ideas which he will put into development in our laboratory. These will emerge in the form of many new transmitters and other equipment that may be constructed for the postwar ham shack.

ANOTHER addition to our expanding editorial staff is Ed DeNike, formerly with National Union for many years. Mr. DeNike will be Managing Editor of RADIO & APPLI-

"It is especially advantageous to have spare tube positions" ★

Don E. Kassner, Chief Engineer
KXEL . . . Waterloo, Iowa

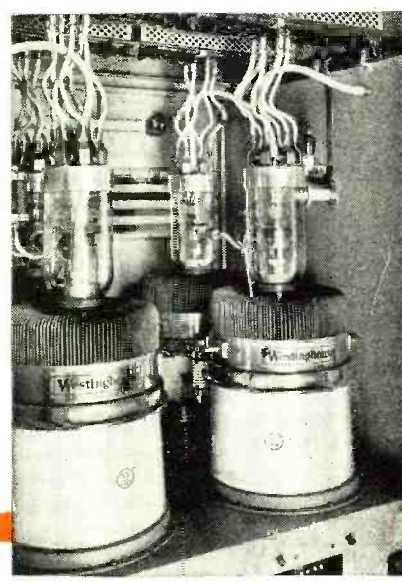
Mr. Kassner knows from actual operating experience the advantage of spare tubes in a high-powered transmitter. For a Westinghouse 50 HG transmitter has been in service at station KXEL since July, 1942. *And Westinghouse is the only manufacturer that equips its 50 kw transmitter with spare tube positions in the Power Amplifier and Modulator Units.*

The use of spare tubes in these vital positions brings the station operator a double advantage: tube-transfer can be made in a very short period of time, eliminating excessive outages where tubes must actually be replaced; and one operator can handle the entire operation, whereas two men might be needed to install a heavy, air-cooled tube.

The transfer is accomplished easily by filament switches in the power control unit and complete physical replacement of the defective tube can be made conveniently at the next regular maintenance period without loss of time on the air.

This is just another example of the sound thinking behind the design of Westinghouse transmitters that brings new advantages in operating simplicity, economy and dependability. Your nearest Westinghouse office can give you all the facts on Westinghouse transmitters... 5, 10 and 50 kw AM, and 1, 3, 10 and 50 kw FM. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-08118



★ "I feel it is especially advantageous to have spare tube positions in the amplifier and modulator circuits, particularly in high-powered transmitters where it is difficult to install the tubes because of their weight. Because of such a feature, it is possible for one operator on duty at a time to operate a Westinghouse 50 HG transmitter. Otherwise, if the tube had to be inserted because of failure, it would take two men, plus a much greater loss of time, which in broadcasting is extremely serious."

(Signed) *Don E. Kassner*

Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

XXV RADIO'S 25th ANNIVERSARY KDKA

ANCES, a new publication in our radio group. This magazine will reach every radio and appliance dealer in the country. First issue is scheduled for November.................O.R.

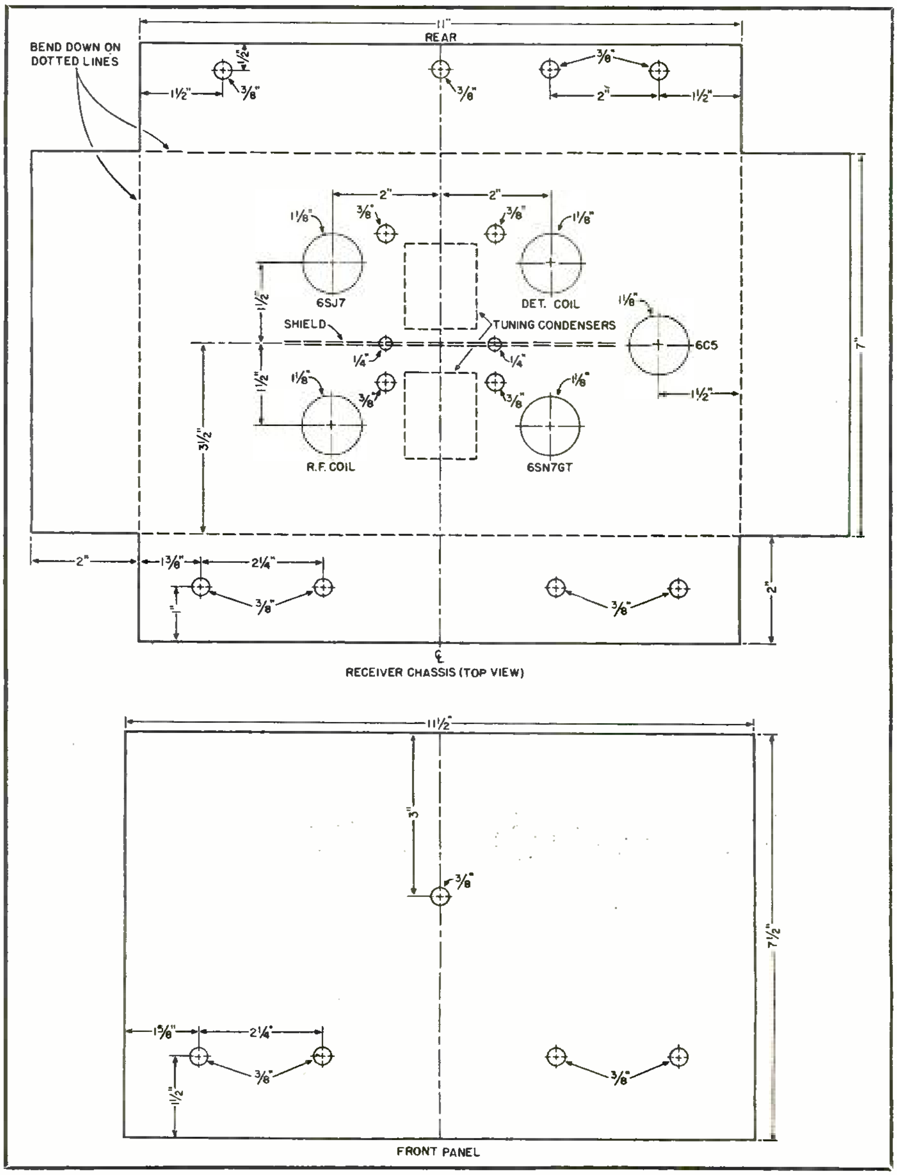
"Junk Box" Receiver

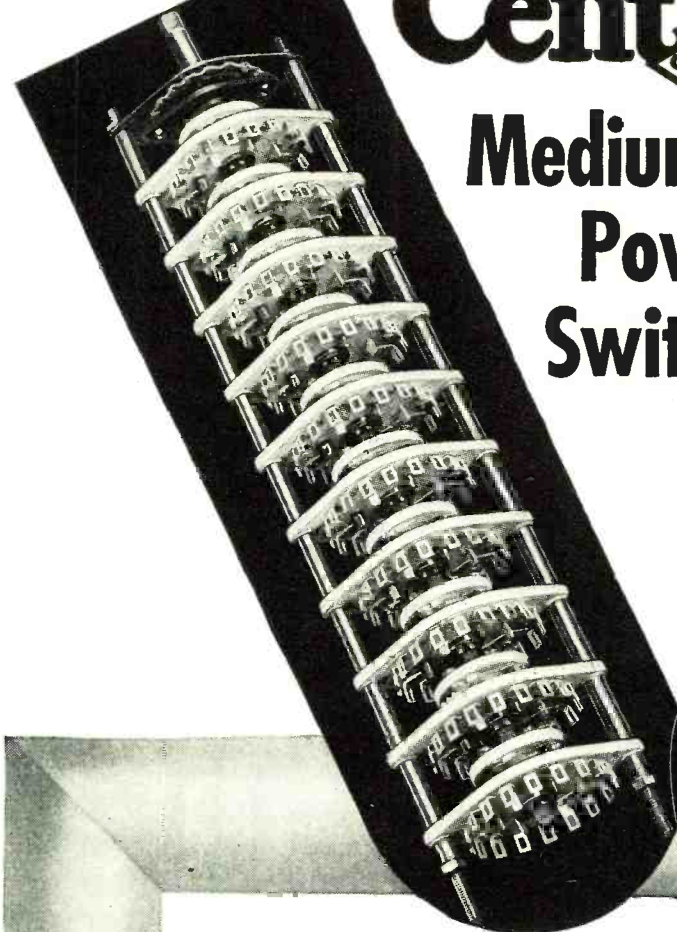
(*Continued from page* 37)

enough solder to make a good electrical connection, being careful not to permit melted solder or flux to run down over or into the tube sockets. The ends of the coil prongs can be soldered much easier if the nickel plating is removed by means of 00 sandpaper and prong and lead dipped in a pool of molten liquid solder. The lead may then be clipped close to the end of the prong and the prong dressed down with the sandpaper, so that a smooth finish is obtained.

As the photographs show, the coils are of the plug-in type wound on ceramic 1⅛ inch, 5-prong forms. The number of turns, the wire sizes, the spacing, and other dimensions of the three sets of coils are given in Table I and Fig. 2. After the coils have been wound and the leads soldered to the prongs, apply a coat of clear nail polish lacquer to the windings to hold them firmly in place. It is desirable, however, before applying the lacquer, to check the coils for frequency coverage and tracking. Tune in a signal around 80 or 90 on the main tuning dial and rotate the r.f. trimmer condenser. This condenser should peak, with a great increase in signal volume, somewhere near the center of its scale. If no peak is obtained, spread or move closer together, as required, the turns of the r.f. coil until the r.f. trimmer peaks at or near the center of the scale. Now rotate the main tuning dial to around 25 or 30 on its scale and carry out the same procedure as above. It will be necessary to make adjustments of the r.f. trimmer for the vari-

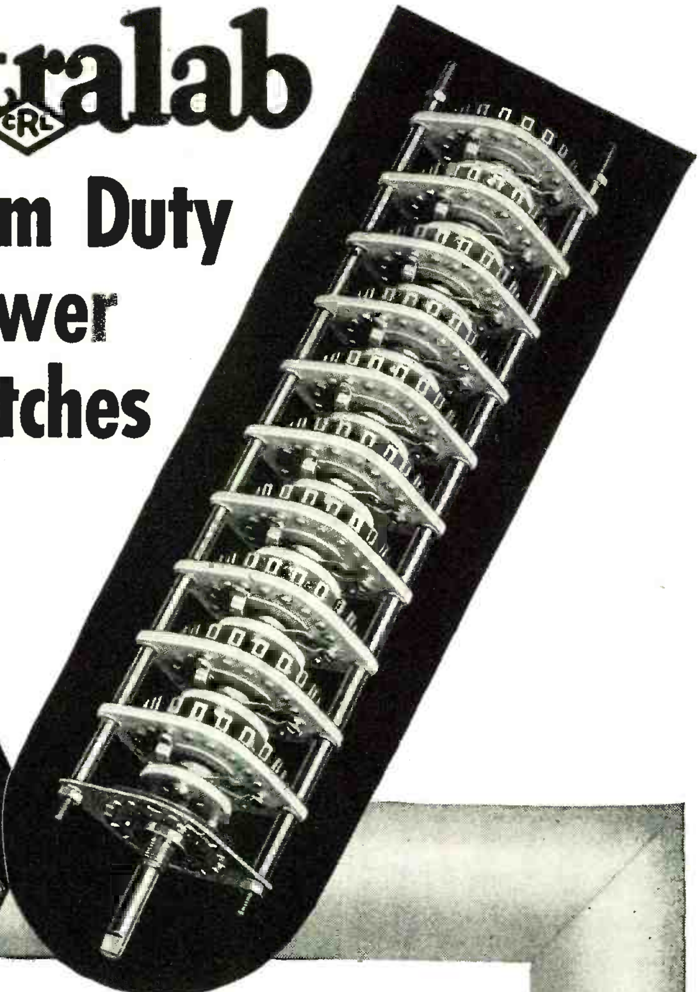
Fig. 4. Mechanical layout of the chassis and front panel. Dimensional location of the various components is approximate. It is likely that changes will need be made if your parts vary from those employed in the construction of this unit.





Centralab

Medium Duty Power Switches



- 7½ amp. 115 V. 60 cycle A. C.
- Voltage breakdown 2500 V to ground D. C.
- Solid silver contacts
- 25,000 cycles of operation without contact failure
- Fixed stops to limit rotation
- 20° indexing

Centralab medium duty power switches are now available for transmitters (has been used up to 20 megacycles) power supply converters and for certain industrial and electronic uses.

It is indicated in applications where the average Selector Switch is not of sufficient accuracy or power rating. Its accuracy of contact is gained by a square shaft, sleeve fit rotor, and individually aligned and adjusted contacts. It is assembled in multiple gangs with shorting or non-shorting contacts. Torque can be adjusted to suit individual requirements. Furnished in 1 pole . . . 2 to 17 positions (with 18th position continuous rotation with 18th position as "off"); and 2 or 3 pole . . . 2 to 6 position including "off".

Centralab

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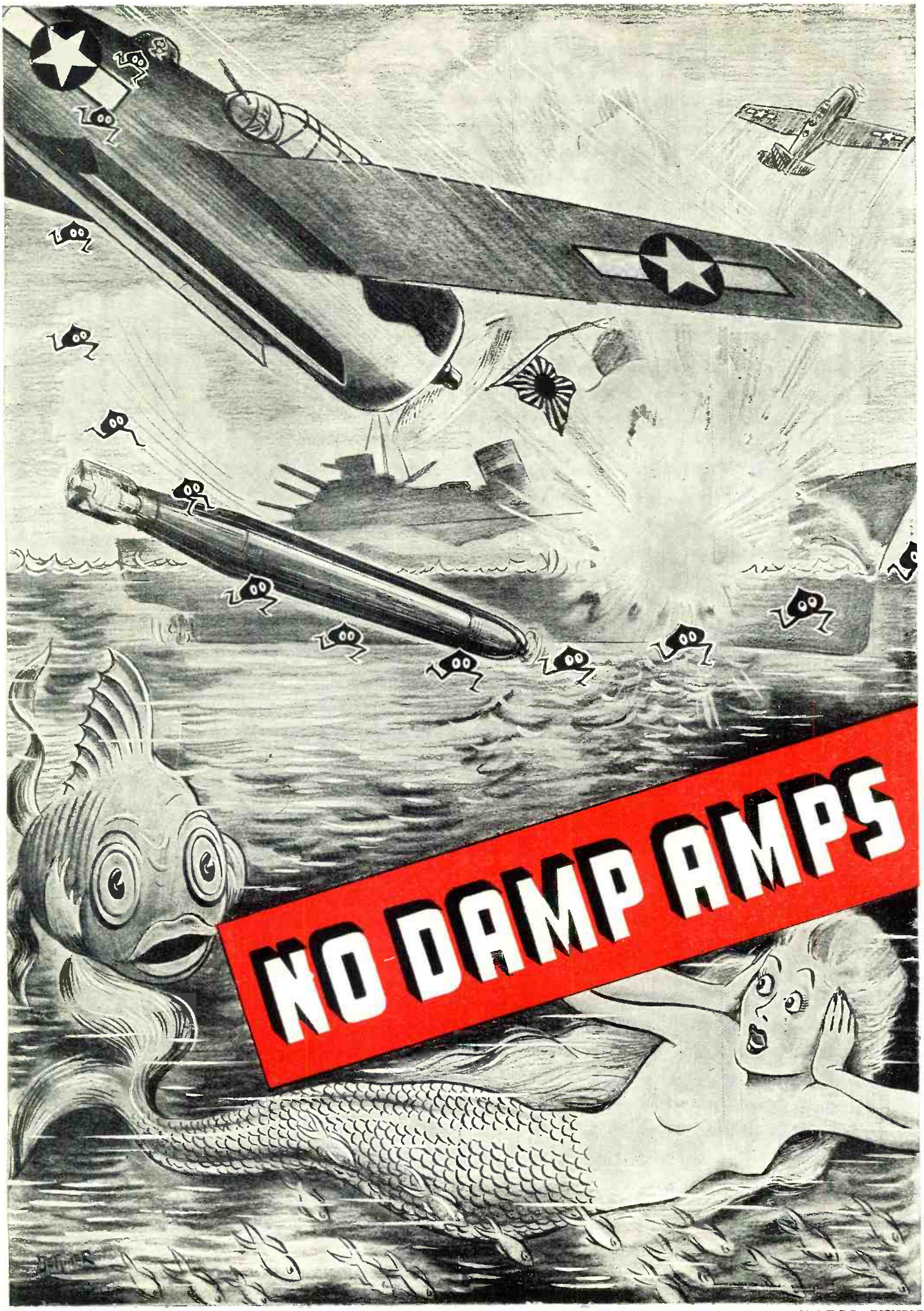
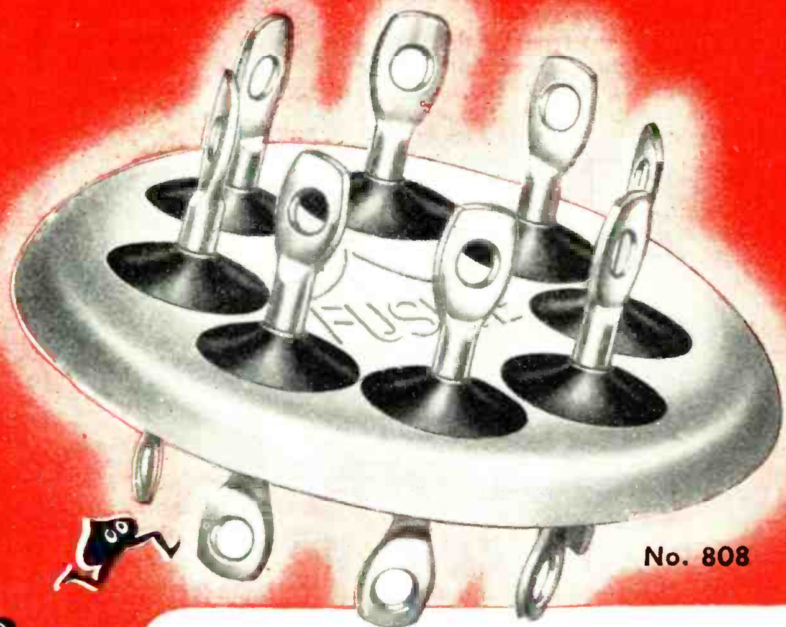
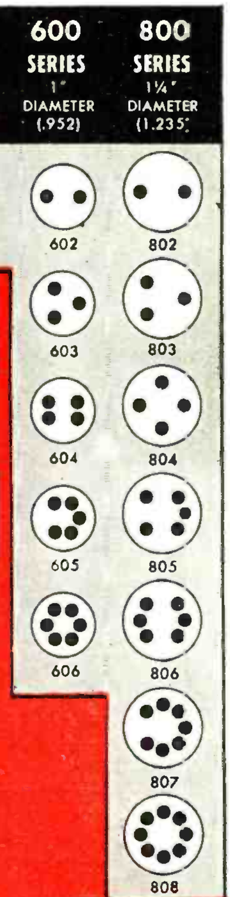
Division of GLOBE-UNION INC., Milwaukee

PRODUCERS OF Variable Resistors • Selector Switches • Ceramic Capacitors • Fixed and Variable • Steatite Insulators and Silver Mica Capacitors.


NO DAMP AMPS



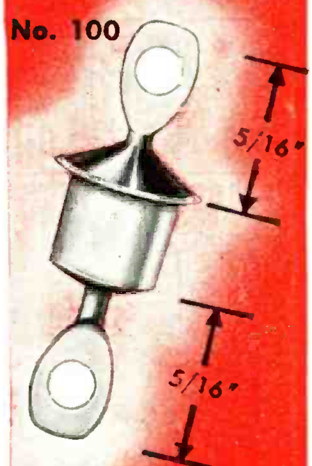


Hole punched and adapter socket formed to receive multi-terminal panels.

Fusite multi-terminal panel used as cover for container. A single sealing operation.

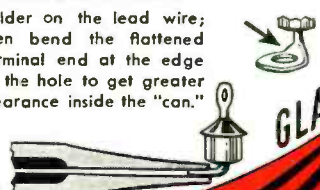
WITH FUSITE SEALS

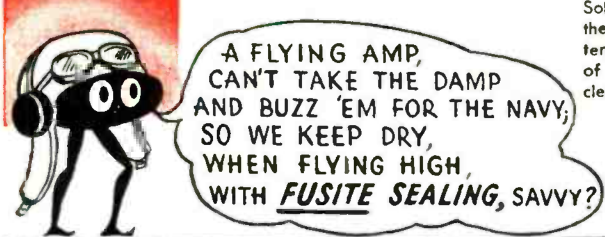
FINISH . . . means "to end". It also means "to bestow the last required labor upon; complete; perfect." Just so with the new *fused* electro-tin finish on **FUSITE** Hermetic Terminals. Microscopically, ordinary electro-tin finish looks like this ▒ **FUSITE's** *fused* electro-tin finish is like this ■ There are no pin-point holes in the finish where oxidation can start to work. **FUSITE's** new and proved *fused* electro-tin finish provides even, uniform protection. It is the completely satisfactory finish to the completely satisfactory hermetic seal . . . **FUSITE** . . . which satisfactorily stands the latest J-A-N tests. **FUSITE's** electrical properties have been bettered, too! Whereas a test of 500 megs, on electrical leakage, was formerly considered satisfactory, the new **FUSITE** now tests close to infinity. Leakage across the glass insulation is almost nil. This mark FUSITE is your assurance of the ultimate in hermetic terminals . . . for your war products of today; for your "peace-work" of tomorrow.



PRODUCTION HINT

Solder on the lead wire; then bend the flattened terminal end at the edge of the hole to get greater clearance inside the "can."





GLASS TO METAL

FUSITE

HERMETIC TERMINALS

NO DAMP AMPS!

CINCINNATI ELECTRIC PRODUCTS COMPANY

CARTHAGE AT HANNAFORD, NORWOOD
CINCINNATI 12, OHIO

ous positions on the main tuning scale but these can be kept to the minimum if the coil adjustments are carefully made.

The controls on the front of the receiver, left to right, are as follows: The r.f. trimmer condenser (C_3), the regeneration control potentiometer, (R_3), the main tuning dial, and the volume control potentiometer. A jack for the headphones is provided at the extreme right edge of the panel.

The rear panel and cover have been removed from the cabinet in order to show the construction of the receiver. At the left of the chassis we have the power cord to the receiver and then in order, left to right, an extra headphone jack, the r.f. bias potentiometer (R_2), and a hole for the antenna lead.

To operate the receiver, place the tubes in their respective sockets and plug in a pair of coils covering the desired range of frequencies. Turn up the volume control full on. Turn up the regeneration control until a pronounced hissing sound is heard in the headphones and rotate the main tuning dial until a signal is heard. Adjust the r.f. trimmer for maximum sensitivity. Adjust the regeneration control until it is just *below* the point where oscillations begin and then adjust the volume control for comfortable headphone volume. In order to receive unmodulated code (c.w.) signals it is necessary to advance the regeneration control slightly *above* the point where oscillations begin. Generally, better c.w. reception will be obtained with the r.f. bias control turned all the way off (maximum bias) as this prevents blocking of the detector on strong signals. For voice or music reception, however, it is recommended that this control be turned full on (minimum bias) and left in this position. Where extremely strong signals or unusual operating conditions are encountered, the r.f. bias control may be adjusted for most satisfactory operation.

-30-

What's New
(*Continued from page* 74)

INPUT TRANSFORMER

A new group of input transformers, known as the 400 series, has just been announced by *The Langevin Company, Inc.*

These transformers are designed for high quality amplifier requirements, while occupying a minimum space. Excellent frequency response is reported by the manufacturer. The units combine a high permeability shield with rotatable strap mounting for minimum stray field pick-up.

Three types of transformers are available in the 400 series; the 401-A operating from 30/250/600 ohms primary to 30,000 ohms secondary, center tapped; 400-C bridging input transformer, with a nominal impedance 600/15,000 ohms to 60,000 ohms sec-

SPRAGUE TRADING POST

A FREE Buy-Exchange-Sell Service for Radio Men

OVER 8,000 TRADING POST ADS!

Over 8,000 individual advertisements have been handled free of charge in The Sprague Trading Post for members of the Radio profession! Convincing evidence that this unique service is still going strong is supplied by the above photo. Here Sales Manager Harry Kalker (center) assisted by Research Engineer Leon Podolsky and Secretary Mrs. G. I. Denoyan give personal attention to a day's accumulation of Trading Post correspondence.

WILL TRADE—35Z3 tube and 36A adaptor for one 12B8GT tube. Sgt. H. Gaurkee. 36208956, Co. D. 45 Tng. Bn., 12 Regt., Camp Howze, Texas.

FOR SALE—Webber tube tester #50 with chart. $27, or will trade for late model sig. generator. Radio Electric Service, Box 47, Henderson, Minn.

WANTED—Echophone EC-1; radio-record changer; and 12SA7, 32L7, 35Z5 and 35L6 tubes. V. R. Hein, 418 Gregory St., Rockford, Ill.

FOR SALE—Rider's chanalyst and Hickok RF04 Oscilliograph. T. M. Duffield, 1617 South 17th St., Lincoln, Nebr.

WANTED—One ea. 6A7, 6K7, 6G5, 75, 43, 25Z5, K38B2 tubes. Edwin F. Cubbage, 240 N. Central Ave., Canonsburg, Pa.

FOR SALE—Ghirardi's Radio Trouble-shooter's and Radio Physics Course books, also N.R.I. textbooks $20. Earl G. Creamer, 1301 Berryhill St., Harrisburg, Pa.

WANTED—Complete copies March and April, 1945, Radio & Television Retailing. Wm. Dressler, 2030 71st St., Brooklyn 4, N. Y.

FOR SALE—RCA portable recorder MI-12701 with RCA mike and sapphire cutting needle. Sommers' Song Shop, Prophetstown, Ill.

WANTED—Hickok or Jackson tube tester; all wave sig. generator and Rider's. R. P. Relog, Box 564, Boulder, Colo.

SELL OR TRADE—About 600 new 12SA7, 12SK7, 12SQ7, 25Z5, 25Z6, 25L6, 35Z5, 50L6 tubes in cartons. What have you? Guy T. Nandi, 292 Atwells Ave., Providence, R. I.

FOR SALE—RCA #325A Audio Frequency Oscillator, new. Rudolph P. Pohl, 1441 Underwood Ave., Wauwatosa, Wisc.

WILL TRADE—Four 35Z5GT/G tubes for good phono motor; or 15 new hard-to-get tubes for good tube tester or sig. generator. Don Spaan, 1308 Muscatine Ave., Iowa City, Iowa.

WANTED—A.C. ammeter 0-15, 6v. genemotor 400-600v. output, carbon mike, SW Radio Receiver, small radios and parts. Bob LaBrenz, 1027 Borton Ave., Essexville, Mich.

FOR SALE—MRI text books; MRI VTOM less batteries; Readrite #406 tube checker; Riders 3 and 4; Ghirardi's "Trouble Shooters' Handbook and Radio Physics Course"; Beitman's "Servicing by Comparison"; Supreme Diagrams 1926 to 1938; condensers, resistors, transformers, chokes and loud speakers, $80, or will sell separately. G. R. Hodgson, 703 E. Smith St., Hicksville, Ohio.

FOR SALE OR TRADE—New V-O-M tester. Want tube and set tester or all-wave sig. generator. Will pay difference. John Sulick, 1252 Brockley Ave., Lakewood 7, Ohio.

WANTED—Two each 35Z5 and 50L6 tubes. Cpl. Herbert H. Schlater, A.S.N. 35711571, Squadron B-2, Boca Raton Field, Fla.

FOR SALE—R.C.P. #446 V-O-M, $15. Pvt. S. Friedman, c/o David Friedman, 1759 W. 7th St., Brooklyn 23, N. Y.

WANTED—Good communication receiver such as SX-25, S-20, National or Hammarlund. Billy Moorefield, Uniondale, Ind.

FOR SALE—Ultra Precision 1A1, sig. gen., $16. Lester Garber, Eureka, Ill.

FOR SALE—Magnavox automatic turntable for 10 or 12" records less Cabinet and 15-watt Operadio amplifier less speaker. E. J. Bala, 1427 Scoville Ave., Berwyn, Ill.

WANTED—2 ea. 12K7 and 12J7 tubes, new, in cartons. Gene Shumway, Box 485, Sterling, Kans.

FOR SALE—RCA station allocator #171. Want copy of Official Radio Service Handibook by Bernsley. Ed's Radio Lab., 462 Elm St., Ludlow, Ky.

WILL TRADE—Meissner 8-tube FM adapter. Want late model sig. generator. George Boles, 315—51st St., Brooklyn 20, N. Y.

FOR SALE—BMR-25C audiograph with phono top and pickup. Cash or trade. D. H. Bensman, North High, Sheboygan, Wisc.

URGENTLY NEEDED—Tube tester. Cash or will trade 6SK7, 6F6, 6P5, 6AC5, 6SJ7, 56, 39/44, 6U5/6G5, 6L6, 45, 46 new tubes. Price's Radio Service, 47 Lincoln Ave., Trenton 9, N. J.

FOR SALE—Many hard-to-get tubes. Write for list. Standard Radio Service, 428 Main St., Hamilton, Ohio.

WANTED—Hallicrafters "Sky Champion" S-20R. Martin Nadler, Jr., 170 E. 90th St., New York, N. Y.

FOR SALE—Dependable tube tester #307; Weston Oscillator #662 and Solar Capacitor analyzer and resistance bridge C-B. John Marsh, 56 Linwood Terrace, Allwood, Clifton, N. J.

WANTED—Radio City 309-P tube tester; V-O-M and sig. generator. R. C. Radio Service, 18 Lane C., Sunflower Village, Sunflower, Kans.

FOR SALE—Large number surplus tubes 30% off ceiling. Write for list. A. Gregg, 239 Market St., Wilmington 40, Del.

FOR SALE—25—12SR7 tubes in sealed cartons. 25% discount; Woodstock typewriter, $25; 2—U.T.C. LS50 transformers $6 ea.; recording motor in case, $20. Want 70L7 or 117P7 tubes. C. Wachspress, 78-15 68 Road, Middle Village 1, N. Y.

WANTED—Sig. generator and output meter in good condition. Pfc. Gerald Dornbos, c/o Miss Anne Dornbos, 8430 South Halsted St., Chicago 20, Ill.

FOR SALE—New hi-fidelity sound system with mike and phono channels, 12" speakers, mike and stand, etc. D. Jarden, 7149 Ardleigh St., Philadelphia 19, Pa.

WILL TRADE—Superior #1250 multitester ac-dc to 750v. Will trade for auto radio test & demonstration power pack or 25, 35, 50L6, 35Z5, 35A5, 7B8 and 7B7 tubes. R. Hockey Radio Shop, 3902 Tyler St., Berkeley, Mich.

URGENTLY NEEDED—Riders Manuals 10, 11 and 12. W. J. Mitchell, P. O. Box 483, Apopka, Fla.

FOR SALE—RCA aviation range receiver with power unit and two other airplane receivers. R. W. Wood, 10950 Longview Ave., Detroit 5, Mich.

WANTED—110-120 v. ac-dc record playback motor or vibrator, may be table radio-phono combination. R. Q. Pepper, USS Card, Fleet P. O., N. Y. C.

FOR SALE—Metropolitan CA10 sig. tracer; Nilson & Hornung's "Radio Operating Questions and Answers" and Cooke's "Mathematics for Electricians and Radiomen." K. L. Wilcox, Coloma, Mich.

FOR SALE OR TRADE—Esco rotary converter with built-in filter. Want Pflueger Supreme casting reel or similar. H. W. Ray, Indianola, Miss.

FOR SALE—Westinghouse O-1 m.a. meter 3" sq. with built-in a-c rectifier; Weston 0-1 amp d-c meter #301; portable radio with new Burgess batteries. Gerald Samkofsky, 527 Bedford Ave., Brooklyn, N. Y.

WANTED—Cash for test equipment, other radio parts and equipment. Elias Thomas, P. O. Box #5, Vallscreek, W. Va.

WILL TRADE—Clough-Brengle C.R.A. scope. Want good electronic V-O-M or Hickok #188X sig. gen. D. T. Dinnen, Main St., Calais, Me.

FOR SALE—Limited number of many hard-to-get tubes. Send for list. Harry Ruigel, 3343 Decatur Ave., Bronx, New York, N. Y.

WANTED—Any make television receiver. Jennings Radio and Cinema Service, Brookfield Center, Conn.

YOUR OWN AD RUN FREE

Sprague will gladly run your own ad free of charge in the first available issue of one of the six radio magazines in which The Trading Post appears. WRITE CAREFULLY or print, hold it to 40 words OR LESS, and confine it to radio subjects. Sprague, of course, reserves the right to rewrite ads as necessary, or to reject those which do not fit in with the spirit of this service.

HARRY KALKER, Sales Manager.

Dept. RN-95, SPRAGUE PRODUCTS CO., North Adams, Mass.

Jobbing Sales Organization for Products of the Sprague Electric Company

SPRAGUE CONDENSERS
KOOLOHM RESISTORS

TM. REGISTERED U. S. PATENT OFFICE

Obviously, Sprague cannot assume any responsibility, or guarantee goods, services, etc., which might be exchanged through the above advertisements

ondary; and the 402-A input transformer with a nominal 30/120 ohms primary to 50,000 ohms secondary.

Further details on these input transformers will be furnished upon request to *The Langevin Company, Inc.*, 37 West 65th Street, New York 23, New York.

HOSPITAL RADIO SYSTEM

A complete, three channel radio amplification system with more than 1,500 individual control boxes has been installed at the Birmingham Veterans

Hospital at Van Nuys, California, by *Newcomb Audio Products Company.*

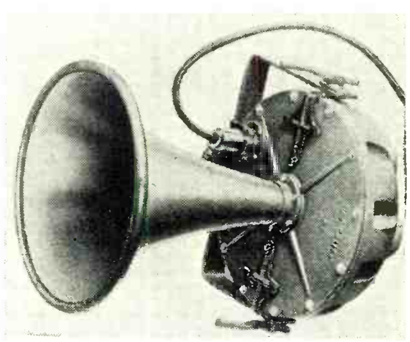
The system, manufactured by the company, consists of three master units, each wired to every bed in the hospital to give the patients a choice of three programs. Installed in the sound room off-stage in the hospital auditorium, the system is designed to permit local programs or announcements originating on the stage.

The engineering department of *Newcomb Audio Products Company,* 2815 S. Hill Street, Los Angeles 7, California, will welcome inquiries on this or similar installation problems.

DIRECTIONAL SPEAKER

A new high powered directional loudspeaker for long range speech projection through high noise levels has been developed by *University Laboratories.*

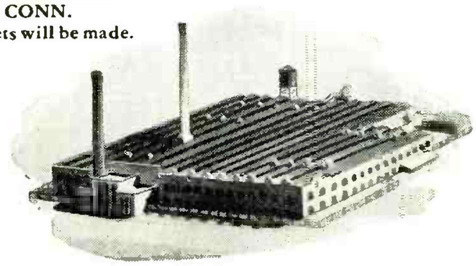
The range of the Model B-6 is approximately one mile over open country and two miles over water. This



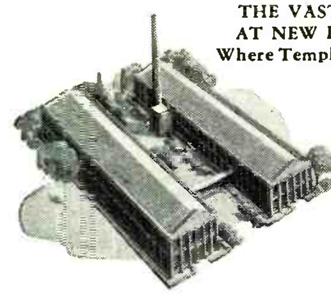
unit was designed primarily for speech reproduction and has a frequency range of 300 to 5000 cycles-per-second and handles 150 watts of audio power.

The speaker is rugged and incorporates blast-proof diaphragms for withstanding concussion. The unit is com-

THE HUGE CABINET PLANT
AT MYSTIC, CONN.
Where Temple cabinets will be made.



THE VAST RADIO PLANT
AT NEW LONDON, CONN.
Where Temple chassis will be made.



"TWO-FISTED" for ACTION!

For the radio merchant who wants a "flying start" as well as *continuous* good business, the Temple Dealer Franchise assures both. Templetone, with its two great plants—one making Temple chassis, the other manufacturing the cabinets—provides a two-fisted, hard-hitting surety of action that will both *start* and *keep you* in business profitably and permanently. Better write in NOW for details.

TEMPLETONE RADIO MFG. CORP.

• NEW LONDON, CONN.

"Where FM will also mean Finest Made"

FM . . . TELEVISION . . . RADIO-PHONO' COMBINATIONS

Temple
RADIO

pletely water-proofed which permits its continuous use outdoors under adverse weather conditions.

Six driver units power the speaker. These are connected in series with a high impedance reactor shunted across each coil. Failure of a coil due to an open connection results in automatic lowering of the shunt reactor impedance and continued functioning of the remaining driver units. The loudspeaker will thus operate with only a single undamaged driver unit, although the acoustic output will drop proportionally.

The physical dimensions include a diameter of approximately 18 inches, over-all length of 24 inches, and weight 60 pounds. A collapsible tripod type of stand is available for direct mounting.

The unit is a product of *University Laboratories*, 225 Varick Street, New York 14, New York.

COMPENSATING CAPACITORS

Centralab has announced that their line of controlled temperature compensating capacitors are now available in a new range.

These tubular ceramic capacitors can now be supplied in any desired temperature coefficient between +120 and −4000 parts per million per degree centigrade.

The range from −750 to −4000 parts per million is new and has the same accuracy of temperature compensation curve and uniform electrical characteristics as the present standard ranges, according to the manufacturer.

The new ceramic bodies have somewhat higher dielectric constants and thus provide higher values of capacitance on the same size tube.

Further details will be furnished to interested persons who request it from *Centralab*, 900 E. Keefe Avenue, Milwaukee, Wisconsin.

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Practical Radar

(*Continued from page 43*)

very sharp directivity in the horizontal plane, the vertical plane, or the antenna may have sharp directional characteristics in both planes.

A wide variety of radiation patterns can be obtained by a suitable selection and arrangement of half-wave dipoles and reflectors. (Fig. 1 is one example.) Sometimes parasitics are introduced near the radiating dipoles, causing deliberate distortion and high directivity of the radiation pattern.

Just as reflectors impede radio energy, directors can be used in front of the radiating dipoles to form more directional patterns.

A director is spaced less than a quarter wavelength in front of the dipole, and the length of the director is slightly less than that of the radiator.

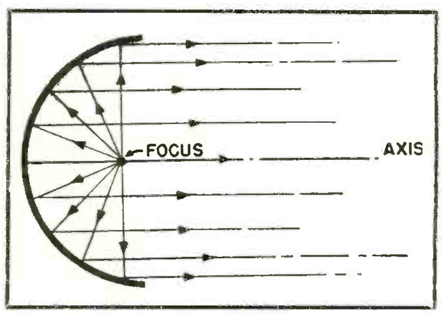
One type of antenna, known as a Yagi array, uses one reflector and two directors to obtain the desired radiation pattern. In this case the radiating element is a folded dipole, having the radiation effect of a half-wave dipole but also having a high characteristic impedance — usually about 350 ohms—for matching to high-impedance transmission lines.

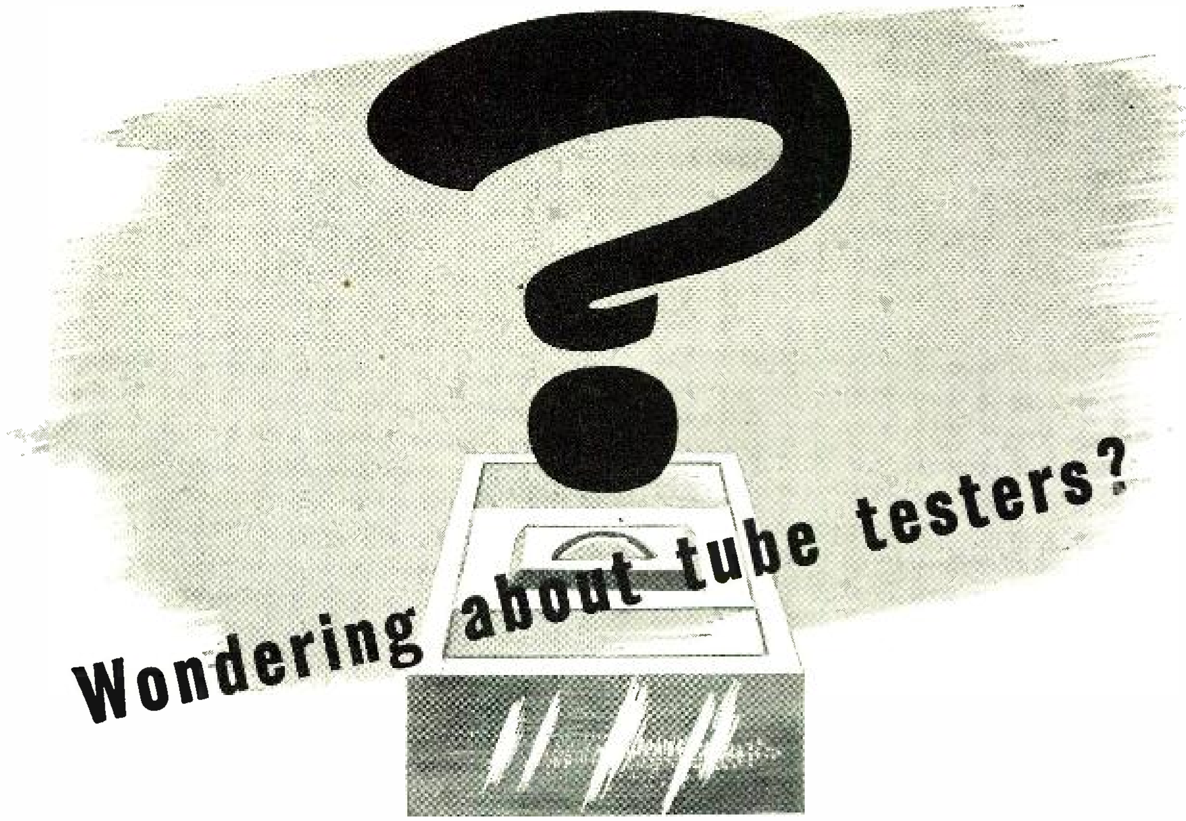
But the most effective means of securing a highly directional radiation pattern as required for radar is by means of phased arrays containing many dipoles.

The three most widely used types of phased arrays are known as the *colinear*, the *broadside*, and the *end-fire* array.

The colinear array consists of two or more dipole radiators placed end to end, and fed in phase. The broadside array consists of two or more dipoles connected in parallel with each other, and fed in phase. The end-fire array consists of two or more dipoles con-

Fig. 12. Use of a parabolic reflector.





Wondering about tube testers?

...Here's what Simpson has ready and waiting for your postwar needs

Sensational? Yes . . .

1. This new Simpson Mutual Conductance Tube Tester tests tubes with greater accuracy than any commercial tube tester ever designed.
2. Provides greater flexibility for future tubes than any other tester.
3. Tests tubes with voltage applied automatically over the entire operating range.
4. Simplifies as never before the interpretation of tube condition from mutual conductance readings.

SIMPSON ELECTRIC COMPANY
5200-18 Kinzie Street, Chicago 44, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE

nected in parallel with each other, and fed out-of-phase.

The method of feeding the antennas, the physical position and method of connecting the radiating dipoles, and the physical position of the reflectors are all factors in determining the directivity pattern of the radar beam.

Generally speaking, antenna arrays consist of a large number of elements (Fig. 9)—usually in multiples of four: 8, 12, 16, 20, 24, 28, or 32 dipoles. Since it would be necessary to have an equal number of reflectors for antenna arrays having so many dipoles, such large arrays usually employ a mesh wire screen behind the radiating dipoles. This screen (Fig. 9) has the same electrical function as if each radiating dipole had its individual reflector.

The radiation pattern for a typical directive antenna array—having a large number of dipoles—is shown in Fig. 11A.

Lobing Systems

The simplest form of radiation pattern consists of a single lobe (Fig. 11A), pulsed r.f. energy being transmitted into space according to that field pattern.

In operation the radar antenna is rotated so that the axis of the single lobe falls directly upon the target, resulting in a maximum echo signal return from the target. The degree of sensitivity of a single-lobe radar system depends upon the angular width of the radiation pattern.

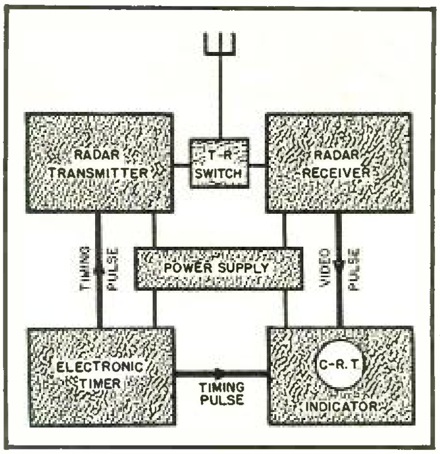


Fig. 13. Single-antenna radar system.

Referring to Figure 11B, position *B* represents the axis of the single lobe; the returning echo signal from the target would be greatest when this axis is directly "on target." But if the axis was slightly off the target, as in position *A*, there would be very little difference in signal strength, and in many cases it would be difficult, if not impossible, to tell whether the radar beam of energy was "on target."

For this reason, some types of radar sets require a much greater degree of accuracy.

This can be accomplished by a double-lobe system of energy pulsing (Fig. 11C). Two transmitting antennas, or one antenna divided and phased differently, can create such a pattern of two *intersecting* lobes. Each lobe has its own axis, but the *effective* line of bearing is a line midway between the axis of each lobe.

When a target is directly on this line of bearing, equal signals are produced by the two transmitting antennas for that particular position. At all other positions of the antenna array unequal returning echo signals are produced. Thus, the combination of two lobes or beams permits an *exactness of definition* when the radar set is "on target." Also, when the line of bearing is not directly on the target, the relationship between the unequal echo signals being received gives an indication in which direction the target lies, so that the line of bearing can be moved toward that direction.

Double-lobe radiation patterns, in a horizontal plane, are used to accurately measure azimuth; double-lobe patterns, in the vertical plane, accurately measure the angle of elevation, from which we can determine the height of aircraft.

Both arrangements of double lobes could be used to give accuracy in azimuth as well as height.

Parabolic Reflectors

At extremely high radar frequencies of operation, a very narrow beam of energy can be obtained without the use of a large number of dipoles.

Since such u.h.f. waves are in many ways analogous to light waves, a parabolic reflector can be used to concentrate the radio waves emanating from a single radiating element. The theory of operation is shown in Fig. 12.

Radio waves are reflected by the smooth surface of the parabola in such a manner that the angle the reflected ray makes with the surface is equal to the angle that the original wave made with the surface. All waves striking the parabola will be reflected outward as parallel waves, highly concentrated in a narrow beam around an axis (Fig. 12).

A more highly concentrated beam can be formed by shielding the outer half of the radiating element, so that *all* radio waves are forced to strike the parabolic reflector.

The only drawback to this antenna system is that the physical dimensions of the parabola must be quite large to satisfy the condition that the source of energy is a point or almost a point. Thus, a parabolic reflector is most useful at extremely high operating frequencies.

A single dipole can be used as the source of energy. Or, a wave guide can be used to "feed" the parabolic reflector. When a wave guide is used, the open end of the guide "shoots" energy directly into the reflector and no physical radiator, as such, is used.

The use of a parabolic reflector increases the energy power of the radiated beam axis by about 300 times.

(*Continued on page* 114)

ALL-FEMININE SERVICE SHOP

War wife continues operation of husband's service shop and finds business profitable.

By JOHN LATIMER

VIRTUALLY every radio shop in the country has, at one time or another, experimented with the female of the species as service-shop personnel. But the Adirondack Radio Service, of Harrisville, New York, is an all feminine radio-servicenter. Not one, but three feminine radioites are to be found at the shop service bench any day between 8 a.m. and 7 p.m.—sometimes burning the midnight oil as a matter of fact.

It all started when radioman Leo Sietz went off to war. His wife had been helping him for the past 2½ war-torn years. When he was drafted in July, 1944, she took over. Her first step was the training of two cohorts from the community—women whose men were fighting at the front.

Mrs. Sietz realized that her customers would be tourists in the spring and summer and inhabitants of a half dozen neighboring Adirondack towns in the winter. Constructing a sleigh for herself, she was able to make personal service calls when mountain roads would have been impassable for motor vehicles of any description. In the summer she uses her station wagon when absolutely necessary for the urgent service requests.

Adirondack Radio Service has several unique operating methods. One of the three operatives does nothing all day but give sets preliminary tests (tubes — loose connection — probing, etc.)

Another assistant handles the circuit-testing of sets which fail to respond to the first routine check. The third operative acts as receptionist and stenographer-bookkeeper. Each of the triumvirate shifts from one set of duties to another every seven days to prevent monotony from setting in.

Again, Adirondack Radio does more than its full share of servicing auto radios in the spring and summer. War or no war, tourists still come to the Adirondacks for their all-too-short vacations. Adirondack Radio Service is listed with all A.A.A. headquarters as a reliable service outlet in case of emergency. It charges a flat $3.50 to repair any auto radio whether the flaw be major or minor.

During winter months Adirondack gives "on the spot service" to farmers and other individuals who bring their sets into the shop. Radios are left in the morning and they are worked on immediately so that their owners can take them home again that evening, thus saving a return trip over rough terrain. No additional tariff is the rule for such "rapid-fire" service technique—it's $1.25 an hour labor charges for any and all comers.

Adirondack does not retail tubes over the counter at present. When a tube goes bad the set must be brought in. Actually this procedure is best for if a set component is the primary reason for a tube going bad—a new tube replacement will not solve the difficulty and will only be a wasted purchase on the part of the set owner. When a set is checked and defective tubes are found to be the only set flaw—a 75c labor charge plus retail cost of any tubes replaced goes into action.

Adirondack Radio Service does a tremendous business in portables during spring and summer months. Tourists and campers invariably possess a portable. Batteries are still a problem and tubes are likewise. Adirondack limits each camper or tourist to one new set of tubes a season (3 months or less) and two supplies of batteries during that same period.

According to Mrs. Sietz, operative of Adirondack Radio Service, it's usually the farm housewife or female of the tourist clan who brings a sick or ailing radio in for service. Invariably they have more confidence in service women than in "the man at the service bench."

This service shop does not handle p.a. repair to any considerable extent, but it has set up a number of air-raid systems throughout Adirondack communities. In addition, it services sound equipment belonging to theaters in that section of the country.

Adirondack Radio Service has another wartime maneuver which is worth mentioning—each operative has a work uniform of slacks, work shirt, and shop jacket. Mrs. Sietz feels that the effect of a smart yet durable work outfit upon service operatives is important to their morale. Too many radioshops, she believes, encourage, or at least allow sloppy dress habits on the part of employees.

Summing it up, Adirondack Radio Service is proof of the statement heard often since the war's inception, to wit: "There's less and less that a man can do that a woman can't imitate."

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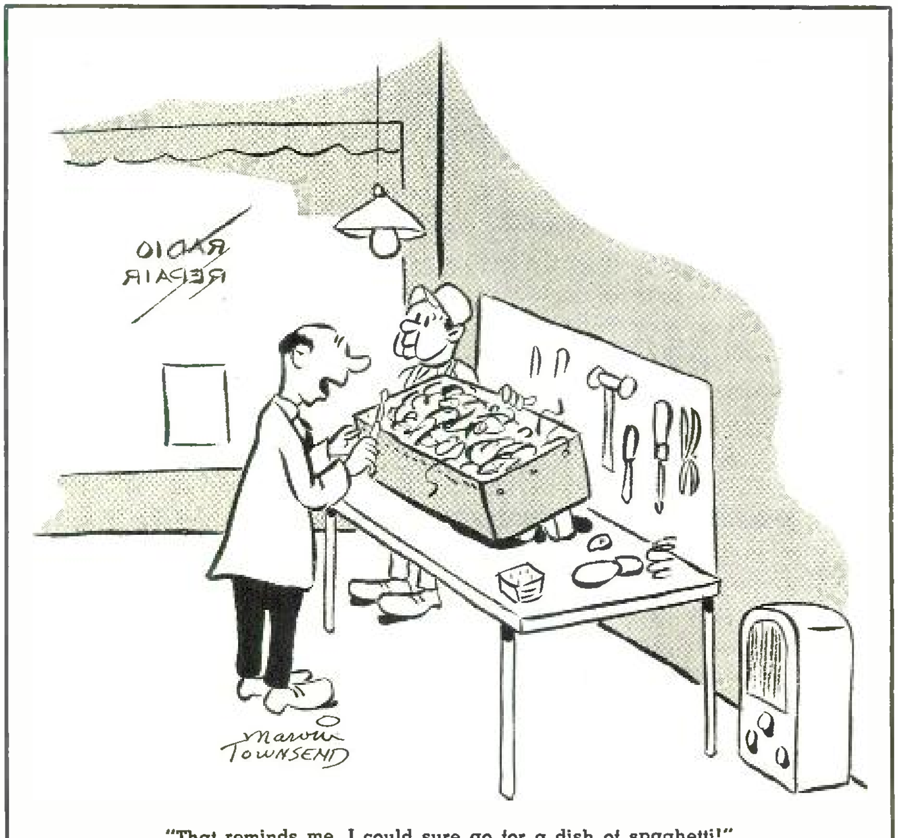
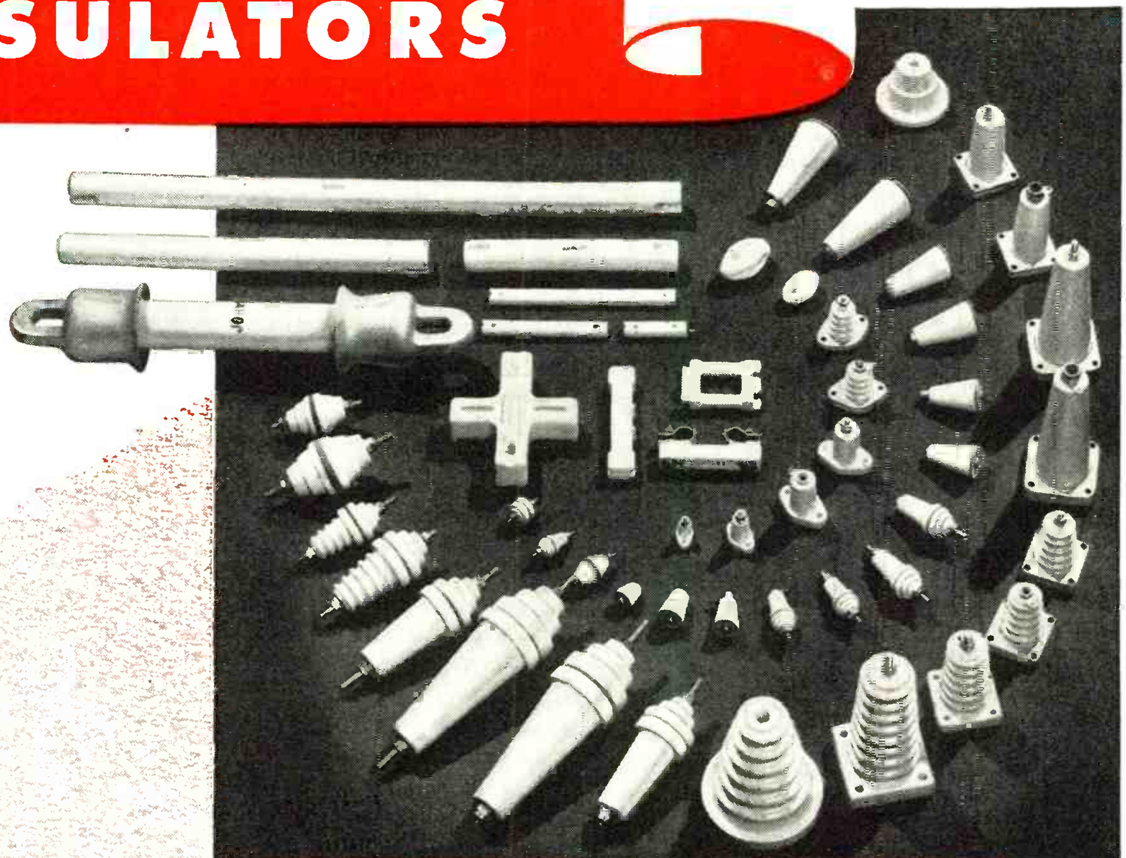


"That reminds me, I could sure go for a dish of spaghetti!"

ENGINEERED INSULATORS



Johnson Radio Engineers have been specialists in insulator design for radio frequencies for almost a quarter of a century. Shapes to provide strength for strains and stresses — reinforced mounting holes and carefully designed mountings — high internal resistance to radio frequency voltage — long leakage path — careful treatment to present a surface that will not collect dirt and foreign matter — quality hardware, not punched nuts and poorly formed parts — materials selected for their radio frequency characteristics, not the ordinary variety of ceramics. To Johnson Engineers an insulator is a piece of radio apparatus and given the same careful attention in design and production. As a result you can't buy a better insulator than Johnson. Your radio-electronics parts jobber stocks Johnson insulators.

Ask for catalog **968-Z**

JOHNSON

a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA

D. C. Motor Operated TIME DELAY RELAYS

By R. C. HEYL

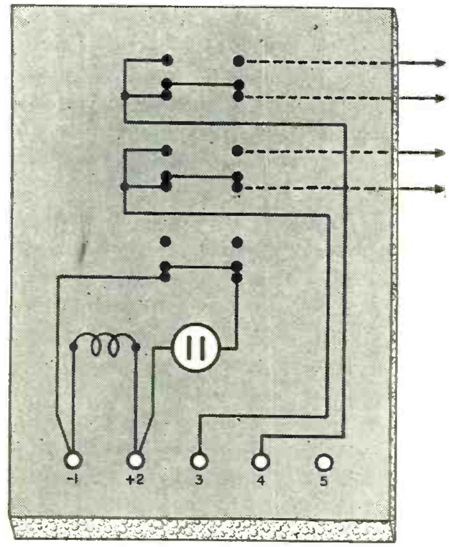
Vice-Pres., R. W. Cramer Co.

THE use of synchronous motor operated time delay relays for the protection of high power vacuum tubes has been standard practice for a number of years. The inherent advantages of this type of relay are ease of time adjustment, wide range of time scale available to suit style of tube equipment employed, and particularly the maintenance of a high degree of accuracy for an extended life, when subjected to high or low temperatures and all kinds of humidity conditions.

Recent important applications of vacuum tube equipment have been under operating conditions where the 50 or 60 cycle a.c., so essential to synchronous motor operation, was not available. Either 400 cycle a.c. or low potential d.c. has been the only power available. The problem has been to develop a timer operating under these conditions which would approach the performance and reliability of the synchronous powered units.

Since much of this equipment is airborne equipment, attention must be paid to size and weight, the effects of vibration, and the exposure of the instrument to extremes of temperature and humidity.

Because the use of 400 cycle equipment is not standardized, a d.c. motor was selected to operate the timer. The speed regulation and, therefore, the timing is not as perfect as with a synchronous motor and changes in voltage and load will somewhat affect performance. However, special attention has been paid to bearings, surfaces of operating cams, and preservation of frame alignment by correct design, which has made it possible to eliminate, to a great extent, variations

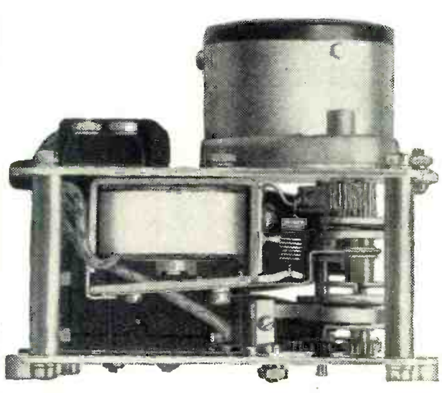


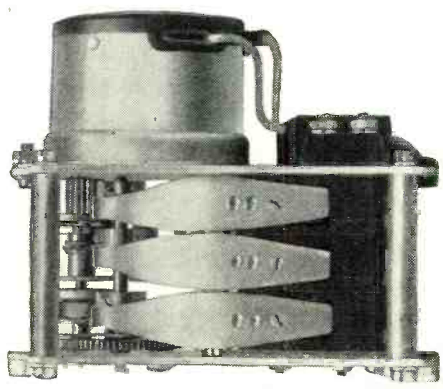
Wiring diagram of time delay relay. Timer must be connected positive and negative as shown, otherwise instrument may be damaged.

of load and thus effectively reduce performance variations with voltage changes. With a voltage variation of plus or minus 10%, performance changes are within 15%. As time delay settings are made with a factor of safety, to provide the proper warm-up period for the tubes, protection is always procured without excessive waste of time in obtaining operation.

The d.c. time delay relay is essentially a small d.c. motor unit, equipped with suitable gear reduction, which drives two interconnected shafts through a small universal joint and magnetically operated clutch. The function of the first shaft, which is

Two views showing the mechanical construction of the time delay relay.





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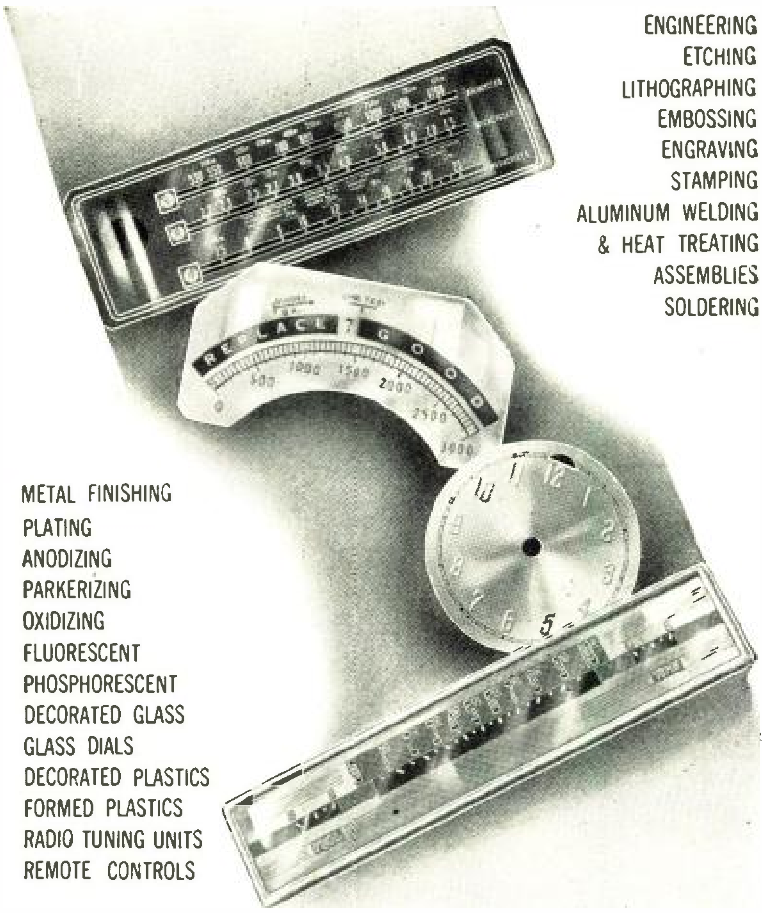

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equipped with a coiled ribbon spring, is to reset the second, or cam shaft, to initial starting position when the power is removed from the timer, thus placing the instrument in readiness at the snap of a switch. Shock absorbing stops are provided to take up recoil. The second, or cam shaft, is driven through gears from the first and is equipped with cams, which operate snap-action double-throw switches by means of operating arms.

When the timer is energized, the clutch coil is empowered and the motor is directly connected by means of the clutch, to the drive and cam shafts. At the end of the time interval for which the timer is set, the cam shaft closes the switch utilized for controlling the tube plate circuit which the relay is protecting. Depending upon the hook-up desired, additional switches may be operated at the same time as may be required.

Shortly thereafter, a third switch is operated by the timer which disconnects the motor from the circuit to prevent further rotation of the cams. The clutch coil remains energized, however, and as long as the d.c. voltage is maintained at the terminals, the relay switches remain in the operating position.

When the d.c. supply is removed, the clutch is released and the timer is reset in a fraction of a second, ready to supply the proper time delay again when required.

Various time ranges are available and, depending upon the gear train supplied, extend from 1.25 seconds minimum to a maximum of 10 minutes. While time adjustments are carefully made at the factory, provision is made for alteration in the field should necessity require.

While the motor is essentially a 6 volt unit, stable resistors are added to the circuit at the factory to provide accurate operation on any voltage up to 30 volts d.c. Information as to operating characteristics, including time range required and voltage of power source, must be designated when timers are prepared.

The motor is a permanent magnet-type utilizing an alnico field ring and the armature consists of 7 coils and 7 commutator segments to provide positive starting. A solid aluminum cup which extends into the air gap provides an electrical loading of the motor due to development of eddy currents, thus insuring uniform torque and speed characteristics. While brushes are used, these have a lifetime use on continuous duty of six months.

The switch units are fully-enclosed, single-pole, double-throw type with snap-action and double-break contacts. They are rated at 10 amperes at either 24 volts d.c. or 110 volts a.c. from sea level to 40,000 feet altitude.

This timer is customarily used to allow tube temperatures to reach a satisfactory operating point, after filaments have been energized, before application of the plate supply. The time cycle supplied can be adapted to the particular tube equipment employed. Ordinarily only two switches are supplied, one for the plate supply circuit, which is controlled, and the other for the timer motor.

It is frequently desired to have the timer provide an additional control function, such as the cutting in of resistance in the filament circuit when over-voltage is supplied to shorten the warm-up period. In such cases, a third switch is easily added in construction of the timer. This switch may be made to operate either simultaneously with the plate circuit switch or in a definite sequence with it as stipulated.

—30—

SALVAGE OF OLD MODEL "WALKIE-TALKIES"

As new model "walkie-talkie" radio sets become available for Army troops overseas and in the United States, soldiers at signal depots are salvaging virtually "everything but the squeal" from the older models, following instructions distributed by the Signal Corps of the Army Service Forces.

The exception of the squeal is made advisedly, since one of the reasons for replacement of the early sets, now rated as obsolete, is that some receivers had a tendency to reradiate energy in the form of high-pitched signals. In combat areas these unintended broadcasts could be picked up by the enemy, sometimes with disastrous results to the radiomen.

Signal depot men are instructed to disassemble the old models, known as the SCR-194 and 195, and recover eighty-five parts, including twenty-seven items which, after inspection and reconditioning, can be used in or with other Signal Corps equipment.

Most of the capacitors, resistors switches and sockets, and such individual articles as transformers, handsets, voltmeters, and antennas are either direct replacements or substitutes for similar components on other transmitting-receiving sets used by the Army. Even the two quartz crystals used in the old "walkie-talkie" can be turned over to a Signal Corps field grinding team for regrinding and further use. Nuts, screws, and washers are neatly sorted and kept for general hardware stock. An example of the meticulous care of the conservation program is the War Department's recommendation that "in removing items such as resistors and capacitors, care should be taken to keep any attached pigtail leads as long as possible. In the event that the pigtail leads are less than one inch in length, the item should be salvaged."

The new "walkie-talkie," known as the SCR-300, has a superheterodyne receiver, as did its predecessor, but the offending squeal is mercifully missing. Other improvements include tripled transmitting range, using the FM (frequency modulation) principle, an extra goose-neck antenna which enables the user to remain inconspicuous while lying on the ground or in a fox hole, and a thorough water-resisting and fungus-resisting treatment. —30—


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Cardiac Instruments

(Continued from page 28)

namely, the "time constant" of the *RC* circuit. In order that the voltage delivered to the amplifier shall be a reasonably accurate copy of the voltage generated by the microphone, and, if we bear in mind that the generated voltage is varying at the rate of the heartbeat, it is necessary that the time constant be of the order of several seconds.

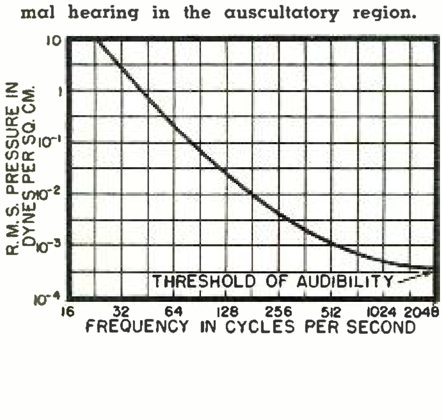
The capacity of the crystal elements used in microphones is of the order of only several thousandths of a microfarad. The value of *R*, therefore, would have to be about 1000 megohms in order to satisfy the requirement that the product *RC* shall be several seconds. The use of an amplifier input resistance of such an enormously high value is not practical, however, because of the unavoidable shunting effect of leakages through the crystal, the wiring, and the grid current taken by the first amplifier tube.

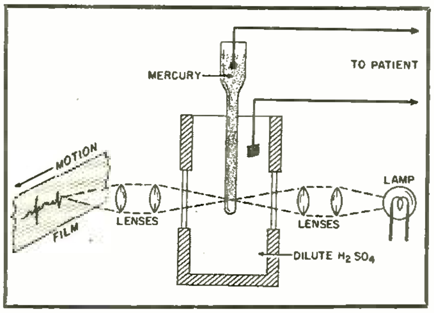
It is this practical limitation which renders the crystal microphone in its usual form unsuitable for pulse wave recording.

In order that the amplifier input resistance be kept at a reasonable value (several megohms), the microphone capacity would have to be of the order of 1 microfarad. The capacity of the crystal microphone may be artificially increased by the simple expedient of shunting an external fixed condenser across it, as shown in Fig 6C. If the circuit of Fig. 6C is analyzed, it will be found to be exactly equivalent to a new microphone Fig. 6D, whose capacity is represented by C_o and whose internal voltage is E_1. It is seen that the microphone may be given any desired capacity, but that the available voltage is reduced in the same ratio as the capacity is increased. The choice of the shunt capacity becomes a compromise between large capacity and more accurate recording on the one hand, and small capacity and higher output on the other hand.

Fortunately, the pressure variations obtainable from the pulse are so great in comparison with the sound pressure variations for which the microphone is designed, and inherent crystal microphone sensitivity is so high that, even after reducing the sensitivity

Fig. 10. Average audiogram obtained from a large number of persons with normal hearing in the auscultatory region.





The Capillary Electrometer. This instrument was devised by Lippmann in 1875 and is based on changes in surface tension that occur at the junction between a column of mercury and dilute sulfuric acid when the electrical potential between them is altered. The instrument consists of a glass tube containing mercury with one end drawn out into a fine capillary and immersed in dilute sulfuric acid. The position of the mercury meniscus depends, in part, on surface tension existing at the boundary between mercury and acid and movements of the meniscus will occur when the potential difference between them is changed. Permanent records are obtained by projecting a magnified image of the meniscus on sensitized paper moving uniformly at right angles to the direction in which the image is displaced. The electrometer is simple and inexpensive but its behavior may be erratic and because of the inertia of the mercury column it does not record rapidly changing voltages accurately. It is possible to correct the tracings so that errors due to inertia are eliminated but this is laborious and the instrument has little practical use today.

and raising the capacity several hundred times by the use of a 1-microfarad shunt condenser, the available output voltage is still in the neighborhood of 1 millivolt. A millivolt impulse is of the correct magnitude to be easily recorded by a standard amplifier type of electrocardiograph. When a standard amplifier type of electrocardiograph is available, and its input resistance is several megohms, a crystal microphone may be adapted for pulse wave recording by shunting a 1-microfarad condenser across it and connecting the combination directly to the electrocardiograph input.

When it is desired to use a string galvanometer as the recording instrument, it will be necessary to design a suitable amplifier to couple the crystal to the string, because the low resistance of the string precludes its use directly.

From delicate, cumbersome mechanisms, electrocardiographic instruments have become sturdy and compact, so that whether they use the original string technique or the amplifying tube, they are now readily portable. None of the mechanical refinements, however, have made it possible to record an electrocardiogram continuously over a long period of time. There are many occasions when such data is desirable. With this in mind, a continuous recording electrocardiograph has been devised and described by Likoff, Rappaport and Levine.[11] Some of the continuous electrocardiographic registrations

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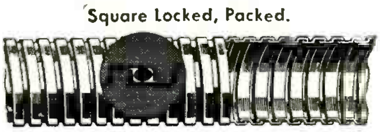

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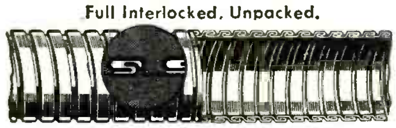

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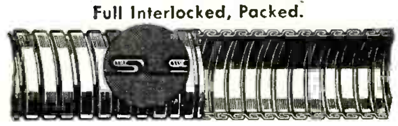


may last as long as twenty-four hours. The ordinary instrument is incapable of continuously registering cardiac action potentials over such a long period of time because of electrical and camera limitations. A continuous recording electrocardiograph was devised which is capable of taking a miniature record one-twentieth normal size upon ordinary moving picture film, and of functioning for 26.7 hours without the attention of an operator. To make suitable photographic reproductions, a simple enlarger was utilized to view the miniature record at normal size.

Fig. 4 is a schematic diagram of the optical system and the other major components of the continuous recording electrocardiograph. The optical system is composed of two independent galvanometric channels; one is used for recording, and the other for viewing and standardization. A viewing channel must be used in which the deflections are exactly twenty times as large as the deflections of the recording beam, for it is impossible to judge and calibrate the instrument when 1 mv. deflects the recording beam only ½ mm. The optics of the recording channel are of an unorthodox design; this is necessitated by the unusual and exacting requirements of miniature electrocardiographic photography. The record must be extremely sharp and well defined, for the minutest flaw, when magnified twenty-fold for visualization, may be sufficient to mar completely the legibility of the electrocardiogram. The cylindric or camera lens arrangement must be capable of focusing the recording beam down to a slit of light 0.0005 inch in thickness. Furthermore, this adjustment must remain fixed for the life of the instrument.

The schematic indicates the manner in which the recording beam impinges upon the film. The recording condenser lens picks up a portion of the light which radiates from the incandescent lamp. The positioning and focal length of the condenser lens are such that it throws a minute image of the lamp filament through the recording optical slit to a point slightly behind the concave recording galvanometer mirror (the theoretical location of the focused image if the mirror were removed). In turn, the concave mirror reflects the beam of light and diverges it so that an image of the recording optical slit falls upon the front surface of the cylindrical lens assembly. The latter squeezes the beam down to a slit of light 0.0005 inch, or less, in height; the width of the beam remains unchanged, and is dependent upon the degree of opening of the recording optical slit.

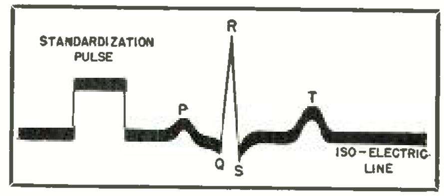
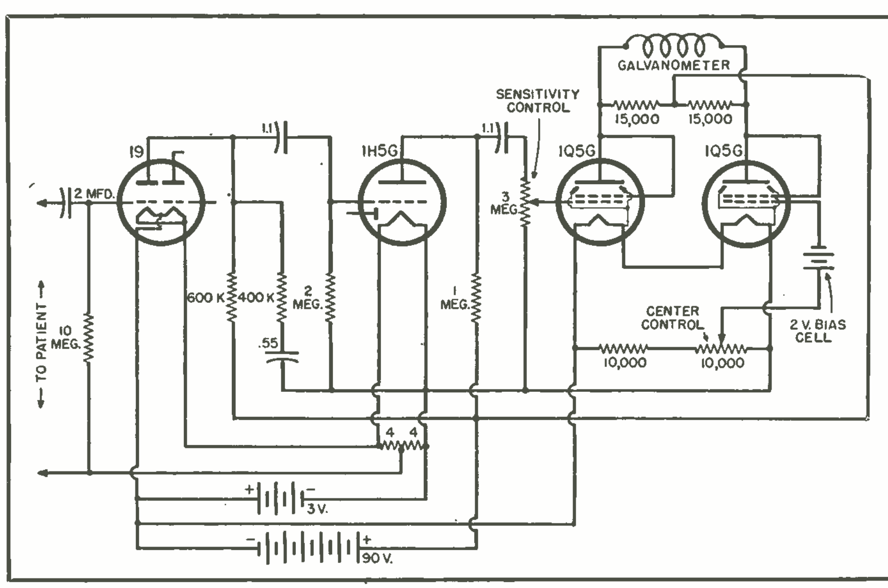


Fig. 11. Sketch shows variation in recorded thickness of electrocardiographic complexes as a function of deflection speed.

When a cardiac action potential is applied to the moving coil (*"d'Arsonval"*) galvanometer after passing through the electrocardiographic amplifier, the galvanometer coil supporting the concave mirror deflects that amount which is directly proportional to the intensity of the action potential. The motion of the galvanometer causes the 0.0005 inch slit of light to move horizontally across the film. The combination of the downward motion of the film and the transverse movement of the slit of light produces the miniature electrocardiogram.

The width of the isoelectric line is proportional to the opening of the recording slit; the greater the opening the wider the line. If the galvanometer is stimulated by a slowly changing phenomenon, such as a P

Fig. 12. Schematic diagram of electrocardiograph amplifier of the Stetho-Cardiette shown in Fig. 8. Schematic diagram for the sound amplifier is shown in Fig. 7.



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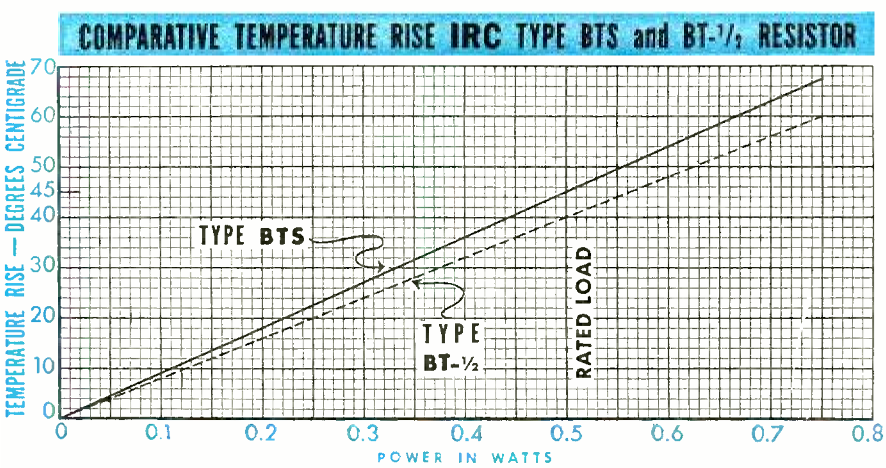
During the war, IRC's production of BTS and BTA Resistors has been absorbed for use in war equipment where size and quality were of primary importance. Numerous expansions have geared IRC's production to war-time needs and these resistors are now available to servicemen and dealers.

BTS size is no bigger than the ¼-watt units you will be replacing and should be used for greater safety in ¼-watt applications. Naturally, Type BTS is completely dependable in all ½-watt jobs. The BTA is smaller than pre-war 1-watt resistors, has a low temperature rise, therefore a great safety factor, and is a highly satisfactory replacement for all 1-watt units. These are modern resistors for modern space requirements and the many, many millions used in Allied war equipment testify to their greater dependability.

Chart shows how closely the new, smaller BTS parallels the heat-dissipating characteristics of the BT-½ Resistor, long considered the quality standard of the industry. Likewise, the BTA curve closely approximates that of the BT-1.



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or T wave, the 0.0005 inch slit deviates from the isoelectric level at a slow rate, and the registering beam is slightly narrower than during the isoelectric phase (Fig. 11). The more rapid the deviation from the isoelectric level, the narrower the line becomes. Therefore, a QRS complex registers as a narrower line than a P or T wave. An infinitely fast deviation such as would occur upon standardization during the transition interval, with an infinitely fast galvanometer, would produce a registration thickness equal to that of the slit of light.

An electronic electrocardiograph, which is capable of registering electrocardiograms on small animals such as white mice accurately has been devised by Rappaport and Rappaport.[12] In normal white mice the heart rate is about 750 per minute as compared to 70 in the human being.

Thus, it can be seen that the art of graphic registration of cardiac action has made gigantic strides to achieve technical perfection. A Stetho-Cardiette produced by *Sanborn Company*, which provides simultaneous or separate stethogram and electrocardiogram plus amplified auscultation, is the present day stepping stone for any well-perfected instrument of the future.

Stetho-Cardiette

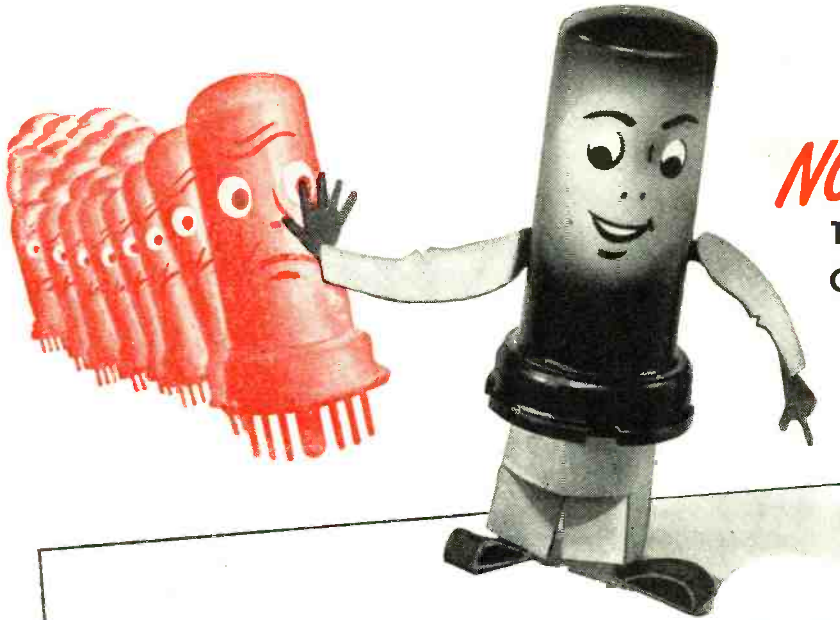
The electrocardiographic portion of the Stetho-Cardiette[8] uses modern radio or audion tubes to amplify the feeble electric currents produced by the action potentials of the heart, and to operate a sturdy, simple mirror galvanometer, which together with a permanently-adjusted, self-operating lens-and-camera system, produces a photographic "heart action" record or electrocardiogram.

In securing stethograms or "heart sound" records with the Stetho-Cardiette, the auscultatory sounds are first picked up by application of bells or chest pieces to the chest, identical to those used with the common acoustical stethoscope. These sounds are converted, by means of a crystal microphone, into minute electrical currents which are then amplified and conducted to a mirror galvanometer like that used for electrocardiograms. The operation of this galvanometer results in the stethogram or graphic record of the heart sounds.

Amplified auscultation is secured by application of the chest pieces in the customary manner, and the use of binaural audiophones. A numbered volume control permits the user to select (and to vary) the degree of amplification desired.

Amplifier and Galvanometer

The Stetho-Cardiette amplifier (Fig. 8) uses seven radio or audion tubes of the very latest design, one set of three tubes for the stethograph section, and a separate, distinct group of four for the electrocardiograph side. In the former (Fig. 7), there are two 1H5G tubes and a 1Q5G, which are



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resistance-capacity coupled with each other, and thereby provide a minimum of distortion since they can be operated linearly. As for the electrocardiograph amplifier (Fig. 12) it houses a #19 tube, a 1H5G and two 1Q5G's; coupling again is of the resistance-capacity type so as to achieve maximum fidelity.

It has minimum susceptibility to a.c. or other electrical interference and practically all a.c. is automatically eliminated from the record. This eliminator in no way distorts the record, but simply by-passes the undesired disturbances. Freedom from artefacts results from the lack of mechanical vibration. A "straight line" circuit provides distortionless recording of the electrocardiogram. To standardize, the operator simply presses a convenient button. Deflection of beam shadow on illuminated viewing scale stops momentarily at "peak." Hence, standardization is easily followed by the eye. Also, the sensitivity is "set" only once—at the start of the test, without the patient in the circuit, but may be repeated during test if desired. Positioning of beam shadow, sensitivity and voltage adjustments, and the like may be made at any time without disturbing the setting of any control. This greatly enhances the ease and celerity of making a test, and is an exclusive feature of the Stetho-Cardiette.

The mirror galvanometers used in the Stetho-Cardiette are simple and sturdy—yet amply sensitive to respond correctly to all electrocardiographic and sound impulses. It consists chiefly of a single permanent magnet of great strength—made from one of the modern alloys just recently developed; and two moving coils, each carrying a mirror—one for recording the electrocardiogram, and the other the stethogram.

The deflection speed of the electrocardiograph galvanometer is approximately 1/100th second—more than fast enough to respond to any heart impulse. Unlike the Einthoven string galvanometer, this speed of deflection is constant at all times, regardless of patient's resistance, skin currents and temperature, or any other factor.

Camera Unit

As for the operation of the camera unit, the entire magazine (Fig. 1) is readily removed for rapid loading—and a single thumb-screw is loosened to open the magazine for insertion of a new roll of paper. A viewing window shows at a glance the amount of paper remaining in the camera and an autographic slot permits the operator to write the patient's name, date, and other data directly on the record. Exposed paper feeds automatically into a separate record container, which is readily removed and taken to the darkroom. The Stetho-Cardiette driving mechanism—a powerful spring motor—is wound with a convenient crank, "built in" to the case. An indicator on the control panel next to the camera switch shows, through a graduated scale, the amount of tension remaining in the motor. This guards against either "running down" the motor or winding it too tightly. For the operator's convenience, a clutch-control is located on the instrument which permits 25 or 75 mm. per second film speed. The speed shift may be made with the camera running or stopped.

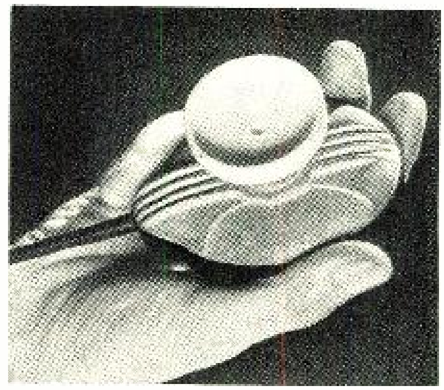


Fig. 13. Microphone supplied with the Stetho-Cardiette. It is of the piezo-electric crystal type, especially designed to pick up heart sounds.

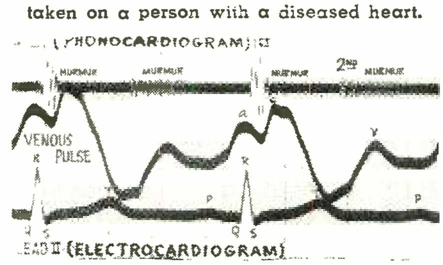
Microphone and Audiophone

The microphone supplied with the Stetho-Cardiette is of the piezo-electric crystal type, especially designed to "pick up" heart sounds, and to convert these sounds into electrical impulses, transmitting them without distortion to the amplifier and audiophones. This specially designed microphone is light in weight, only 10 oz.; and is shaped to fit comfortably in the hand (Fig. 13).

There can be no question that the *Sanborn* Stetho-Cardiette fulfills a technical gap needed in medical science. It has been built upon years of electrocardiographic instrumentation experience and incorporates all of the latest developments in the field.

(Ed.—The author, Maurice B. Rappaport, attended the Polytechnic Institute of Brooklyn and Columbia University where he studied electrical engineering, electronics, physics, and physiology. He has since concentrated on various scientific contributions, including pioneer work on the use of cathode rays, instrumentation in physiology, medicine, and scientific instruments. Mr. Rappaport is now Research Engineer at the Sanborn Company, Cambridge, Massachusetts, where he has done considerable fundamental research

Simultaneous registration of heart sounds over the apex of the chest (phonocardiogram), the pulse over the jugular vein (Venous Pulse), and the electrocardiogram. The three simultaneous recordings were taken on a person with a diseased heart.



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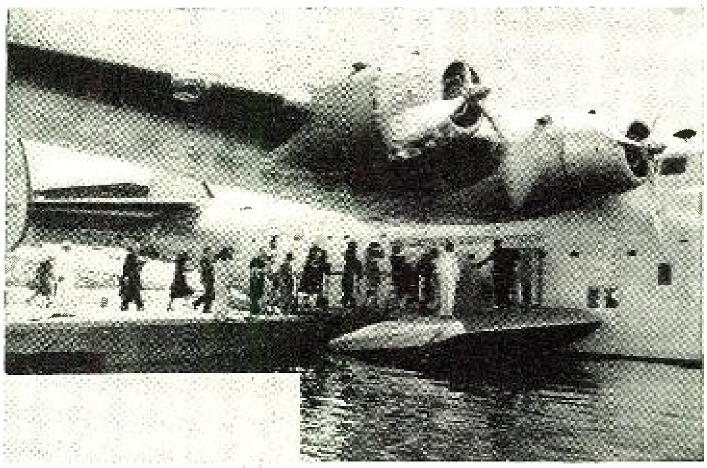
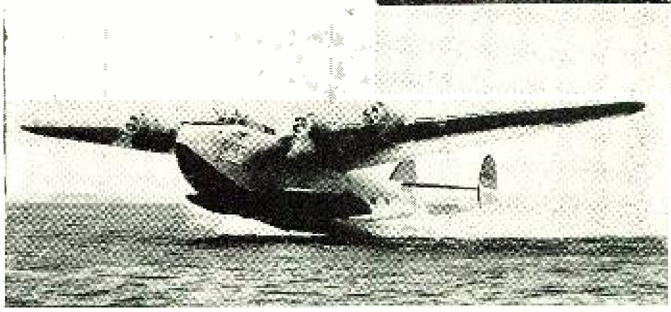
CARRY PASSENGERS, CARGO, MAIL

TO ALL PARTS OF THE WORLD

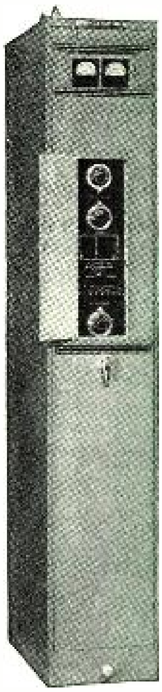
The choice of Wilcox radio communications equipment by Pan American World Airways is in keeping with Wilcox's record of supplying the commercial airlines with a large amount of their ground equipment. In addition, the Wilcox line includes aircraft transmitters, receivers and control equipment; also, many other forms of electronic and radar equipment.





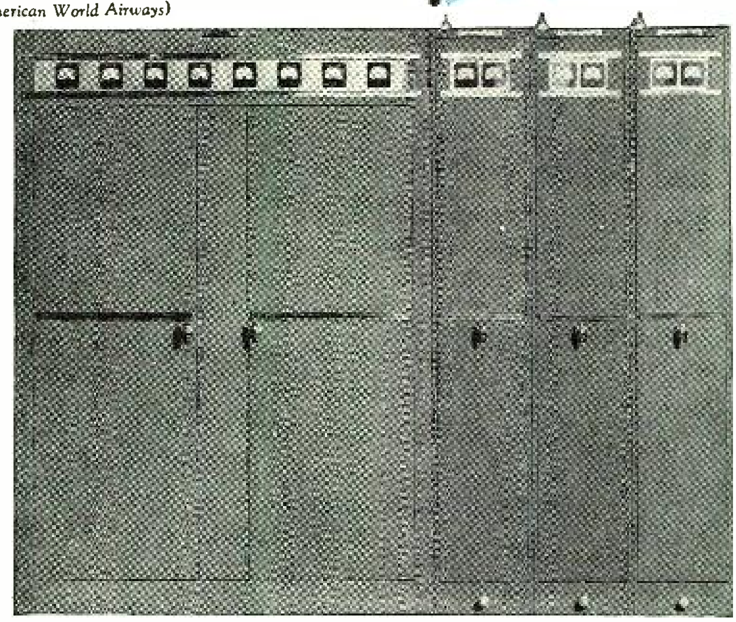
(Photos courtesy Pan American World Airways)

From Calcutta to Chunking



In Venezuela

. . . Pan American has installed this Wilcox 96C transmitter complete with power supply, modulator, remote control equipment, two RF channels and crystals. This station is a key point in Latin American operations... at the crossroads of three of Pan American's routes.



...is a group of Wilcox 96A transmitting stations. They were furnished Pan American to assist in the operations of CNAC, an aviation company owned and operated jointly by Pan American and the Chinese National Government... an airline which has proved a vital link in the lifeline of Chinese supplies during war.

WILCOX ELECTRIC COMPANY, INC.

Manufacturers of Radio Equipment

Fourteenth and Chestnut — Kansas City, Mo.

on heart auscultation, blood pressure measurement, pulse registration, and electrocardiography. Many of his articles have been published in leading medical publications and five, in particular, are listed in the bibliography of this article.)

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—30—

Practical Radar

(*Continued from page 98*)

Receiving Antennas

The function of the receiving antenna is to receive or pick up the returning echo signal and pass it to the receiver with a minimum of loss. The receiving antenna system includes the transmission line connecting the antenna array with the receiver.

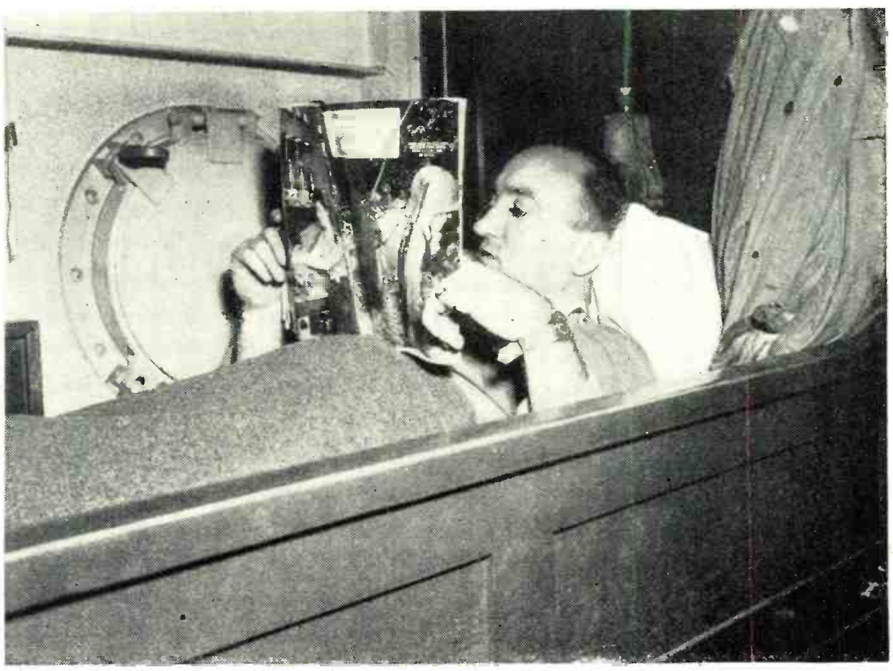
All of the properties of transmitting antennas which we have discussed are equally applicable to receiving antennas, when used at the ultra-high frequencies of radar operation.

Since there is a reciprocal relation between transmission and reception of energy, it is possible to use two antennas which are exactly similar in all physical and electrical characteristics.

A dipole array or parabolic reflector arrangement similar to that used to transmit the radar pulses can be used to receive the reflected echoes. And these signals are then passed directly to the radar receiver for detection and amplification.

Since the transmitting antenna and the receiving antenna are so similar —electrically and physically—and since they function during alternate periods of each complete out-and-back radar cycle, it is obvious that a single antenna could be used for both transmitting and receiving, if there was some method of switching the antenna between the radar transmitter and the radar receiver.

Sgt. Samuel Singer of Pittsburgh, Pennsylvania, relaxes in his bunk with a copy of RADIO NEWS. The sergeant, a Signal Corps radioman, is the only soldier aboard the civilian-manned Army Transportation Corps' seagoing tugboat, LT-222, operating in the Mediterranean. In addition to his job as chief radio operator, he was often called upon to send messages by semaphore and blinker light, and occasionally manned the 50-caliber machine guns. Although the sergeant is a noncommissioned officer in the Army, he holds an officer's position at sea and is entitled to eat at the Captain's table.



FOSTER TRANSFORMERS

AVAILABLE NOW!

Facilities for peacetime manufacture of transformers are already available at A. P. Foster, and, as war commitments are filled, will be increasingly at your service.

During the war years A. P. Foster has supplied thousands of custom-designed and custom-built transformers to all branches of our armed services, for use in all parts of the world under great extremes of climatic condition.

High production schedules have been maintained by advanced Foster manufacturing techniques. High standards of performance were demanded, achieved and will be maintained—to the benefit of America's peacetime economy.

As your own reconversion plans advance from the conference stage to the blueprint stage, it may well be worth your while to bear in mind that Foster engineers and designers are ready *now* to consult with you on every transformer problem and to furnish estimated costs and delivery schedules on experimental or quantity production of standard transformers or special jobs custom-built to your own specifications.

- BOB REID, 810 West 57th Street, Indianapolis 5, Ind., Telephone Broadway 2725
- BAUMAN AND BLUZAT, 2753 West North Avenue, Chicago 47, Ill., Telephone Humbolt 6809-10-11-12
- THE A. P. FOSTER COMPANY, BARRETT BORDER, 11 W. 42nd St., New York 18, N. Y., Telephone PEnnsylvania 6-9133

SPECIALISTS IN BUILDING TRANSFORMERS SINCE 1938

A. P. FOSTER COMPANY

TRANSFORMER ENGINEERS & MANUFACTURERS

719 WYOMING AVENUE, LOCKLAND 15, OHIO (SUBURB OF CINCINNATI)

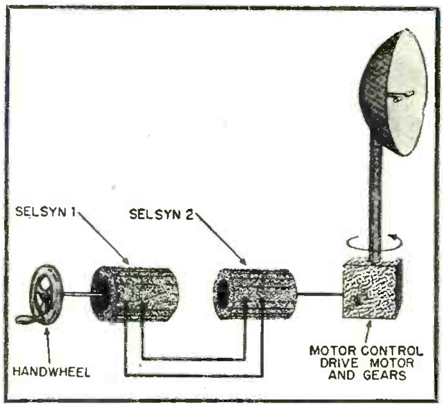


Fig. 14. A selsyn motor system.

A mechanical switch could not function many thousands of times per second, so an electronic switch known as a transmit-receive switch, or T-R switch (Fig. 13), is introduced to our basic radar set. This switch protects the receiver while the transmitter is pulsing, and then makes certain all of the received echo-signal energy passes directly to the receiver.

The T-R switch consists of combinations of spark gaps and sections of tuned transmission lines. When the transmitter pulses, the spark gaps flash over and, with the sections of transmission lines, form a high impedance path for the r.f. pulse into the receiver but a low impedance path for the pulse into the antenna. This allows most of the transmitted pulse to be radiated by the antenna system. However, a very small portion of the pulse is permitted to "leak through" into the radar receiver, in order to form the transmitter pulse or "pip" on the time base of the cathode-ray oscilloscope.

When the transmitter is not pulsing, the spark gaps of the T-R switch are quiescent and, with the sections of transmission lines, form a high impedance path for the returning echo into the transmitter, but a low impedance path for the echo into the receiver. This allows all of the reflected echo-signal energy to reach the receiver.

Controlling Radar Antennas

A final word about radar antenna systems concerns the method of controlling the physical movement of the antennas.

In small radar sets, the antenna may be controlled by a handwheel directly connected to the shaft of the antenna, so that it may be turned, by hand, in any direction.

But larger radar sets require more complicated arrangements for turning the heavy antenna arrays. Selsyn motors can be used for this purpose.

A typical control system (Fig. 14) consists of two selsyn motors, which rotate together and synchronously. There is no rigid mechanical connection between the two motors, yet any movement of the rotor of one causes an electrical unbalance resulting in a similar movement in the other motor.

(To be continued)

LATE NEWS

ABOUT RADIO SUPPLIES AND ELECTRONIC EQUIPMENT

THESE VALUABLE ITEMS *Available Now* OR VERY SOON . . . WIDE VARIETY . . . BIG SELECTION AND QUANTITIES

- head phones
- test equipment
- component parts
- marine transmitters and receivers
- code practice equipment
- sound detecting equipment
- vehicular operation police and command sets
- radio beacons and airborne landing equipment

HOW hallicrafters AS AGENT FOR RECONSTRUCTION FINANCE CORPORATION CAN HELP YOU GET YOUR SHARE OF THE AVAILABLE RADIO EQUIPMENT

Hallicrafters Co., Chicago, Illinois, world's largest exclusive manufacturer of short wave radio communications equipment, has been appointed by the U. S. Government as agent for the Reconstruction Finance Corporation.

Hallicrafters now offers for sale to the radio, electrical and electronic industries and to all interested parties a wide variety of radio materials. Each of these items is tested and appraised by Hallicrafters engineers—your assurance that you are getting a fair price and finest quality available. Ready for sale and shipment immediately through normal channels. Act now while selections are large.

hallicrafters RADIO

WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT

CLIP THIS COUPON NOW...

RFC DEPARTMENT 112, HALLICRAFTERS
5025 W. 65th ST., CHICAGO 38, ILL.

Gentlemen: Please send up to date listings of Government radio and electronic supplies.

NAME ______________________

ADDRESS ______________________

CITY ______________ ZONE ______

STATE ______________________

Manufacturers' Literature

Readers are asked to write directly to the manufacturer for the literature. By mentioning RADIO NEWS, the issue and page, and enclosing the proper amount, when indicated, delay will be prevented.

In view of the present paper shortage, a limited number of copies of the booklets described herein are printed. Manufacturers will endeavor to comply with all requests; however, if your copy is not received after proper request has been made, it most likely will indicate that the supply is exhausted.

RESISTANT FINISHES

A new leaflet covering the company's type 51 rust inhibiting finish is now available for distribution from *Special Chemicals Company.*

Pertinent data as to application, solution, and processing is included. Copies of the leaflet will be forwarded upon request to *Special Chemicals Company,* 30 Irving Place, New York 3, N. Y.

REFERENCE SHEET

The *Alden Products Company* has issued a new reference sheet for their standard "Blue Book" catalogue.

This sheet covers dial light sockets, fuse holders, telegraph keys, and coil housings and coil forms. Four new dial light socket types are illustrated with dimensions and one jewel light socket is shown.

A copy of this sheet may be obtained by writing *Alden Products Company,* 117 N. Main Street, Brockton 64, Massachusetts and asking for Page 1, of Section D, "Blue Book" catalogue.

VISUAL GAGES

A new catalogue which illustrates and describes Visual Gages manufactured by *The Sheffield Corporation* of Dayton is now being offered by the company.

The catalogue shows the various attachments which can be used with the Visual Gage, making possible a great number of different applications.

The instrument is an indicating comparator, with either English or metric scale, used for checking external and internal dimensions, width, thickness, height, depth, diameter, out-of-round, concentricity, the angularity of surfaces or angularity between a bore and a surface, and run-out. Various applications of this instrument are demonstrated.

A copy of the catalogue will be forwarded upon request to *The Sheffield Corporation,* Dayton 1, Ohio.

NEW SERVICE CATALOGUE

A new 12-page catalogue covering up-to-the-minute information on fixed and variable resistors which are available for non-military repair and replacement uses is being offered by *International Resistance Company.*

The catalogue features the new small sized BTA and BTS resistors as well as presenting the entire BT and BW line in preferred RMA ranges. Also included is data on the new IRC Century Line of controls. An easy-to-use index is included for ready reference.

Copies of Service Catalogue No. 50 are available from the distributors of IRC products.

PARTS CATALOGUE

A copy of the "1945 Supplement," a listing of all types of radio parts and components is now being offered to radio servicemen by *The Radolek Company* of Chicago.

Radio textbooks, condensers, speaker replacement parts, victory transformers, resistors, controls, cabinets, chasses, and intercommunicators are only a few of the many items listed in this catalogue.

In order to receive your copy, address requests to *The Radolek Company,* Randolph at Jefferson Street, Chicago, Illinois.

INSTRUMENT STORY

A pocket-size brochure dealing with the history, uses, and applications of hermetically sealed electrical indicating instruments is now available from *Marion Electrical Instrument Company.*

The booklet besides relating the techniques used in manufacturing these instruments demonstrates the various future uses of all types of meters in electrical equipment under varying conditions.

A free copy of the brochure may be secured by writing *Marion Electrical Instrument Company,* Manchester, New Hampshire.

RCA BROCHURE

A new brochure dealing with the many different uses of sound systems in industry, institutions, and commercial organizations is being offered by the *RCA Victor Division* of *Radio Corporation of America.*

Entitled "RCA Sound Systems," the brochure uses block diagrams to present the special services rendered by sound in various types of establishments and the arrangement of control consoles, microphones, and loudspeakers in different kinds of installations.

The needs of industrial plants and offices, schools, hospitals and penal institutions, and various types of commercial establishments are covered by the diagrams and accompanying text.

FAMOUS KENYON T-LINE TRANSFORMERS

BORN IN THE EARLY 1930's...

TODAY THE MOST COPIED-OF-ALL TRANSFORMER HOUSINGS

THE MARK OF EXCELLENCE

We, at Kenyon, take a good deal of pride in our famous **T-LINE TRANSFORMERS.** Similar units are now produced and advertised by many of our competitors who long ago realized that the **T-LINE** Housing was a superior Housing in many respects — outdating by years the unpotted open-type Transformers produced by other Transformer Manufacturers.

Additional features of the famous

KENYON T-LINE

are:

- ***Excellent Appearance***
- ***Universal Mountings***

Mounting centers remain exact because they are die-punched all at the same moment in a single operation.

- ***A Manufacturer's Dream***

Because they provide an excellent electrical and mechanical design that can be made cheaply from plentiful materials.

Kenyon is extremely satisfied with its outstanding engineering developments. The **KENYON T-LINE** case when produced in the early 1930's was years ahead of its time.

Our engineers are indeed proud to be the originators of such a popular design and point to its duplication with pride.

Kenyon engineering intends to maintain its place as a pioneer in the continued development of outstanding Transformer Equipment.

Inquiries invited. Write for our NEW 1945 Illustrated Catalog

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK, U. S. A.

A copy of this brochure will be forwarded upon request to *RCA Victor Division, Radio Corporation of America,* Camden, New Jersey.

FLUORESCENT CATALOGUE

A new fluorescent catalogue featuring all of the new fluorescent fixtures is being offered by *Olson Radio Warehouse.*

Included in the listing are industrial and commercial fixtures as well as kitchen units and bed lamps. In addition, details of a new development in strip lighting which can be supplied without reflector, half reflectors, or full reflectors are given.

Every type of fixture described in the catalogue is in stock and is immediately available without priority within 48 hours.

Copies of the catalogue may be obtained by writing direct to *Olson Radio Warehouse,* 73 East Mill Street, Akron 8, Ohio.

PARTS CATALOGUE

Radionic Equipment Company has just released their new Catalogue "C" which lists hundreds of hard-to-get radio parts.

This booklet will be of special interest to radio servicemen and laboratory engineers. Merchandise listed in the catalogue is immediately available.

Copies of the catalogue will be forwarded upon direct request to *Radionic Equipment Company,* Dept. PR, 170 Nassau Street, New York 7, New York.

CONTROL DISPLAY

International Resistance Company has introduced a novel merchandise display to market their Century Line of Type DS controls.

The convenient counter display merchandiser offers sixteen of the most frequently called for controls which are displayed in such a manner that selection of needed controls by serviceman is simplified.

In addition to space for the controls, the merchandiser has a holder for folders dealing with the line. The folder is in full-color and describes in detail the items included in the Century Line.

Details of this display unit may be obtained upon request to *International Resistance Company,* Dept. 20-G, 401 N. Broad Street, Philadelphia 8, Pa.

CRYSTALS

The *Beaumont Electric Supply Company* of Chicago has just issued an interesting 16-page booklet telling the story of the manufacture of quartz crystals.

The story is told in pictorial form with informative captions and explanatory material.

A copy of the booklet may be secured by writing *Beaumont Electric Supply Co.,* 1319 S. Michigan Avenue, Chicago, Illinois.

CATALOGUE

Precision Equipment Company of Chicago have just issued an "Industrial Buyers' Bulletin" listing equipment which is in stock for immediate delivery. The listing includes such items as steel tool-room units, fans, slide rules, micrometers, counting scales, time switches, inverters, wire strippers, etc.

A copy of this bulletin will be forwarded upon request to engineers, purchasing agents, and other industrial executives. Requests for this bulletin should be addressed to the company at 32 North State Street, Chicago 2, Illinois.

—30—

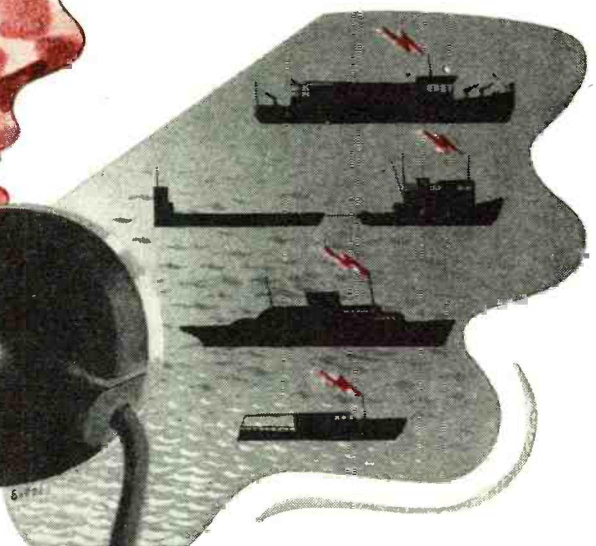
Jungle control tower on a forward RAF fighter airstrip, operating against the Japanese in support of the 14th Army. All fighter aircraft to and from this field are controlled from this improvised tower by radio or blinker light.

relays

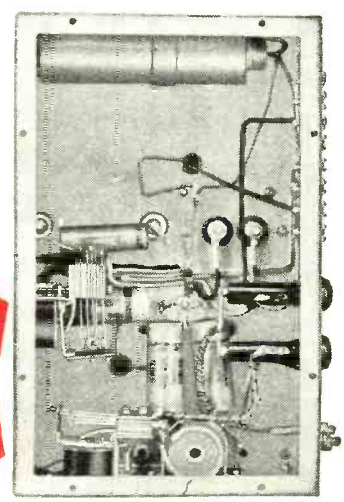
IN MARINE COMMUNICATIONS

From ship to ship and from ship to shore—whether on war craft or on peacetime boats of commerce and travel—marine radio communications equipment plays a major role. Leading manufacturers of such equipment use Relays by Guardian, two of which are shown installed in the DC power supply unit of the HT-11 Radiophone manufactured by the Hallicrafters Company, Chicago.

hallicrafters RADIOPHONE



Hallicrafters HT-11 Radiophone Unit Showing DC Power Supply



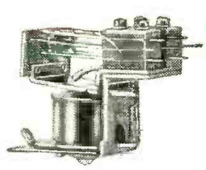
for Automatic Control of Electrical Circuits...

THERE'S A *Relay* BY GUARDIAN

In this application one Guardian relay in its normal position feeds the input of the Vibrapack for receiving purposes. On the changeover from receiving to transmitting it disconnects the Vibrapack and simultaneously energizes the other relay. This in turn connects the Dynamotor input and output circuits.

Both relays are Guardian Series 115 with double wound coils for operation on 6 or 12 volts D.C. with the 6 volt winding in parallel and the 12 volt winding in series. It is a small, compact relay, ideal for use where space is limited.

Its use in Marine Radiotelephone is but one illustration of the many applications of relays in radio and electronic equipment. For complete description of numerous types of Relays by Guardian, write for Guardian's new Bulletin No. 6.I.



Series 115 DC Relay

GUARDIAN ELECTRIC

1630-K W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY

Radar Terms

(*Continued from page 42*)

Indicator—Any of several types of cathode ray oscilloscopes.
Indicator gate—See Gate.
Isolating circuit—A stage which passes signals in only one direction through a circuit.
Klystron—A velocity modulated tube used to produce low-power u.h.f. oscillations.
Lighthouse tube—A high-frequency triode of special design used to produce u.h.f. oscillations of medium power.
Limiter—A circuit which limits, clips, or removes either (or both) the positive or negative extremities of a wave form.
Listening period—The time during which a radar transmitter is quiescent or not radiating energy.
Magnetron—A high-frequency magnetic-field diode of special design used to produce u.h.f. oscillations of very high power.
Main pulse—See transmitter pulse.
Master oscillator—A source of timing oscillations which control or affect all other radar circuits.
Microsecond—One millionth of a second.
Modulator—A circuit which directly controls or triggers the radar transmitter.
Multivibrator—A relaxation oscillator which oscillates of its own accord (a free-running multivibrator), or which oscillates only when triggered by an external voltage.
Overdriven amplifier—Amplifier circuit in which the combination of cut-off limiting and saturation limiting of a sine wave produce a rectangular voltage wave.
Peaking circuit—A differentiator circuit used to sharpen a wave form.
Peak power—The maximum output power of an r.f. pulse at the transmitter.
Presentation—The form in which radar echoes appear visually on an oscilloscope.
Pulse—A sudden change of voltage (or current) of brief duration.
Pulse duration—The time duration of a pulse.
Pulse generator—See Electronic timer.
Pulse rate—See Pulse recurrence frequency.
Pulse recurrence frequency or p.r.f.—The timing rate of radar pulses, originating in the electronic timer.
Pulse recurrence time—The reciprocal of pulse recurrence frequency.
Pulse width—See pulse duration.
Quiescent period—See Listening period.
R.F. oscillator—Output stage of the radar transmitter in which u.h.f. oscillations are generated.
Range—The direct-line distance between a radar set and a target.
Receiver—The component of a radar set which receives, detects, and amplifies echoes reflected from targets.
Receiver gate—See Gate.
Recurrence rate—See Pulse recurrence frequency.
Repetition rate—See Pulse recurrence frequency.
Ring oscillator—Any number of pairs of high-frequency triodes operated as an r.f. oscillator in a tuned-grid tuned-plate circuit.
Rotary spark gap—A pulse-producing device in which circularly arranged electrodes are rotated past a fixed electrode producing periodic high-voltage arc discharges.
Saturation limiting—Limiting action of an amplifier when operated beyond the point where grid current flows.
Scanning—The direction of pulsed r.f. energy over or across a given region or area.
Sea return—That part of the r.f. pulse re-

flected by water surrounding a sea-borne radar set.

Spark gap—An arrangement of two fixed electrodes between which a high-voltage arc discharge takes place.

Squaring amplifier—See Overdriven amplifier.

Squegging oscillator—An extreme form of grid blocking in an r.f. tuned-grid tuned-plate circuit.

Synchronism—The relationship between two or more periodic or recurrent wave forms, when the phase difference between them is zero.

Synchronizer—See Electronic timer.

Tail—Attenuated decay of an r.f. pulse.

Target—Any object which produces a radar echo.

Time base—The trace produced on the screen of a cathode ray tube by deflection of the electron beam.

Time constant—An indication of the speed with which a circuit can be charged or discharged.

Timer—See Electronic timer.

Transmitter pulse—Burst of r.f. energy radiated by the radar transmitter. The pulse appears as a strong signal at the left end of the oscilloscope time base. —30—

Saga of the Vacuum Tube

(*Continued from page 58*)

294. *White, G. W.—"The 'Discharge Tube' Used as a Wireless Valve" Electrician Vol 76, October 22, 1915, page 103.*

295. *Denman, R. P.—"Catalogue of the Collections in the Science Museum. Electrical Communication. II Wireless Telegraphy and Telephony" H. M. Stationery Office London, 1925, page 44.*

296. *See reference 284, page 165.*

CAPTIONS FOR ILLUSTRATIONS

Fig. 205. Round type "C" Valve. Photograph courtesy R. McV. Weston.

Fig. 206. Left—Round type "N" Valve with screw base. Right—Round type "N" Valve with Ediswan bayonet base. Photograph courtesy Marconi's Wireless Telegraph Co., Ltd.

Fig. 207. Marconi type "27" Receiver, 1914-1918, using Round type "N" Valve. Photograph courtesy Marconi's Wireless Telegraph Co., Ltd.

Fig. 208. Round type "T" with multiple cathodes. Photograph courtesy R. McV. Weston.

Fig. 209. Top view of Round type "T" with tubulation removed, showing characteristic Round mesh type grid.

Fig. 210. Round type "CA" Valve. Photograph courtesy Radio Corporation of America.

Fig. 211. Marconi Short Distance Wireless Telephone Transmitter and Receiver. The tube in the gallows frame is the Round type "TN" used for transmitting. The tube at the right rear is the Round type "C" used for receiving. Photograph courtesy Marconi's Wireless Telegraph Co., Ltd.

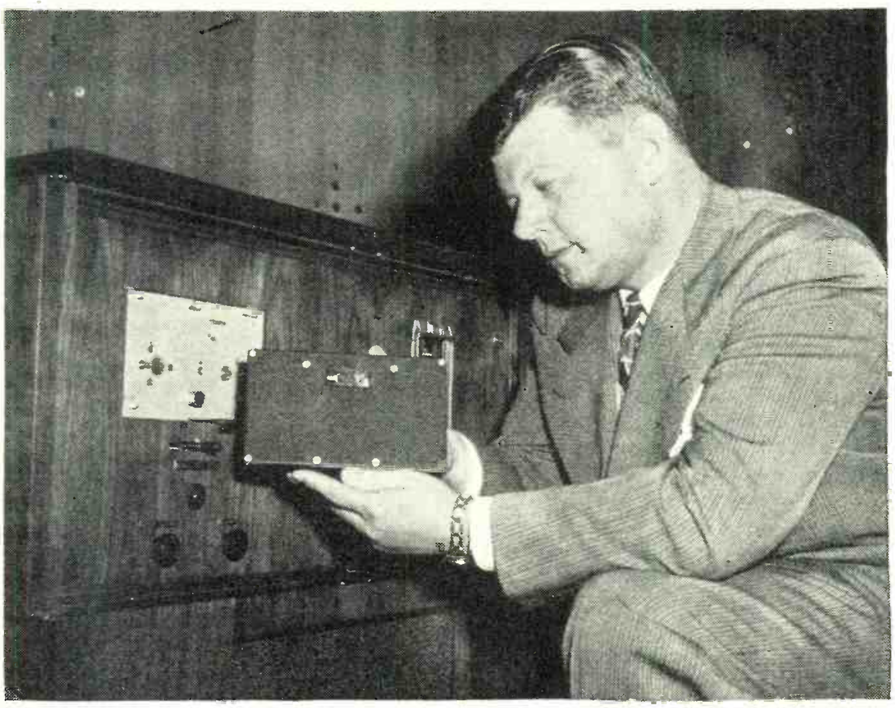
Fig. 212. White Valve. Photograph courtesy R. McV. Weston.

Fig. 213. Mark III Amplifier using White Valve and de Forest Audion. Photograph copyright by H. M. Stationery Office.

Fig. 214. Osram R2A Valve, fitted with candelabra base for use in naval apparatus designed for de Forest Audion. This valve was usually supplied unbased, the user applying whatever base he saw fit. Photograph courtesy Bell Telephone Laboratories.

(*To be continued*)

William P. Lear, President of Lear, Inc., holding the "magazine" of a radio and wire recorder combination shown recently at a special preview given to the press and science writers. The "magazine" does away with threading the wire; it can be changed as easily as slipping a pack of cigarettes into your pocket. Wire recorders will become a part of many postwar home receivers and they will also be offered as a separate unit, to be attached to present sets, as well as for other commercial entertainment, educational, and industrial uses.




The Lines are down... BUT NOT FOR LONG!
Motorola F-M equipment in a fixed transmitting station.
Motorola Mobile Unit mounted on a line patrol car.
Motorola 2-WAY F-M RADIOTELEPHONE HELPS MAINTAIN CALIFORNIA POWER SUPPLY
Sandstorms, cloudbursts and blizzards are no surprises for line-patrolmen of the California Electric Power Company. Here, in the Sierra Nevadas, communication is an important factor in the power-line maintenance that is a 24-hour job.
Two-way F-M radiotelephone was seen as the answer to this communication problem, and Motorola (makers of the battle-tough "Handie Talkie") was the obvious choice for equipment that could be depended on under all conditions.
More and more, industry is turning to Motorola for radio-telephone communications. One of our field engineers will be happy to show you how the efficiency of *your* operation can be increased through the use of radio.
FREE! Write for detailed Motorola Radiotelephone Directory covering more than 1000 Motorola 2- and 3-way F-M systems in United States, Canal Zone and Hawaii.
Motorola
GALVIN MFG. CORPORATION • CHICAGO 51
COMMUNICATIONS AND ELECTRONICS DIVISION
F-M & A-M HOME RADIO • AUTO RADIO • PHONOGRAPHS • TELEVISION
POLICE RADIO • AIRCRAFT RADIO • RADAR • MILITARY RADIO

Within the INDUSTRY

EMERSON RADIO AND PHONOGRAPH CORPORATION has announced the appointment of the *Tafel Electric and Supply Company* of Nashville, Tennessee as distributor for the *Emerson* radio and television sets.

Carl W. Thomas is the merchandise manager of the company and will act in the capacity of sales manager for *Emerson* radios.

* * *

SUPREME INSTRUMENTS CORPORATION of Greenwood, Mississippi has announced the appointment of *American Steel Export Company, Inc.* of New York as export sales representative for the company's line of radio and electronic testing equipment.

W. G. Maitland, manager of the *Export Company's* Radio Division, will handle sales of *Supreme* equipment in all foreign countries with the exception of Canada and Alaska.

* * *

J. J. CLUNE has been appointed Sales Manager of *National Union Radio Corporation's* Distributor Division.

Mr. Clune will combine his new activities with those as head of the company's War Service, a department which he has directed since the outbreak of the war. He is one of the oldest employees in point of service with the company as he joined the organization in 1930.

In his new position Mr. Clune succeeded Ed. DeNike who resigned from *National Union* to become Managing Editor of *Ziff-Davis Publishing Company's* new dealer publication, RADIO & APPLIANCES.

* * *

WEBSTER-CHICAGO CORPORATION of Chicago has named *H. Neuert & Associates* as export representative.

The Neuert organization, located at 32 W. Randolph Street, Chicago, Illinois, are specialists in the radio and electrical fields.

* * *

DEL WAKEMAN has been named Advertising Manager of *The Magnavox Company* of Fort Wayne, Indiana, according to the announcement by Frank Freimann, Executive Vice-President of the company.

Mr. Wakeman was formerly associated with *Keeling & Company*, Indianapolis advertising agency, in the capacity of Vice-President and Manager.

In his new position, Mr. Wakeman will direct the current *Magnavox* advertising program which uses a series of portraits of great men of music and a second series depicting events in the lives of the composers. This program was adopted by the company during the period when civilian production of receivers was curtailed.

* * *

FRANK L. MARSHALL has been named to the sales staff of *Aerovox Corporation* in New Bedford, Massachusetts.

Mr. Marshall, formerly assistant sales manager of *Bundy Tubing Company* of Detroit, assumes the post of assistant sales manager for Aerovox, handling sales to equipment manufacturers.

Mr. Marshall is a graduate of Northwestern University where he was a member of the Big Ten championship basketball team of 1931. He is a member of the Army Ordnance Association.

* * *

CONCORD RADIO CORPORATION of Chicago has acquired two buildings at 227 to 233 W. Madison Street, Chicago which will give more than twice the square-footage of the present quarters.

This store is being constructed to provide added facilities for the greatly increased volume and also to offer the latest facilities for the display, demonstration, and sale of radio sets, amplifiers, and other postwar equipment as soon as these are available.

* * *

C. M. WYNNE, director of export sales for *Overseas Industries, Inc.,* will be in charge of export sales for the *Galvin Manufacturing Corporation.*

Overseas Industries, Inc. will act as Export Sales Department for the *Motorola* radios in all parts of the world outside of the United States and will cooperate with *Galvin* in taking their expanding merchandising campaign to foreign countries.

The firm is located at 431 S. Dearborn Street, Chicago 5, Illinois.

* * *

RCA VICTOR DIVISION has purchased the *Brenkert Light Projection Company* of Detroit, according to the announcement made by Frank M. Folson, Executive Vice-President of the company.

The *Brenkert Company* manufactures motion picture projectors, arc lamps, and accessories. The company will continue to operate as a separate company under its existing name, and Karl and Wayne Brenkert will remain active in its management.

Production facilities will be increased to meet the rising demand for the products of the company.

* * *

LAKE RADIO SALES COMPANY of Chicago has recently become a member of the National Electronic Distributors' Association.

Announcement of this association with the NEDA was made by Hy Goldberg and Bernard Friedman, co-owners of the company.

The firm handles all types of radio parts and cabinets.

* * *

MURRAY G. CROSBY has joined the firm of *The Paul Godley Company*, Consulting Radio Engineers, Upper Montclair, New Jersey.

Mr. Crosby will specialize in radio communication systems, including FM problems, development projects, point-to-point mobile and air-borne communications, multiplex operation, relay transmission, etc.

Mr. Crosby was associated with the Communication Division of *RCA Laboratories* as a research engineer for the past 20 years. He specialized in FM and holds over 100 patents, among them being the reactance-tube automatic frequency control type of frequency modulator used in FM transmitters.

He is the author of a number of basic technical articles on the subject of frequency and phase modulation.

* * *

MAGUIRE INDUSTRIES, INC., has been granted the necessary authority by the Federal Communications Commission and the War Production Board to use its newly developed railroad radio equipment to conduct an extensive series of experimental tests with the *Reading Railroad*.

The tests will cover the operation of very high frequency space radio equipment in freight yards, terminals, and for end-to-end communications on freight trains. The frequencies allocated for these tests are within the 156-162 megacycle band which has been proposed for railroad service.

Officials of the company have indicated that a major part of the engineering and production facilities of the company will be devoted to the railroad communications field.

* * *

RAYTHEON MANUFACTURING COMPANY is negotiating with the Waltham Park Commissioners to lease a site in the Prospect Hill Park, Massachusetts, for the erection of a television and FM broadcasting station.

This is one of the highest points in Metropolitan Boston and authority to grant leases within the park district was extended to the city of Waltham by Governor Maurice J. Tobin of Massachusetts.

The station will serve Metropolitan Boston and surrounding territory and it is planned to incorporate in it television and FM transmitters, a power room, quarters for the engineering staff, and a large public room to enable visitors to observe the operation of the station.

* * *

THE RECORDIT COMPANY of St. Louis has announced that as of July 1, the name of the firm is *Recordit Distributing Company.*

In announcing the change, A. Edward Gross, president of the firm, explained that the new name will assist in identifying the company in the field of distributors.

The company is located at 315 N. 7th Street, St. Louis, Missouri.

* * *

STEWART-WARNER CORPORATION has named *Philadelphia Distributors* of Philadelphia to handle their line of postwar home radios for eastern Pennsylvania, southern New Jersey, and northern Delaware.

Al Hughes and Harry Ellis, owners of *Philadelphia Distributors* first became distributors of Stewart-Warner radios in 1935.

* * *

MEFFORD R. RUNYON has been elected to the post of executive vice-president and director of the *Columbia Recording Corporation,* according to the announcement made recently by Edward Wallerstein, president of the company.

Mr. Runyon was on active duty with the Navy with the rank of Commander until his retirement from active duty on May 30.

Mr. Runyon joined the *Columbia Broadcasting System* in 1931, became vice-president in 1936 and later was named director of the company. He was granted a leave of absence by the company to enter active duty as a Lt. Comdr. in the U.S. Navy in September, 1942.

He will make his headquarters at the Bridgeport, Connecticut, plant of the *Columbia Recording Corporation.*

* * *

THE HALLICRAFTERS COMPANY has filed applications with the WPB and the OPA in Washington for spot authorization to manufacture 250,000 FM converters.

These units are designed to enable prewar FM receivers to receive programs on the new 88 to 106 megacycle band established June 27 by the Federal Communications Commission.

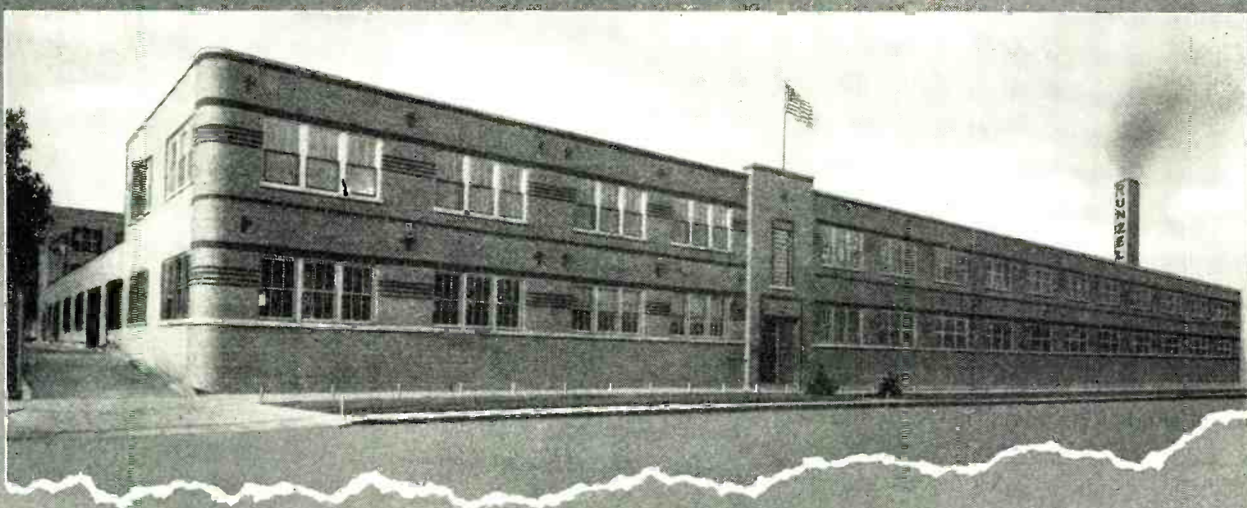
The converter was designed and demonstrated by *Hallicrafters* at the request of the FCC after it was pointed out at the hearings that 400,000 or more prewar FM receivers would be made obsolete if the band was changed.

Runzel

CORDS · WIRES · CABLES

IS READY

This battery of cord braiding machines, carefully watched over by especially trained inspectors, is one of the typical operations necessary to making a good product.

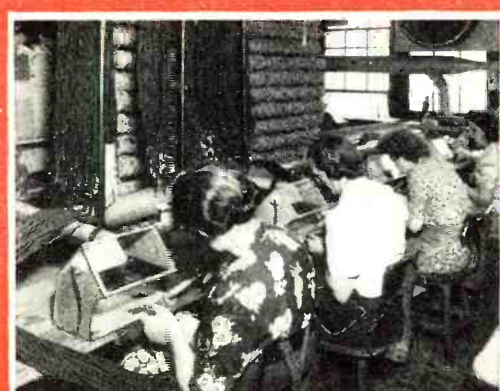


with

THE PLANT • THE PERSONNEL
THE EQUIPMENT

for Fast Service to the

COIN MACHINE • RADIO
TELEPHONE • ELECTRONIC
AND ALLIED INDUSTRIES



Soldering terminals on cords requires not only skill, but painstaking effort and patience, supplied by these trained operators.

RUNZEL CORD & WIRE CO.

4723-31 MONTROSE AVE. • CHICAGO 41, ILLINOIS

Both one-tube and three-tube models have been developed and during the period when FM stations are being changed over to the new frequencies a receiver provided with one of these converters will be able to receive stations in both the old and new bands by switching the converter in or out of the circuit.

* * *

GENERAL ELECTRIC COMPANY has announced three new personnel appointments in the Electronics Division.

Paul L. Chamberlain has been appointed Manager of Sales for the Receiver Division with headquarters in Bridgeport, Conn.

Harry A. Crossland has been appointed assistant to the manager of the Government Division with headquarters in Washington, D. C., and James D. McLean is the new Manager of Sales for the Transmitter Division at the Schenectady headquarters of the company.

* * *

ROBINSON-HOUCHIN OPTICAL COMPANY of Columbus, Ohio, has announced the appointment of Dr. Christian A. Volf as Director of Research in the electronic and acoustic division of the company.

During the past 20 years, Dr. Volf has operated the *Volf Acoustic Laboratories* in New York and California during which time he contributed a number of developments in the acoustical field.

The Volf Resonator is one of his contributions to the radio field, beside improvements in the first radio loud speakers.

At the same time, the company announced that the production of Radiotone, a recording unit developed by the company has been temporarily discontinued so that all of the efforts of the research staff can be concentrated on the development of the new RH Rad-O-Recorder and other electronic equipment. The company anticipates that on or before January 1, 1946, a new line of semi-professional equipment will be available.

* * *

BENDIX RADIO DIVISION, through its general sales manager of radio and television, Leonard C. Truesdell, has announced that fifty postwar *Bendix* radio-phonograph combinations are being awarded as prizes in a novel war bond letter writing contest for GI's in the European Theater.

Certificates for postwar delivery of the combinations through distributor and dealer channels have been turned over to Stars and Stripes, official Army overseas newspaper, for awarding to those writing prize winning letters on the subject "My Savings and Postwar Plans."

The contest which is sponsored by the ETO War Bond and Insurance Office is open to military personnel in the ETO who have taken out a new war bond allotment or have purchased a bond since May 1, 1945.

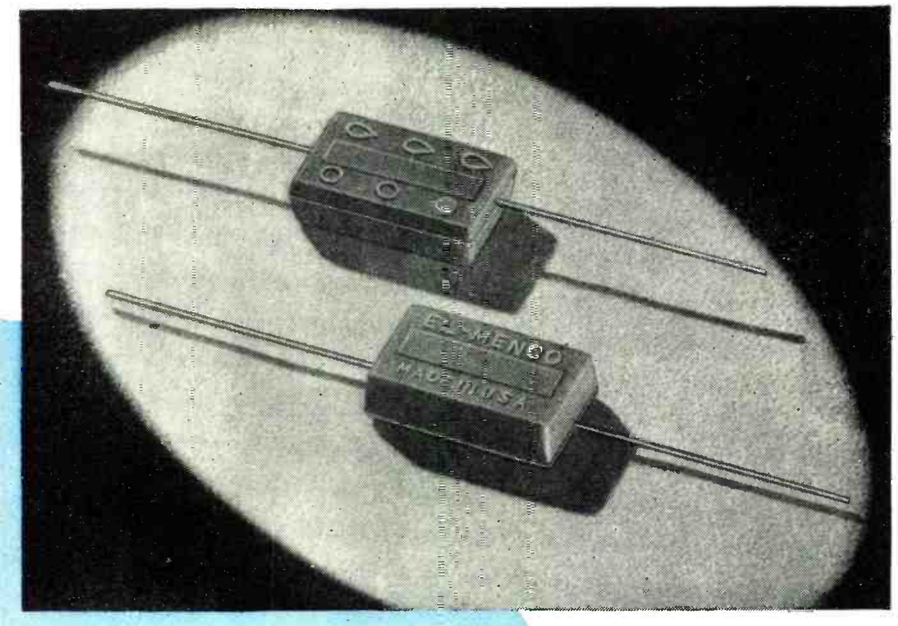
Other prizes in the contest include automobiles, trucks, and refrigerators.

* * *

SIDNEY E. JOHNSON of Atlanta, Georgia, has been named southern regional manager of the sales department, manufacturing division of the *Crosley Corporation,* according to the announcement made by James H. Rasmussen, *Crosley* general sales manager. Mr. Johnson succeeds Syd D. Camper, who has resigned to become distributor for the *Crosley Corporation* in Jackson, Mississippi.

—30—

The photograph shows the monitoring room at Radio Luxembourg, where all news was gathered for use in broadcasts to the Wehrmacht and civilian populations inside the Reich and German-occupied territories.



Trifles

MAKE PERFECTION

Trifling in its size and prominence, the capacitor nevertheless plays a vital role in electronics performance. In planning your postwar product, insure the correctness of your capacitor equipment by installing El Menco—the capacitor that has been tested around the world.

Send on your company letterhead for new capacitor catalog.

El-Menco

CAPACITORS

Molded Mica — Mica Trimmer

ARMY NAVY

THE ELECTRO-MOTIVE MFG. CO.
Willimantic, Connecticut

Wheatstone Bridge

(*Continued from page* 31)

deflection to permit realization of the full accuracy of the instrument, which is substantially plus or minus .2%. So, as is usual to all bridges, the battery voltage is increased by connection of a 45, 90, possibly even 180, volt dry battery to the upper left pair of binding posts marked "EXT. BAT." The internal 6-volt battery is then disconnected in favor of the external battery by simply throwing the toggle-switch down to its "EXT. BAT." position, when measurements in the range of 1 to 11 megohms are made exactly as above.

No doubt by now most readers are mentally saying, "Fine, but *how* do you read that wierd looking dial? And why does it look the way it does?" The answer is as simple as it appears not to be apparent. The dial is graduated linearly from 0 to 11.4, and actuates a potentiometer of 11,400 ohms nominal resistance. But since the potentiometer must be wound with commercial resistance wire, even though the wire itself and the winding technique are held to unusually close tolerances, no two potentiometers have the same total, or incremental, resistance to the high degree of accuracy demanded in such a bridge. The superficial solution is to hand-calibrate each and every dial—a laborious and costly operation. Yet this is exactly what is done. Only the head was first used to save the hands. Each dial is etched identically; each is alike—yet each dial perfectly matches a potentiometer differing slightly from its predecessor. This is effected by reading the dial graduations, not against a single fixed fiduciary marker—the usual intersection of two lines—but by reading the conjunction of three lines. Thus number 6 on the dial, for example, is read when the intersection of its dial graduation, the curved line bisecting it, and the diagonal line made by the sloping edge of the transparent indicator all three coincide.

Examination of Fig. 1 will reveal that the dial graduation associated with the numeral 6 (or other numeral and its graduation) will fall under the transparent fiducial marker for a range of 11 dial divisions, or 10% of the total dial length. Thus variations in individual potentiometers of as much as plus or minus 5.5% may be accommodated upon a standard, neat-appearing dial by the process of adding a third line, bisecting the major dial graduation at the appropriate point. Actually, this third mark is made in the form of a curve scribed directly into the face of the dial in final laboratory test and adjustment of each instrument. It is in fact an exact trace of the resistance increment of the particular potentiometer employed in the particular bridge. This three-line-conjunction method of providing precise indication is worthy of remembrance, since its employment can result in an order of dial calibration accuracy impossible to a factory-made dial and resistors, capacitors, etc., usually used through necessity by the individual experimenter.

Turning to Fig. 2, the simplicity of the bridge is clearly apparent. At the upper right is the microammeter, a 100-0-100 movement of very low resistance to insure maximum sensitivity and so maximum accuracy of null indication. Below it is the group of eight precision wire-wound, substantially zero-temperature-coefficient resistors used in the ratio arms. Ranging from 1 ohm to 1 megohm in decade steps, they are selected for two arms of the bridge by the special low-resistance switch immediately below them—the range, or "MULTIPLY BY," switch. To the right are the binding posts for connection of the unknown resistor to be measured. At right top is the post for the external battery for 1 through 11 megohm resistance measurements. Just to the left of the meter is the "INC. SEN" switch for the meter, and visible only as a tiny black dot above it, the 10 ohm wire-wound resistor shunting the meter for its protection in preliminary adjustment of the R-dial until the push-switch is depressed. To the left are four standard A-cells of 1½ volts each, connected in series to yield 6 volts to power the bridge for all resistance measurements from .01 ohms up to approximately 1 megohm. Disposed between the batteries is the variable bridge arm, a large, high-quality precision wire-wound potentiometer of special design, since it must indeed be carefully controlled in production to yield a demanded total and incremental resistance uniformity of plus or minus 2%. Wiring is all of heavy bus-bar, except for flexible battery connections.

The accuracy of such a bridge may be conveniently regarded as the sum of all errors of the resistors employed in any one measurement. Three out of a total of ten resistors are employed on each range. Fixed resistors are held to plus or minus .1%, and the potentiometer is hand-calibrated to equal accuracy at each major graduation, or 11 points, on its dial. The over-all accuracy therefore to be expected should be to plus or minus .2% theoretically, since it is most improbable, indeed, that three resistors, each held to plus or minus .1% will all vary to the same degree and in the same direction. Careful investigation has revealed that this theoretical accuracy is realized in production. However, it is also a function of the operator's care in reading the meter null-indication, or bridge balance. This accuracy may be amplified in extreme cases by the use of a magnifying glass on the meter, and by use of a higher-voltage external battery, since the higher the bridge battery voltage, the higher will be the accuracy of the null indication.

Fig. 3 shows the schematic circuit of the Model 901 bridge. It is simple in the extreme. The bridge itself consists of the four diagonal arms A, B, S, and X; X being the unknown resistor. If resistor A = B, then S = X, for one simple statement of bridge balance, or zero current indication upon meter M. This relationship may be stated a number of ways, and is in different texts. From it may be derived ratio equalities, and it is from this fact that unknown resistances lying between .01 ohms and 11 megohms may be measured by comparison with one variable resistor of 11,400 ohms and a total of eight (actually nine through dual usage of the 1 kilohm standard used successively in two different bridge arms) fixed resistors.

Such then is the modern form of a precision d.c. resistance bridge based upon conventional techniques and constructed at a minimum of cost with no sacrifice of accuracy through employment of modern methods and war-born design and production accomplishments. These may or may not be worthwhile, depending upon the reader's desire for accuracy and the sensitivity of his pocketbook to what amounts to about a two-to-one saving in cost.

—30—

..... LETTERS .....

FROM OUR READERS

CORRESPONDENTS PLEASE

"AS A subscriber of your magazine, in which I am very interested, I should like to ask you a few questions.

"However, before I ask the questions perhaps I should explain who I am. I am a Dane (if my English is not so good, please excuse me) and I am working as a radio technician in Thorshavn, situated on these small islands.

"You will understand that it is often very difficult for me to get the right and most recent information about my job. I have had a lot of American radio sets for repair and often I have been in great need of information about valves and other special components in American sets.

"I should like to ask you if you could possibly get in touch with some of the firms who advertise in RADIO NEWS offering their catalogues, etc., free and have them send catalogues to me. From these I would be able to learn a lot of special data.

"The next thing I should like to ask about is, if there is a Dane, Norwegian or Swede among your subscribers who would be willing to correspond with me to discuss radio. If it is not possible to get correspondence with a Scandinavian, I would be glad to write to an American, but there are certain language difficulties.

"I hope you are not uninterested in my problem! I bring my greetings and best wishes to RADIO NEWS and all of its readers.

Ingvar Olsen
c/o Ingenieur F. Wellejus
Thorshavn, Faroe Isles.

Readers who would like to correspond with Mr. Olsen should write to him direct at the above address. Your first request has been met, Mr. Olsen, we have written the American manufacturers for you.

* * *

BELGIAN UNDERGROUND

"I'VE been waiting five long years before I could write you this letter. So much has happened since 1940. But now it's all over, and my family and I are still alive!

"Let me first cry out our immense gratitude to the mighty States who delivered us so quickly from the nazi slavery. I feel so happy now I can write again to my favorite RADIO NEWS journal. Many times during headphone listening and news hunting I blessed the strong American material of my war set with the robust 78, 6A8, 6K7, 6D6, 6H6, 6A7 and 42. Now these tubes are seven years old and are very tired and I hope some new ones will come over soon.

"Do you know how much people paid for a 6A7 during the occupation? Between 450 and 500 francs which is 200 times the 1939 price. The 25Z5 was also very rare but I helped many listeners by mounting on the old tube base a metal rectifier which gave good results. Diode-triodes were not to be found and many sets were in secret (radio servicing was prohibited) changed over to anode-bend detection. Many sets had a mixture of European, and American tubes with three or four different heater voltages!

"Briefly, the wireless amateurs, and I'm proud to be one of them, have done everything to give people the opportunity to remain in touch with the sweet "Voice of America" in spite of the heaviest jamming and terror.

Marcel Vandervorst
Ghent, Belgium.

Reader Vandervorst's narrative makes our efforts to locate 50L6's look pretty picayune. We are glad to hear from fellow amateurs in the liberated countries.

* * *

MANUFACTURERS' SUGGESTIONS

"IN REGARD to 'Practical Suggestions' by Thomas H. Bell in the June issue ——

"I am also one of the old timers, having been in the servicing business for over twenty years, and I wish to add a most hearty AMEN! to all that Mr. Bell had to say. The chassis with the umpteen gadgets to loosen and dangle at the ends of wires, the plugless speaker cable, the unmarked chassis, the myriad of tube types, and the construction of some speakers are all pet peeves of mine.

"Mr. Bell also speaks of the loop aerials. Some of these battery portables are terrible, for you must unsolder the leads to remove the chassis, splice in extra leads, etc., etc.

"Another bad one is the chassis which cannot be aligned while in the cabinet but the dial markings are nicely fastened *to the cabinet.*

"Why rivet output transformers to speakers and especially with iron rivets? Transformers do have to be replaced and drilling iron rivets can get cuttings in an air gap if extreme care is not used, or you can spoil the cone.

"Let's hope the manufacturers give us a break on these things in the future. They could solicit suggestions.

Ralph H. Mercer
Lake Worth, Florida.

* * *

"READER Thomas H. Bell makes various suggestions to set manufacturers in your June number. The ideas are helpful, but after all, it seems to me they do not hit the primary trouble. The primary trouble is that Reader Bell, like most of us, finds it almost impossible to stand up and squarely tell a customer that it is going to take several hours time, the charge is so much per hour, and the bill will be all out of proportion to the original cost of the radio. Too many repairmen resort to the expedient of running some high charges into their bill for parts and holding the labor charge down.

"All this seems due to several conditions. The relation of repair cost to original cost is very high with a radio as compared to other things the public is familiar with. We have many dabblers in radio and persons who get into the game because comparatively small capital is required. We can be sure that manufacturers will continue to put doodads and gadgets on their radios if they think they help to sell them.

"I think we should be willing to fix whatever the manufacturer turns out and tell the customer frankly it is the nature of radio for repair costs to be all out of proportion to new cost because it will take so much time and there seems to be no way to do it quicker. In normal times, the customer will then have to decide whether to repair or junk, just as he does with his auto. I doubt if much can be accomplished by cooperative action among radio repairmen, so it will probably be a case of each man for himself.

"I feel, like Reader Bell, in returning a set in the best possible working order, so I suppose I spend more time on some radios than I am justified in doing.

C. S. Walton
Wheatridge, Colorado.

* * *

"I WAS very much interested in the letters you published in the July issue of RADIO NEWS in which some of your readers expressed their ideas on what the postwar receivers should be like. I would like to accept your invitation for readers to express their ideas on this subject.

"The following is a list of my ideas:

1. R.f. stage on all receivers except the very lowest priced models.
2. Well constructed dial mechanisms which will operate smoothly and are equipped with a "second" hand indicator on the dial for logging purposes.
3. Elimination of pushbutton tuning except on the larger deluxe models. The pushbutton tuning on these should be of the electro-mechanical type.
4. Tuning indicator on all models except small table models and portables.
5. Sturdy construction with shielding of all r.f., oscillator and i.f. coils.
6. Elimination of loop antennas as an integral part of the set except in the cheaper models.
7. More emphasis on installation of antennas with receivers.
8. Limited number of chassis types with a minimum of tube types and a variety of cabinet sizes, styles, and types to choose from.
9. Tone control with bass boost on all except the cheaper models.
10. Better constructed and more fool-proof record players available in

combination only with the better receiver chassis.

"Thus our postwar super deluxe home receiver will consist of a high quality AM tuner, and i.f. system with an r.f. stage, variable selectivity, short wave coverage (with real gain) an FM tuner, with both FM and AM tuners equipped with smooth running two speed tuning knobs and dials that can be accurately logged, push-button tuning that really works, matched antennas connected to both FM and AM tuners, tuning indicator, a high fidelity audio amplifier with bass boost and volume expansion that can be switched out, high fidelity reproducer with bass reflex, a beautiful cabinet, a well-constructed fool-proof record player, and a high quality recording system. And, oh, yes, a good AVC system. What's that you say? Such a receiver is impossible? Well, I can dream can't I?

Laurence Smith—W7FOM
Missoula, Montana

We are still anxious to receive our readers' comments on the postwar receiver. Send in your letters!

* * *

"BY PAST and present experience with trained and untrained radio men, I firmly believe that all radio men and women should be trained in radio theory and modern servicing technique by a recognized radio school and only graduate radio men and women with diplomas could operate a radio repair shop. This would eliminate all guesswork as to Who's Who and Why.

"Radio schools should have the controlling factor in saying just who can operate a radio service shop."

J. W. Willoughby
Gainesville, Texas

* * *

A THANK YOU NOTE

THIS is a note of thanks; thanks for your swell magazine, thanks for keeping me familiarized with radio and thanks for keeping me abreast with new developments. While engaging the enemy one has little time to think of theory, but when I receive each copy of RADIO NEWS I find myself gradually returning to the good old days and it all returns to me out of some obscure corner.

We have been fortunate since VE Day in being able to listen to a radio. The commercial sets have all three bands; long, medium or broadcast, and shortwave. The shortwave band is most popular since we have a greater selection of programs and can find anything from swing (American style) to symphony. Listening to an English program the other day, I discovered it was Radio Center, Moscow.

I'll sign off now with thanks again from one who is keeping his hobby alive while many miles away.

Gratefully yours,
Pfc. Adolph Oesterle
Somewhere Overseas

Many thanks to you, Pfc. Oesterle, for your complimentary letter.

—30—

Spot News
(*Continued from page* 14)

82 mc., No. 5 television channel; 82-88 mc., No. 6 television channel; 88-92 mc., non-commercial educational FM; 92-106 mc., FM; 106-108 mc., facsimile.

The allocation is essentially the one proposed as alternative Number 3, except that the non-government fixed and mobile services have been moved from 104-108 megacycles to 72-76 megacycles, and FM and television have been adjusted accordingly. FCC points out the advantage of this change is that it makes possible immediately the use of all 13 television channels below 300 megacycles. Under the original Number 3 proposal, the entire 6 megacycle television channel between 72 and 78 megacycles could not be used until the aviation markers centering on 75 megacycles were moved.

Radio receivers for postwar FM service will cover the entire band from 88 to 108 megacycles, instead of merely 92-106 megacycles. Chairman Porter of FCC has advised radio manufacturers to design their FM receivers to incorporate the 106-108 megacycle band assigned to facsimile, indicating that the FM band will be extended to cover this frequency when facsimile is moved up to the 400 megacycle region.

Approximately 400,000 persons purchased FM receivers before the war and it was presumed the change in frequencies would mean such sets would be useless after the war. Most of the receivers are combination AM-FM and the AM part will continue to be used. There is agreement that the band (42-50 mc.) for which these receivers were made is inadequate and unsuited for FM reception. Accordingly, says FCC, no one today argues that postwar FM should be degraded to the point necessary to accommodate these receivers. Interim operations in the present band from 42 to 44 megacycles is being provided until such time as equipment for the higher frequencies is freely available to the public. A converter has been demonstrated to FCC and it will make existing receivers capable of tuning to the higher frequencies. It will retail for about $10.

WHAT IS A CRYSTAL GRINDER?
Ask any group of 100 persons, civilian or military, and the answers invariably will mention everything from a jeweler's assistant to a salt machine. Crystal grinders, it seems, are a rare species. Yet, without them, the five successful invasions of the Mediterranean campaign might not have been so successful and our air war in Italy might not have run so smoothly.

Crystals, as the radio industry well knows, are vital radio parts and crystal grinders are highly-skilled technicians who fashion the crystals into stabilizers for planes, radios, beam stations, and ground transmitters. These specialists received lengthy training before going overseas in small teams. There were only four such crews in the entire Mediterranean theater during the war with Germany—three of these were with the ground forces and one with the Air Service Command.

The unit serving the Air Forces, comprising one officer and three enlisted men, turned out an average of 20 crystals a day, all different and each requiring from half an hour to three days' work. Actually, the team did only special jobs, since about 40,000 stock crystals were shipped to them each month from the States.

"We always maintained a vault with more than 350,000 crystals on hand for routine requests," explained Lieut. John D. Some of Newell, S. D., the officer in charge, "and we made sure the vault was bomb proof, fire proof, and burglar proof. When you figure that each little crystal is worth about $20 and the total value of our storeroom was some $7,500,000, well, that was quite a few war bonds in anybody's money."

The unit's busiest period came three months after the Italian invasion, when Allied troops stormed ashore in Southern France. As in all invasion operations, new crystals were installed in all plane and ship radios so that the new frequencies would confuse the enemy.

Imported mainly from Brazil, the quartz used for crystals is milky in color, the individual crystals varying in size from ⅜ of an inch to two inches. Frequency is determined by the thickness of the crystals.

THE FCC HAS GRANTED TWO classes of construction permits to the *Raytheon Manufacturing Company* which indicate further expansion in the communication field.

One of the permits grants *Raytheon* permission to construct five experimental microwave radio relay stations to be installed at New York, Lexington, Bristol, Tolland, and Webster, Massachusetts. This New York to Boston circuit is the first leg of the proposed nation-wide microwave communications system.

The second permit authorizes the company to erect two developmental frequency modulation stations in New York on top of the 700 foot Lincoln Building, utilizing frequencies of 105 and 107 megacycles.

RADIO CABINET MANUFACTURERS have been granted an eighteen per-cent increase over their October, 1941, price level by the OPA under the reconversion pricing formula. This action was taken at a Chicago meeting of the Advisory Committee of the OPA Radio Cabinet Manufacturers Industry and although the cabinet manufacturers, as a whole, are not satisfied with the increase, they are going to give it a try. However, this action does not apply to plastic cabinets. Full-scale cabinet manufacturing cannot begin immediately because of the extremely tight situation in the lumber industry.

MAJOR S. D. LANGSTROTH, CHIEF OF THE ARMY-NAVY ELECTRONICS STANDARDS BUREAU at Red Bank, N.J., discussed, with OPA officials recently, specifications for a new base for radio tubes. Despite many improvements in tubes, the tube base continues to be made largely of vaselite filled with wood flour cement, which absorbs moisture and has a tendency to expand and crack in damp climates. The new base material under discussion is michanol, a sturdy material impervious to moisture. Three companies are manufacturing the new base and it probably will reach the market in about six months at a cost slightly higher than the standard type base.

Personals

C. Russell Feldman, president and board chairman of International Detrola Corporation, has been elected chairman of the board of the ROHR Aircraft Corporation . . . **Don Calder,** formerly general sales manager and director of specialty products division of Allied Control Company, has joined Electronic Testing Laboratories, Newark, N. J., in a similar capacity. Mr. Calder will coordinate sales and research activities of the organization in specialized electronic product development . . . **R. Gordon Hamblen** has been appointed personnel director of the Springdale and Norwalk plants of Machlett Laboratories, Inc. For the past two and one-half years, Mr. Hamblen had been personnel manager of the company's Norwalk plant . . . **J. Arthur Rank**, British film executive, has consolidated his interests in radio and television with the purchase of Bush Radio, one of England's foremost radio manufacturers . . . Appointment of Cia Mexicana Electro-Mercantil S.A. as a distributor for Crosley Corporation in Mexico City was announced by **J. W. DeLind, Jr.**, director of exports for Crosley . . . The appointment of two new sales representatives is announced by Clarostat Manufacturing Co., Inc. **Wood & Anderson Company** of St. Louis is to represent Clarostat in the industrial and jobbing fields in their territory. **Henry P. Segal Company** of Boston will serve the New England territory.

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Audio Oscillators
(*Continued from page* 29)

an oscilloscope. The amplitude of the waveform on the scope-tube was held constant with the oscillator output voltage control and the meter read for different frequencies. As the oscilloscope has nearly perfect frequency response at these relatively low frequencies, the curve is quite accurate. The frequency is varied in small steps and the output voltage at each frequency is noted.

The values obtained are recorded and when all the values desired are obtained, a curve is drawn on semi-log graph paper. This is graph paper which has linear graduations along its Y axis and logarithmic graduation along its X axis.

In Fig. 1 is a series of response curves for a typical amplifier with high and low boost tone controls. This particular amplifier has a five-position switch for adjusting the tonal response. It is readily noted from the graph that the boosts occur at 4000, 5000, 8000 and above 15,000 c.p.s. Note also the change in the low frequency curve when the control was advanced to full boost, i.e., the frequency at which it boosted was lowered from 90 c.p.s. to 50 c.p.s. The curve of the amplifier with no compensation is noted just below the first series of curves. This curve was plotted in volts as a db. curve would have appeared in a relatively straight line.

With the oscillator then as a check on the finished results, special response curves may be imparted to audio systems to compensate for deficiencies in pickups, speakers, records, and acoustic conditions which are undesirable. Also, special sound effects can be created. Of course, the audio oscillator may be connected to the amplifier with the speaker connected, and the oscillator varied; any resonant conditions of a room or auditorium will be immediately apparent as the critical frequency is found. That frequency might then be subdued in the amplifier with a filter network.

Another common use for the audio oscillator is to modulate a radio frequency signal generator. This, then, provides a private broadcasting station whose signal frequency may be varied and whose audible frequency may be varied too. We may now measure the response characteristics of the entire radio receiver from antenna to loud speaker. Here we may find that the high frequency response is suffering because of a sharp intermediate frequency amplifier which is cutting side bands and attenuating the higher frequencies. If we have sensitivity to spare, we may stagger the i.f. trimmer condensers so as to provide a wider band pass, or we may introduce a compensating high frequency boost in the audio system, or both.

If we add a distortion analyzer to our setup, we may measure the distortion of the audio system or the distortion of the whole receiver. Distortion analyzers are rather complex pieces of equipment, but one may be improvised. If an electronic switch is so connected as to alternately impress the output of the oscillator and then the output of the receiver, on the vertical plates of an oscilloscope, any difference between the two superimposed sine waves will be a measure of the distortion of the whole receiver.

The turns ration of a transformer may be measured by connecting the oscillator output to the primary and measuring the applied primary voltage and the induced secondary voltage. The turns ratio is proportional to the two voltages. ($E_1/E_2 = T_1/T_2$.) The response of the transformer may also be determined, but care must be taken to see that first, the output impedance of the oscillator must equal or be lower than the primary impedance of the transformer, and the secondary must be loaded with the proper resistance to accurately simulate the load imparted to it in the circuit it was designed to be used in.

Rattles in loud speakers are a disturbing item which may be located with the audio oscillator as can rattles and resonances in baffles. The oscillator is either connected to the speaker directly if it has a low impedance output, or through an amplifier. The frequency is varied until the rattle is heard. This technique is particularly advantageous where the rattles occur at only one frequency. They are usually quite easily removed when they may be induced at will and studied at leisure. Some common causes are loose voice coils, partially cemented paper patches on the cone, and taut voice coil leads.

Loose mounting bolts on the speaker and the output transformer cause annoying, hard to find rattles. The author has even run into a case of a loose high note deflector which was the cause of a very hard to find rattle. Cabinets contribute their share of rattles and resonances, which are easily located with an audio oscillator. The cure is either a brace in the proper place or some sound-absorbing material such as celotex or hair-felt added where it will eliminate the offending vibrations.

While on the subject of vibrations, an important use of our oscillator is that of a power source for a stroboscopic light source. If we connect a neon lamp to the output of the oscillator and the voltage is high enough to fire the lamp, we have a stroboscopic light source.

With a reflector placed in back of the lamp, we have a device which operates in a manner similar to that of stroboscopic method of determining the correct speed of a phonograph turntable. The stroboscope discs are relatively common. They are placed on the turntable and the light from a 50- or 60-cycle lamp is allowed to shine thereupon. The disc is marked with the proper number of lines around its circumference, so that when the turntable is revolving at 78.26 r.p.m., the lines appear to stand still. This is a partial illusion, however, as the lines move while the lamp is off, and the lamp comes on when they arrive at a certain position. This gives the illusion that they stand still. A sine wave is not as ideal a wave form as a saw tooth for this service but will be adequate for some work.

Speaker cones may be inspected while in motion as they may be made to appear to stop or move very slowly forward or backward by varying the frequency. Similarly, vibration in cabinets and also machinery may be stopped and inspected.

In conjunction with a recorder, a frequency response test record may be made which is indispensable for testing and developing phonograph pickups. A record of this type is useful in providing a pickup with the proper compensating networks so as to properly play back transcriptions with special response characteristics, introduced to meet special conditions. If a single frequency is recorded, then the speed constancy of a phonograph turntable may be determined.

If the constant frequency record is played back through an amplifier and mixed with the oscillator's output, any variation or wow will be apparent at a low frequency beat. Also, the turntable speed may be adjusted precisely to the speed which will allow the finished record to produce a frequency identical with the oscillator. This will, in effect, compensate for recording and playback speed variations due to loading of the motor.

An interesting item which works both ways is an audio frequency standard. If a Wien bridge audio oscillator, whose output is several watts or so at 110 volts, is connected to an electric clock and the frequency is adjusted to 60 cycles; you have an accurate frequency source which can be checked by time signals periodically. Or you

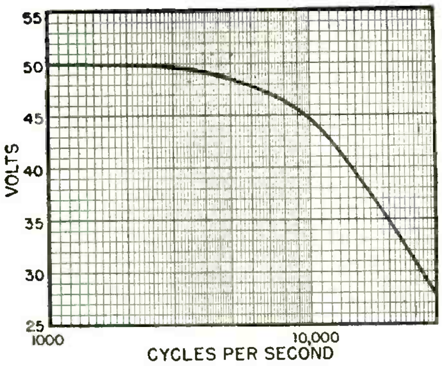


Fig. 2. Frequency response characteristic of a copper-oxide rectifier-type a.c. voltmeter. Its accuracy is undependable over 1000 cycles. It is advisable to employ a v.t.v.m. type meter when making frequency measurements.

have an accurate clock if you check the frequency of the oscillator against WWV's standard frequency broadcasts. This, of course, is not as accurate as the elaborate standards which use a temperature compensated crystal whose frequency is divided down to 1000 c.p.s. and runs a special 1000 cycle clock, but if line voltage variations are not too great and temperature extremes reasonable, it is fairly accurate.

For other purposes, our clock may be made to run at other speeds. The average electric clock will run at frequencies from 50 c.p.s. to 120 c.p.s. so their motors can be used with our oscillator to power, for instance, some tone wheels in an electronic organ. The frequency could, in this case, be varied to place an octave of tone wheels driven by the clock motor in tune with some other instrument. The well-known Hammond electric organ uses tone wheels driven by an electric clock type motor which takes advantage of its synchronous properties to keep the organ always in tune.

A system could be worked out, for instance, which included a synchronous motor, and an audio oscillator for a power source, which in the presence of varying loads on the motor changes the frequency of the oscillator, which would in turn change the motor speed and compensate for the greater or lesser load. This would constitute an ideal system for a phonograph or recording motor.

The slip in a synchronous motor could be determined by magnetizing the end of its shaft and placing a coil with an iron core near the magnetized spot. When the shaft is rotated, a frequency would be generated. If this frequency were beat with the supply source frequency of the motor, a beat frequency would result. This beat frequency could be measured by introducing it into one set of plates of an oscilloscope and our audio oscillator introduced into the other plates. Observation of the resulting Lissajous patterns would give us the exact value. The speed of the motor could be determined by comparing the pickup coils' output directly with that of the oscillator on an oscilloscope or by the zero beat method with earphones and an amplifier.

An unusual application is one where two audio oscillators have their frequency determining dials mechanically coupled to two intermittently moving shafts. The outputs may be connected to a servo motor, and the system would then become an electro-mechanical differential. The servo motor would tend to move as the sum or difference of the two shafts' incremental rotations.

The author has found his audio oscillator one of his most useful pieces of equipment over a period of years, both in radio service work and in electronic research. There seems to be no end of new uses. Perhaps this article has suggested a new application to you.

—30—

Q.T.C.

(*Continued from page* 50)

tronics and its other developments, has given added impetus to progress in the field of marine safety. If much of this progress is not to be lost through economic pressure in the post-war period, it behooves us to take steps now that will insure that the merchant marine fleets of the world may take advantage of new safety measures and still compete on an equal basis." So at least it looks possible that many of our wartime safety regulations, the good ones, are here to stay.

A. BRUVILL sailed aboard a tanker recently and expects to be gone for some time. . . . H. Rore was also assigned to a tank. . . . P. Mirkham took out a new freighter assignment. . . . Leif Hvidsten writes from the far east where he is running around the islands aboard a cargo vessel and, from all reports, likes the merchant marine. . . . T. L. Boot and F. Johnsen are both out on tanker assignments. . . . H. Horn is out on a cargo assignment.

THE Federal Communications Commission announced recently the adoption of the band between 92 and 106 megacycles for FM, which means that the nearly 400,000 FM sets now in use by the public will eventually require conversion from the present bands of from 42 to 50 megacycles to the new frequencies. FCC reports that this delay (other frequency allocations were completed sometime ago) will not hamper production of new FM receivers as WPB has reported it will be late '45 or early '46 before materials can be made available for such production.

ONE ocean, at last is safe again and ships sail, with all lights burning, without fear of being sunk by enemy action, and can go when and where they like. . . . Once again Lloyds' is issuing its famous "Shipping Intelligence" listing arrivals, destinations, and departures of ships. . . . Atlantic Coastal regulations have been relaxed and only the busier harbors maintain strict regulations ....73.

Practical Radio Course

(Continued from page 49)

of padder capacitance required. Also, for an i.f. of 456 kc., the padder capacitance required is practically equal to the maximum capacitance of the oscillator tuning capacitor employed.

Since the padder capacitance adjustment that ordinarily must be made in order to "track" a receiver precisely at the low-frequency end of the band during alignment necessitates only a small variation in the comparatively high total value of padder capacitance, the padder usually is made up of a main fixed mica capacitor C_{p1} in parallel with an adjustable trimmer-type capacitor C_{p2} of smaller capacitance, as illustrated in Fig. 3. This circuit shows the preselector and padded oscillator tuning circuit arrangement commonly employed in single-band (broadcast) commercial receivers. Of course, the preselector may have more, or less, than the two tuned circuits shown.

Padder vs. Cut-Plate Method of Tracking

It is evident that the "padder" method of tracking the oscillator is an *electrical* method of causing the oscillator frequency to change less rapidly than it otherwise would, whereas, the cut-plate oscillator capacitor method explained in the previous lesson accomplishes the same result by a special *mechanical* shaping of the oscillator tuning capacitor plates. The "padder" method is the more popular of the two because it is cheap, can be satisfactorily employed in multi-band receivers and, in receivers employing any i.f. value, can be easily adjusted on the manufacturing assembly line and in subsequent servicing adjustments on the receiver and provides acceptably close tracking.

In our discussion of the series-padder and its effect upon the tracking of the oscillator frequency, we assumed that the padder is connected in *series* with the *total* tuning capacitance of the oscillator (see Fig. 1). In actual practice there are always some tuning capacitances that are not tracked (that is, are not actually in *series* with padder C_p). Which these are, and how important they are, depends upon how the individual components of the oscillator tuning circuit are arranged in the circuit.

In Fig. 4, four different possible arrangements of oscillator tuning circuit components that can be employed are illustrated. In each, C_o is the main oscillator tuning capacitor, C_t is the trimmer, C_p is the padder, C_d, the (distributed) self-capacitance of the coil (i.e., the capacitance between the individual turns of the winding), C_e the capacitance between ground on the one side and the coil and the attached leads on the other, C_g capacitance of the grid-capacitor, and C_{gc} is the grid-cathode capacitance of the tube. The crosses in these circuits indicate the points where the band-switch would be inserted in a receiver designed for multi-band reception.

Now all of these capacitances are effective in tending to tune the coil. Since C_d is intimately associated with the construction of the coil itself, it is obvious that it cannot be separated from it. Therefore, it cannot be "tracked" by the padder capacitance, because no possible circuit arrangement will put the padder C_p in series between it and the coil inductance.

In the circuit arrangements at (*A*) and (*B*), the padding capacitance C_p is placed between the high-potential end of the tuning coil and tuning capacitor C_o. In arrangements (*C*) and (*D*) it is placed between the tuning coil and ground. This has the advantage of not adding to the self-capacitance C_d in parallel with the coil, for in arrangements (*A*) and (*B*) the capacitance to earth of C_p is in parallel with the coil's self-capacitance C_d. However, arrangement (*D*) has an advantage over that at (*C*) in that since the trimmer C_t has been placed directly across the tuning coil, it can compensate for variations in coil self-capacitance and stray capacitances.

A summary of the capacitances that are not tracked by the padder C_p in the various circuit arrangements of Fig. 4 follows:

(A)—C_e, C_d and C_{gc} are not tracked
(B)—C_e and C_d are not tracked
(C)—C_d is not tracked
(D)—C_d and C_t are not tracked.

The circuit arrangement at (*C*), then, best fulfils the tracking conditions assumed in our previous discussion and illustrated in Fig. 1. However, by knowing which capacitances will not be tracked for any particular oscillator tuning circuit arrangement used, and then properly choosing the circuit constants during design of the receiver, the untracked capacitances can often be made so small that their influence is reduced to negligible proportions. In any case, it is now clear why the values required for the padder and the trimmer capacitances depend on where the two are inserted in the circuit. Deviations from the theoretical tracking curve caused by the distributed capacitance C_d of the coil can easily be compensated for by the appropriate corrections at the coil and the trimmer.

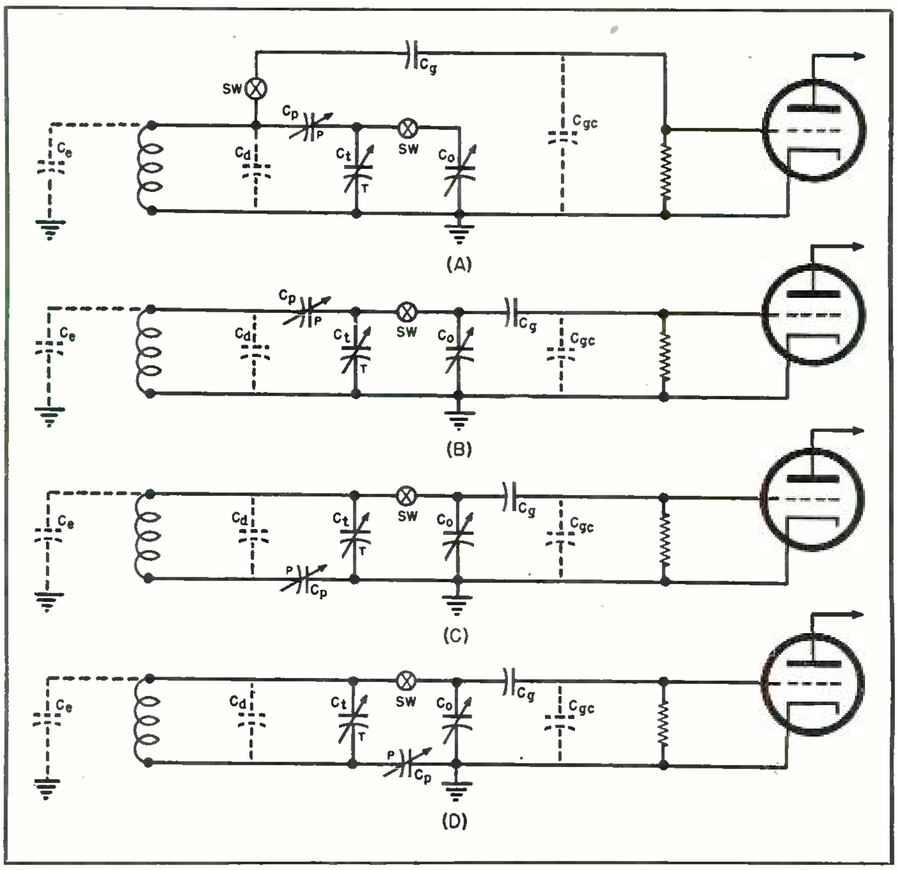
The foregoing discussion shows that variations of the shunt trimmer capacitor C_t affect the oscillator frequency deviation at the *high-frequency* end of the tuning band, while series padder capacitor C_p controls the frequency deviation mainly at the *low-frequency* end. This, therefore, suggests the procedure for adjusting the oscillator to track closely all over a tuning band. The receiver tuning dial and input signal should first be set to the highest required zero-error signal frequency specified in the receiver manufacturer's aligning instructions (for the standard broadcast tuning band this usually is 1400 kc.) and trimmer C_t adjusted to give maximum audio output from the receiver. The receiver tuning and input signal are next changed to the lower zero-error signal frequency specified by the receiver manufacturer (for the standard broadcast tuning band this usually is 600 kc.) and padder C_p adjusted to give maximum output. Returning to the higher frequency, C_t is readjusted if necessary, and the procedure is repeated until the best results are obtained.

In multi-band receivers, the tracking is adjusted in this way at two particular frequencies (those specified by the receiver manufacturer) on each band, usually with the exception that adjustment of a low-frequency padder on the highest-frequency band is not necessary.

Erratum

The text material referring to Fig. 1, of Part 34 of this series, appearing in the May, 1945, issue, erroneously referred to the tank and tickler coil as being a single tapped winding. In order that oscillations be produced, this coil must be of two separate windings and connected so that the direction of the tickler winding (L_t) is in the reverse

Fig. 4. Four different possible arrangements of oscillator tuning circuit components. The effectiveness of the low-frequency tracking padder C_p differs for each.



of that employed for grid coil "L." The feedback circuit, shown as a dotted line in Fig. 1 from "C_p," should also be connected to the ground of the battery "E_b" as this battery also forms a return to produce oscillation.

(To be continued)

Quartz Crystals

(Continued from page 45)

thousand hours. Power supplies stable enough for use with delicate ionization circuits have been developed.

The seal of crystal holders, once checked inaccurately by immersion in hot water, followed by internal inspection, is now checked very accurately by the use of ionic seal test equipment. Since most crystal holders in use today leak at high altitudes, the rate of leakage is specified and must be determined. The ionic current passed between the electrodes of a given size quartz oscillator plate, at a given pressure, for a given time, denotes this rate of leakage.

Radio engineers have learned to consider the equivalent circuit of the quartz crystal unit when designing oscillators. Most important of all, the complexity of these units, due to the fact that they are a combination of three elements, has been realized. They can not be defined as simply as coils, capacitors, etc. For example, the impedance of a quartz crystal unit may vary as much as 100,000 ohms in two slightly different oscillators, at frequencies within a few cycles of each other.[4]

A system for rating the quality and performance of quartz oscillator plates has been developed[5] but is not widely used at present, due to the fact that the oscillators in use today were designed with very little regard to the circuit properties of the crystal. It is believed that when these properties are recognized in the design of oscillators tomorrow, crystal units will be catalogued according to their merit (*M*), their performance index (*PI*), and their impedance (*Z*). Various methods and equipment are in use today for determining these values. It must and will be standardized eventually. During investigations with similar equipment it was learned that the performance of a quartz oscillator plate over a wide temperature range could be predetermined with reasonable accuracy. The long two hour temperature runs necessary for most crystal units today will be unnecessary tomorrow.

With increased knowledge of the physical and electrical properties of quartz oscillator plates, it has been possible to make them smaller in size (Fig. 2). The improvements in plating methods and predimensioning[6] have been largely responsible for this trend to a smaller unit. A plated unit has the advantage of much closer piezo-electric coupling but is not practicable for use on high-frequency plates in some oscillators. Many plated units are being used in the high-frequency range, however, by applying a mixture of bakelite cement and poly-silver to dampen the activity and prevent fracturing of the plate.

Due to the phenomenal properties of quartz crystals when cut at various angles and in various shapes, many special uses are made of them. The torsional quartz rods, pressure quartz discs, and optical wedges shown in Fig. 1 represent a few of these. Another special application of quartz plates make possible the measurement of pressure in explosions where the pressure rises in less than one half a millisecond.[7]

Now that the fundamentals of the properties of quartz crystals are understood, and they have proven their value to science, the future may hold developments beyond our comprehension.

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Transformer Theory

(*Continued from page* 35)

that the flux produced by a winding depends on the product of the turns in the winding and the current flowing in it. Hence a current i_s flowing in the secondary will require a current given by equation (3) to balance out the flux produced by i_s.

$$i_p = i_s \cdot \frac{N_2}{N_1} \quad \ldots\ldots (3)$$

From equation (2) the value for i_s can be substituted to give equation (4).

$$i_p = \frac{E}{R_L} \cdot \frac{N_2^2}{N_1^2} \quad \ldots\ldots (4)$$

Since the flux in a transformer core is common to both the windings, any variation in the secondary load resistance will result in the appearance of a reflected resistance in the primary side of the transformer. If the resistance which appears in the primary is denoted R_p, its value is given by equation (5).

$$R_p = \frac{E}{i_p} = \frac{E}{\frac{E}{R_L} \cdot \left(\frac{N_2}{N_1}\right)^2} = R_L \left(\frac{N_1}{N_2}\right)^2 \ldots (5)$$

This equation indicates that a resistance R_L connected into the secondary circuit will reflect a resistance into the primary circuit which is a function of the load resistor and the turns ratio of the transformer.

As an example of the way in which

some of the information presented above can be used in a practical case, consider a situation such as given in Fig. 2. The 6C5 tube is transformer coupled to some following stage and is biased so that $\mu = 20$ (the tube's amplification factor), $r_p = 10{,}000$ ohms, and $I_b = .008$ amperes. The transformer has a primary winding of 3000 turns and a secondary winding of 9000 turns. The mean magnetic core length (l) is assumed to be 6 inches and the cross sectional area (A) .4 sq. in. This length can be found by measuring the inner and outer distances around the core, multiplying them, and taking the square root of the product. The flux density in the lossless transformer is 25,000 lines per square inch and the incremental permeability is to be 1/15 the direct current permeability.

The permeability of iron is defined as the ratio of the flux density to the magnetizing force or

$$\mu = \frac{B}{H} \quad \text{.............................(6)}$$

The quantity B is the flux density in lines per square inch and H is the magnetizing force in gilberts. For a given iron-core coil H in gilberts per inch can be found by substituting in equation (7), where l is in inches.

$$H = \frac{4\pi N_1 I_b}{10\, l \times 2.54} = \frac{4 \times 3.14 \times 3000 \times .008}{10 \times 6 \times 2.54} = 2 \quad \text{.............................(7)}$$

The value of μ, the direct current permeability, is found by taking the ratio of B to H which in this case is 25,000/2, or 12,500. The inductance offered by the primary winding can be determined by using the equation

$$L = \frac{.4\pi N_1^2 A \mu \Delta}{10^8\, l} \text{ henries}$$

where $\mu\Delta$ is the incremental permeability and is equal to 12,500/15 or 834. If the values given in the example are inserted in this equation, L is found to be 15.7 henries (l in cm., A in cm.^{2}).

We now have a bit of information which will enable one to find out something of the transformer performance at various a.c. frequencies. If an a.c. signal of 1 volt at 500 cycles were impressed on the grid circuit of the tube, what voltage would appear across the open-circuit secondary?

An inductance of 15.7 henrys will have an inductive reactance of

$$X_L = 2\pi f L = 2 \times 3.14 \times 500 \times 15.7 = 49{,}300 \text{ ohms}$$

at 500 cycles. The a.c. component of plate current will then be

$$i_p = \frac{\mu e_g}{r_p + X_L} = \frac{20 \times 1}{10{,}000 + j\,49{,}300} = \frac{20}{50{,}500} = .0004 \text{ amps.}$$

The voltage appearing across the secondary will be the voltage across the primary winding times the ratio of N_2 to N_1.

$$E_s = i_p \times X_L \times \frac{N_2}{N_1} = 59 \text{ volts}$$

The secondary voltage can also be found for other a.c. frequencies, thus enabling the transformer performance within this range to be predicted with fair accuracy. —30—

China Looks Ahead

(Continued from page 66)

the coastal provinces had access to a radio receiver even for a few minutes a day.

Today, only a couple of thousand receivers remain in Unoccupied China. In the conquered areas, the Japs promptly confiscated all sets except four-tube medium-wave models capable of getting only the local Jap propaganda broadcasts. In Free China, only 500 new sets—and these were for official government use in Chungking—have been manufactured since 1939. No second-hand sets are available at any price.

The Chinese Central Radio Works—a government manufacturing company controlled by the National Resources Commission—has already begun the difficult job of assembling radio components to turn out the first 50,000 sets manufactured for civilians in China in eight years. Due to the slow, painful process of transporting parts into the country, it is estimated it will take at least a year to complete this order. Government deadline on completion of the receivers is set for July 1946.

Before the war, most completed receivers, as well as new and repair parts, sold in China were American-made. Most popular receiver was an *RCA* five- or six-tube table model capable of receiving both medium- and short-wave programs. British sets generally ranked second in sales. Popular European makes included *British Colombia, General Electric Co., Ltd.* of London, *Marconi, Dutch Philips* and *Telefunken* of Germany. Since Shanghai was the clearing port for over 70% of the radio equipment moving into China, virtually no sets reached China after the fall of that city in the spring of 1938.

Before the war, prices of all-wave foreign receivers ranged anywhere from $60 to $100, which made them out of reach of 90% of the Chinese market. A cheaper four-tube medium-wave set, retailing around $25, was imported from Japan and had its largest sale among the Chinese.

The primary concern of the Central Radio Works is to get sets in the hands of the Chinese in the poorer, inland provinces. For this reason, the government plans to put out its receivers on what Penn calls a "costs-no-plus" or non-profit basis.

Present planning is to peg the price on the government sets around $14-gold—an admittedly meaningless figure under present inflated price levels in China. For example, to keep one skilled workman in the plant costs the government anywhere from $1000 to $1500 a month under present inflated wage scales. Despite the few people who can listen, short-wave has become tremendously popular in China in the last eight years and the Central Radio Works plans to manufacture only all-wave sets.

Because of manpower and equipment shortages, as well as its own limited plant, the Central Radio Works will turn out only a small proportion of the receivers the government hopes to place in Chinese homes in the early postwar years. China will rely heavily on imports of foreign sets, mostly from the United States, and even more heavily on American-made components and accessories. One of the goals of the Chinese training program, according to Penn Tsing-Yeh, is to familiarize trainees with American equipment so they will be able to service it and instruct others in servicing when they return to China.

China's unique climatic conditions, particularly the moist, humid temperatures of Southern China, present another difficulty in receiver manufacture. Unless high-quality components are used and sets given special construction for tropical wear, condensers soon deteriorate, coils burn out, and short circuits are likely to occur. Before the war, medium-wave sets designed for the 250 to 550 meter band and short-wave between 13 and 49 meters were generally found most suitable.

On the broadcasting side of the picture, the only broadcast service in China today is that provided by 17 government-operated stations, the largest of which is a 50,000 watter in Kunming. Before 1937, there were 100 broadcast stations on the air, 40 of them concentrated in Shanghai. Although Shanghai was in the somewhat anomalous position of having more stations than any other city in the world (New York only has 23), their combined power and hours of operation were insignificant.

Seven or eight of the largest Shanghai stations were licensed to foreign companies—American, British, Nazi, French, Russian and Italian—and broadcast only to their nationals and a few fluently bi-lingual Chinese. (Their principal influence was in popularizing American jazz music among the Chinese to such an extent that the Chinese government stations soon began to carry programs of American recordings).

About 20 of the 100 stations—usually those with better power and more regular operating schedules—were operated directly by the provisional Chinese governments or by the Kuomintang. The other 80 were commercial outlets.

Traditionally, however, China has had little commercial broadcasting in the American sense. Large business firms, steamship companies, department stores, etc., would apply for a license, set up a small low-powered transmitter (anywhere from 50 watts to at most a kilowatt), and go into the business of broadcasting. Up until a few years before the war, they did little selling of time to other firms but used the stations primarily to boost the sale of their products or service.

In general, commercial broadcasting was informal and service sporadic. In Shanghai, for example ,transmitters were set up in lofts, behind stores, and in garages. It must be said that government regulation in China before 1937 corresponded roughly to that period in the United States before 1927 and the creation of the Federal Radio Commission. License periods were limited to one-year, and some proportion of programs were supposed to be "public service" in nature.

As was to be expected, when the Japs moved into the coastal cities, they immediately took over the commercial stations and began jamming broadcasts from Free China. Some equipment from the government stations, salvaged by the Chinese, was loaded onto the backs of mules and trucks and moved into the interior where it was reassembled, but the largest station in all China—a 75,000 watter in Nanking—had to be dynamited to prevent its falling into enemy hands.

Two of the government's 17 transmitters now on the air are short-wave stations, the now famous "Voice of Free China" stations in Chungking. Best known to Americans is XGOY, the English-language station which for years has turned out the most complete and authoritative news on events inside China.

American radiomen and newscasters back from the China theatre and appearances on the XGOY transmitter tell of nerve-wracking experiences with power failures and hit-or-miss habits of Chinese coolies servicing the station. But all are unanimous in their praise of the engineering skill and ingenuity displayed by the Chinese in building the station in the face of tremendous operating difficulties.

The other short wave, XGOX, a 10,000 watter, broadcasts from Chungking in several languages beamed principally to Asia, Russia and Middle Europe.

According to Dr. Penn Tsing-Yeh, who has taken an active part in blueprinting China's postwar broadcasting system, "What China plans in the way of postwar broadcasting is a combination of the best features of the American and British systems, with heaviest emphasis on commercial operations."

While about 95% of the projected 500 stations are to be commercial outlets, to insure coverage of the agricultural, interior provinces, the Kuomintang plans a network of a dozen or more high-powered government stations. These stations will be located with an eye to maximum coverage throughout China and will carry no commercial programs.

"Because of the shortage of wireline equipment and the acute need to use what equipment there is for private communications, network operation of commercial stations does not appear to be an immediate postwar prospect," says Penn. There will be more, not less, government regulation of broadcasting stations and a ceiling of 100 kilowatts power is proposed for commercial operations.

It is anticipated that stations will follow the American practice of selling time to a variety of sponsors, foreign as well as Chinese, and the generally larger revenues to be expected from this type of operation will encourage the rapid development of commercial broadcasting after the war, Penn feels. Broadcasting will, in effect, become a fulltime job of licensees rather than the secondary interest of large business concerns.

With its limited line-of-sight coverage and the difficulties of obtaining equipment, exploitation of FM for broadcasting is not likely soon, according to Penn, although use will probably be made of FM for relay and booster stations. Television, with its prohibitive costs, is also remote, except for one experimental station which the government plans to build in the new capital.

China, though lacking in funds and equipment to exploit radio in years past, has always been alert to its possibilities, Penn says. Chinese newspapers, for example, made much of the early efforts of KDKA in this country back in 1920. And only two years later in 1922, the Wing-On Company, a large department store in Shanghai, adapted a small field transmitter for program transmission and went on the air to the excited wonderment of thousands of Chinese spectators. And a somewhat amusing sidelight on the enthusiasm of the Chinese for radio is seen in the fact that before the war the gift of a radio set was generally considered the most prized possession of a Chinese bride's trousseau.

"We are fully aware," Dr. Penn Tsing-Yeh points out, "of the tremendous difficulties ahead of us in bringing radio to China. But with careful planning and the assistance of the Western countries in providing equipment, we believe it can be done."

If that assistance is forthcoming, and it is being urged by many U. S. business, government, and military leaders not only as a spur to world trade but for more compelling reasons of world security, the Chinese experiment will be an interesting one to watch.

Starting 25 years later than the Western countries, China is certainly handicapped at the outset. But she also has the tremendous advantage of having at her command the latest technological advances and refinements in radio made in this country and Europe since the war. At the same time, she may be able, with careful planning and expert engineering advice, to avoid many of the mistakes that attended the early, haphazard growth of radio in the West.

—30—

0-300 Volt Supply
(*Continued from page* 39)

this article, a reduced bias on the series or regulator tube will tend to increase the plate current, reduce the effective plate resistance, and thus lower the voltage drop across the tube. As a result, the output voltage tends to remain consatnt.

Resistors R_5 and R_6 are used for purposes of isolating the two 807's and thus prevent possible oscillations. The resistances between the plate and screen of the 807's are used to break up the inter-electrode capacitance between the plate and grid of the tube by operating the screen at a lower potential than the plate and further aid in preventing possible oscillations. Incidentally, the resistors in series with the plates and those used between plate and screen should be carbon. Wire wound resistors may produce oscillations at certain values of current due to the inductance and distributed capacity of the resistor windings.

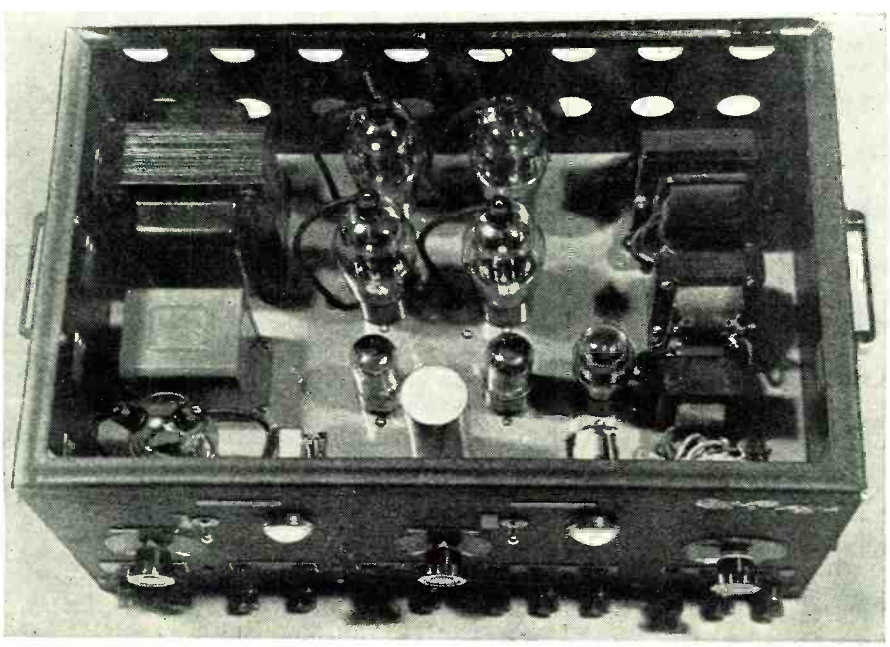
Condenser C_2 on the output improves the efficiency of the regulator by virtue of the fact that the fraction of the output voltage change impressed upon the grid of the 6SJ7 is increased when this change occurs rapidly. However, the reactance of the condenser at the ripple frequency considered must be small in comparison with the resistance which it shunts. If this condition is true, then the condenser increases appreciably the ability of the circuit to reduce ripple. However, should the reactance of the condenser be too large, then a time delay results and the system does not respond instantly. This is due to the fact that the initial compensation due to changes in output voltage exceeds the final value obtained after the condenser voltage reaches equilibrium.

It will be noticed from inspection of the circuit that separate filament transformers were used to furnish filament voltage to the tubes. This is necessary due to the fact that the cathodes of the tubes are at different potentials with respect to "B—." If the filaments were supplied from the same transformer, the leakage between heater and cathode which is always present to some degree in tubes, would tend to upset the balance of the system and thereby cause poor regulation.

When it is desired to go below 160 volts, then the two supplies are set bucking each other and the difference taken between the two. This is done by means of switch S_3, a three deck affair, which simultaneously performs three functions: It connects the two supplies bucking each other, inserts the proper bleeder resistance, and changes the circuit ground. In this connection it is important to note that what was the plus side of supply No. 2 when the supplies were used individually, now becomes the minus side of supply No. 3.

The theory of operation of the bucking supply is essentially the same as described for the individual supplies. The main difference lies in the fact that the bucking supply is now present at approximately 160 volts and a fixed amount of current bled through it. This bleeder current is dependent upon the value of resistance shunting the output of this supply. As shown in the schematic, different values of bleeder current can be obtained depending upon the resistance inserted across the output. This is done for purpose of power economy. It should be borne in mind that the current bled through the bucking supply should not be less than the load current, otherwise poor regulation will result.

Top view of power supply unit shown with top cover removed. All power transformers and filter chokes are well spaced to prevent magnetic interaction.



With the switch S_1 in any one of the three positions, bleeder current of 50, 100, or 150 ma. will flow through the bucking supply. The return path of the load current will flow through this bleeder network. As the output voltage of the bucking supply tends to stabilize itself at its present value and since the IR drop across the shunting resistors must be the same at no load and full load, it is obvious that the current flowing through the bucking supply must reduce by an amount equal to the load current. Should the load current exceed the bleeder current then the IR drop across the bleeder resistance will be greater than would normally exist with the bucking supply voltage and the system will therefore lose control.

At voltages below 160 volts and with the bleeder set at 150 ma., the maximum load current that can be drawn is 150 ma. The reason this was not made any higher is in part due to the fact that in the vicinity of 160 volts output, the adjustable supply is set at near its maximum value. Reference to the data and curves in Fig. 2 will show that the currents in the vicinity of this maximum output voltage are somewhat limited. The 0-160 volt supply was therefore based upon this limitation.

At voltages above 160 volts, and using a 20,000 ohm-per-volt meter, there was absolutely no change in meter reading from no load to full load at any output voltage setting. However, at low voltages such as 10 volts and 5 volts where a better reading could be obtained on the meter, there was a change of .2 volt. This change of output voltage is the cumulative effect of both supplies, and where the voltage change may be considered to be .1 volt in each supply the per-cent regulation is exceedingly good at voltages above 160 volts. However, at low voltages, where the voltage variation in output is .2 volt, this variation is comparable to the output voltage and purely on a percentage basis obtained from the formula No. 1 the percentage regulation is not as good as at higher voltages.

$$\% \text{ Regulation} = \frac{V_0 - V_L}{V_L} \cdot 100 \ldots (1)$$

where V_0 is the output voltage at 0 load and V_L is the output voltage at full load.

With respect to line voltage changes, it is evident from the curves (Fig. 1) that the regulation is also exceedingly good.

In using this supply it should be remembered that the curves and data represent the maximum current obtainable from each section when used alone. When both sections are used simultaneously, the total current consumed should not exceed the ratings of the transformer, rectifier, and choke.

To add to the completeness of the power supply, a 5 volt-3 ampere, and 6.3 volt-10 ampere source were included. To protect the supply from damage in case of short circuits and also to protect any current meters that may be used in external circuits, the input and output of the supply were fused. Unless shielded parts are used, care should be taken in the construction to prevent magnetic coupling between the component parts.

All in all, this type of power supply should find many uses around the home or laboratory. It provides a dependable source of voltages and currents within the ranges most commonly used.

-30-

Frequency Meter

(*Continued from page 47*)

employed, the 6SJ7 and 25Z5 must be "bled" by means of shunt resistors R_1 and R_2 in order to equalize their heaters with respect to the high-current 6V6. The filament dropping resistor, R_3, will in this case be 172 ohms and is preferably a line-cord type. The 6V6 may be replaced with a 25L6 type, with the result that bleeder resistors R_1 and R_2 will not be required R_3 will then be 195 ohms.

No special precautions are necessary in the wiring of the instrument. Unless frequency meter M is intended for operation at 60 or 120 cycles per second, susceptibility of the circuit to hum interference will not be as consequential as in the usual amplifier applications. Wiring may be run as convenient. Components likewise may be placed where they "best fit into the picture."

Mechanical Features

The instrument shown in the photograph is built in a 9" x 6" x 5" metal cabinet. Components are mounted on the tray-bottom normally supplied with this cabinet (I.C.A. No. 3825) and on its front panel.

As seen in the photograph, the meter is mounted along the top center portion of the front panel, and directly beneath this is gain control R_1. The input jack, a normally-closed single-circuit model, is mounted in the lower left-hand corner of the panel, and the on-off toggle switch, S, in the lower right-hand corner. The line cord passes through a ready-cut access hole in the rear of the cabinet.

The small cabinet is well provided with ventilating louvres and provides ample circulation of air for the compactly-arranged parts. Heat, incidentally, has given no trouble in operation of this instrument, since prolonged warm-up periods are not required for accuracy and stability.

A great deal of latitude is possible in the building of individual amplifier-type reed frequency meters, since the builder will not be restrained by critical design. Any type of layout appealing to the builder is satisfactory, and more compact arrangements than the one achieved by the writer are entirely possible. Indeed, one user of the pictured instrument has already suggested building a duplicate, employing the voltage-doubler power supply, entirely in a medium-sized, sloping front meter box.

Adjustment and Testing

After the wiring has been inspected and found correct, the instrument may be tested. The following procedure is recommended:

1. With gain control R_1 in the position of minimum gain, switch on power supply by throwing S to "on" position.
2. Allow 1 minute for the tube heaters to come up to operating temperature.
3. Connect a d.c. voltmeter, having a sensitivity of at least 1000 ohms per volt, between ground and the tap on voltage divider R_5. This meter must be set to indicate 250 volts.

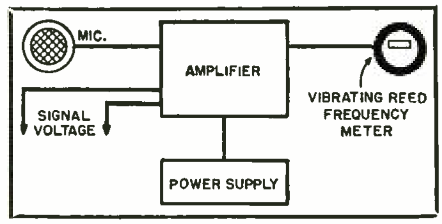


Fig. 5. Basic operation of the amplifier-type reed frequency meter

4. Adjust position of the slider on R_8 until exactly 250 volts are indicated by the voltmeter. At this point, tighten the slider screw to secure the band on the resistor.
5. Supply an audio-frequency signal to the instrument by plugging in the output of an audio oscillator into the jack. The frequency of the signal must be within the range of the frequency meter, *M*.
6. Advance gain control R_1 slowly, observing that meter, *M*, is actuated—one or more of its reeds vibrating.
7. Advance the gain control still further, noting that one reed is predominant in its vibration, thus indicating the signal frequency.
8. Change the signal frequency in each direction, noting that other reeds now go into vigorous vibration. One reed will always vibrate with greatest amplitude when its exact frequency is "struck" by the input signal. When the signal frequency is halfway between the frequencies of two adjacent reeds, however, both reeds will vibrate—*each to half its independent amplitude.* Thus, the 400- and 405-cycle reeds vibrating simultaneously, each to half the amplitude they would reach if vibrating independently, indicate a frequency of 402.5 cycles.
9. In order to check the instrument for "sound input," connect a microphone, preferably of the carbon or high-gain crystal type, to the jack. Advance the gain control to maximum gain and sound a horn, bell, chime, or similar sound generator into the microphone. If this sound frequency corresponds to a frequency within the range of meter, *M*, one or more of the reeds will go into vibration and the unknown sound frequency may be read as indicated earlier in the article. If the sound source is extremely weak, or if the microphone employed has very low voltage output, a pre-amplifier ahead of the jack will be required.

The instrument requires no circuit adjustments to place it initially into service. This is one of the outstanding advantages of the vibrating-reed frequency meter. To use the instrument in the frequency range covered by the indicating meter, it is necessary merely to switch on the power and "pipe in" the signal, either as a current delivered to the input jack or as a sound picked up by a microphone.

The amplifier-type reed meter is ideally suited to production test operations in which a quick, direct indication of frequency is required. Because of its high input impedance, the instrument causes negligible loading of such circuits under test as oscillators, amplifiers, etc.

—30—

V.H.F.—Federal Airways
(*Continued from page* 34)

It was very disturbing in the headphones on aural reception. But the effect was greatly diminished in the double-modulation visual range system when automatic gain control was used.

Propeller modulation was encountered where the size of the airplane propeller was comparable to one-half wavelength. However, this effect was minimized by selecting the best location for the receiving antenna. In one of the air line tests on a Douglas DC-3 the propeller modulation was barely noticeable and, very strange to say, none of the pilots mentioned it in their reports.

Under average noise conditions of an airplane equipped with the usual shielded plugs and harness, the distance range of a 100-watt transmitter was 40 to 50 miles at 1000 feet when the transmitting array was 16 feet high and one-quarter wavelength above a counterpoise in flat country. At higher altitudes, such as Pittsburgh (1200 feet above sea level), with the antenna 12 feet high, one-quarter wavelength above a counterpoise, the distance range was 60 to 65 miles at 1000 feet above the ground. No appreciable change in distance range was observed between horizontally and vertically polarized antennas.

Atmospherics

The enormous improvement which v.h.f. offers over the low frequencies in the reduction of atmospheric static, as brought to the attention of airmen participating in the Pittsburgh tests, is really what won them over completely and irrevocably to aviation radio. The report establishes a new low in understatement when it reports the following airline pilots' comments:

"Little static on v.h.f., considerable on low frequency."

"Little rain static. Very heavy static on low frequency."

"Very little atmospheric static—none close to stations, 25 miles out."

"No static with lightning around."

And, whereas, the CAA engineers' modesty is quite becoming, the fact remains that the pilots' "grapevine" buzzed excitedly, even happily. For weeks on end, conversation around hangars and in pilot rooms centered on the subject v.h.f., with speculation running rife as to future developments.

Well, optimistic as they were over the Pittsburgh findings, pilots were in no position to comprehend the full promise v.h.f. held—still holds—for aviation. Nor, for that matter, is it reasonable to believe that the engineers themselves fully appreciated the vista opened to them.

Following what is now commonly known as the Pittsburgh experiment,
(*Continued on page* 158)

"This section is designed to help the radio industry obtain trained, experienced, technical men to facilitate vital war production. Before applying for any of these positions consult your local United States Employment Service office to determine War Manpower Commission regulations concerning the changing of jobs. If you are already employed in war work at your highest skill, stick to your present job."

(*Continued from page* 155)

it was decided to install a model v.h.f. Airway of 8 transmitters between Chicago and Newark, N. J., operating on 125-megacycles. Construction was begun at once and by early 1941 this, the first v.h.f. Airway, was ready for use. The airlines, notably TWA and American Airlines, cooperated by installing v.h.f. equipment in a few of their planes and kept careful logs. Needless to say, trips over this airway were greatly sought after by the pilots.

The lessons learned at Pittsburgh and Indianapolis were incorporated in the Chicago-Newark project. The original 8 stations produced four aural courses which, as will later be seen, is considerably different from the two aural-two visual system that was finally adopted. Unfortunately, however, there was a shortage of equipment and operational tests by the airlines were necessarily limited. Then, with the coming of war, all hope of conversion was abandoned by the CAA until here recently.

It will doubtless be of interest to compare the equipment used on the "model" v.h.f. Airway with that used in Pittsburgh and Indianapolis. Power in the ground station remained at 200-watts while the rest of the equipment included sideband generator racks, control rack, and motor alternators. As insurance against commercial power failure, an engine generator was also supplied for stand-by power. Additional performance insurance was also obtained from two field monitors located on the station site some distance from the antenna.

The antenna comprises a set of 5 horizontal loops mounted on a tower 30 feet high and fed by means of coaxial transmission lines. These latter are filled with nitrogen under five pounds pressure to prevent absorption of moisture. Ordinarily the ground station is located on relatively high ground in order that the radiation may have uninterrupted paths to the aircraft it serves.

Present-day receiving equipment is merely certain refinements over that first used. It consists of a crystal-controlled superheterodyne with filters to separate the signals that control the visual indicator from the aural and voice channels. The visual indicator on the aircraft indicates to the left, over a blue portion of the scale, or to the right, over a yellow portion. This tells the pilot if he is to the right or left of the visual course (see cut). At the same time if he listens to the aural portion of the range he will get an "A", or an "N", in code, depending on which side of the aural course he is flying.

The receiving antenna currently most popular is the so-called "V". It is a horizontal antenna having a minimum of directional properties so that the signal received does not depend on the attitude of the plane with reference to the ground transmitting station.

The last and probably the greatest boon v.h.f. brings to commercial flying operations is instrument landing. This is an absorbing subject and requires more space than is available here. The system which has been adopted for installation is in the main in two parts—localizer and a glide path. The former is a radio beam directed down the center of the runway several miles out beyond the edge of the airport, while the glide path is a parabolic beam curving downward to the runway at a normal gliding angle from a point 1,500 feet above the ground 5 miles distant from the airport. An instrument on the dashboard "shows" the pilot both the localizer, by means of a vertical needle, and the glide path, by a horizontal needle. The simple procedure is for the pilot to keep the one perfectly vertical and the other exactly horizontal. And since this device is not affected by static, instrument landings become actually easy.

While applauding this achievement, we must not overlook the fact that the size of the v.h.f. antenna system plays a large part in bringing about the happy result. The 5 transmitters have an overall antenna length of 50 feet which is, roughly, 1/250th the overall length of a similar low frequency antenna system.

At the present writing the CAA has launched a program which, in time, will have instrument landing systems at every major airport in the country. This, of course, is a part of CAA's conversion from low to very-high-frequency throughout the entire Civil Airways. This conversion will cost between $10,000,000 and $20,000,000 and will take at least three years to complete. It so happens that CAA has Congressional appropriations for close to fifty per cent of the entire job and contracts have been let for almost that amount of the work. And there is little doubt that the Congress will, in due course, make sufficient appropriations to completely cover the country and its possessions with adequate very-high-frequency airways and instrument landing installations.

—30—

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Erratum

The cover photo caption appearing on page 4 of the August, 1945, issue should have been credited to the Standard Transformer Corp. (Stancor) instead of the Standard Transformer Co.

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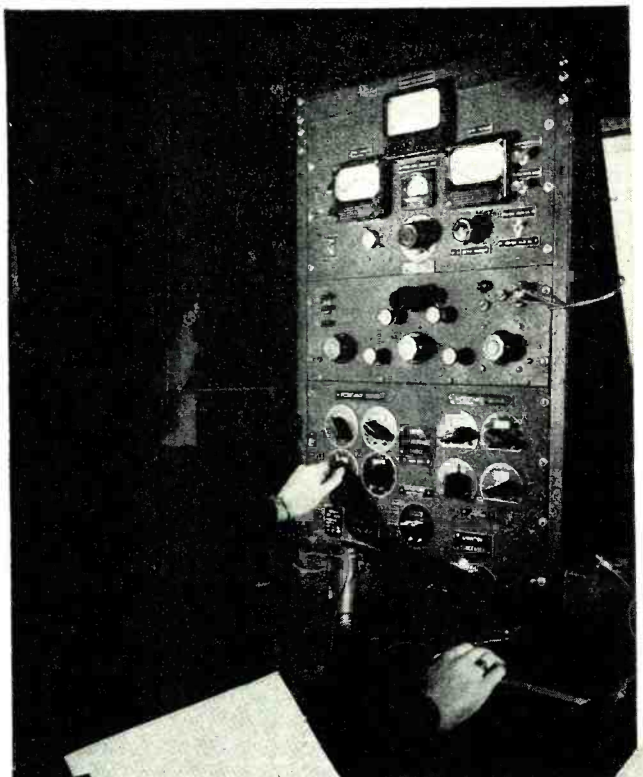
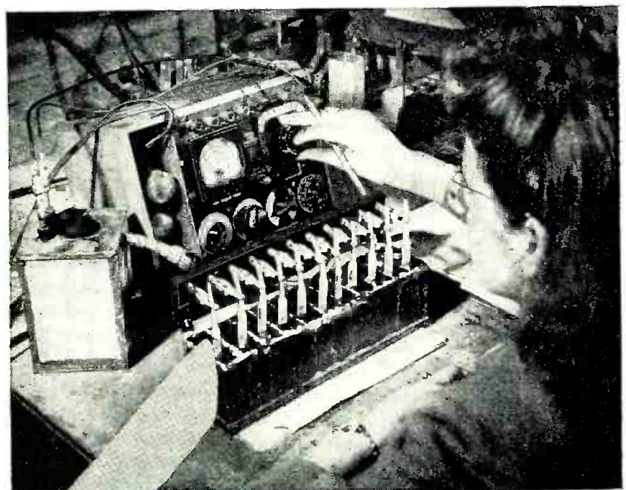
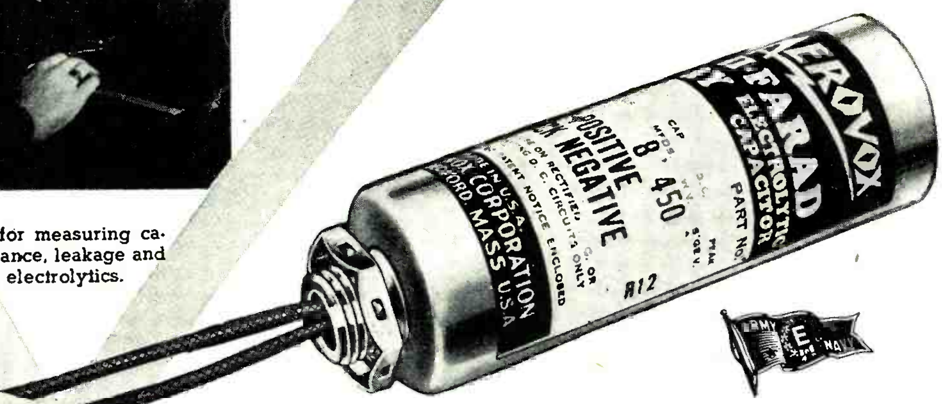
Sept. 1945



An Aerovox capacitance bridge for measuring capacitance, equivalent series resistance, leakage and other electrical characteristics of electrolytics.

Obtaining the characteristics of aluminum foil samples in order to insure uniform Aerovox quality of each unit throughout production.





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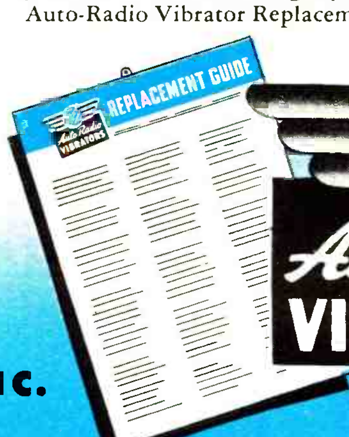
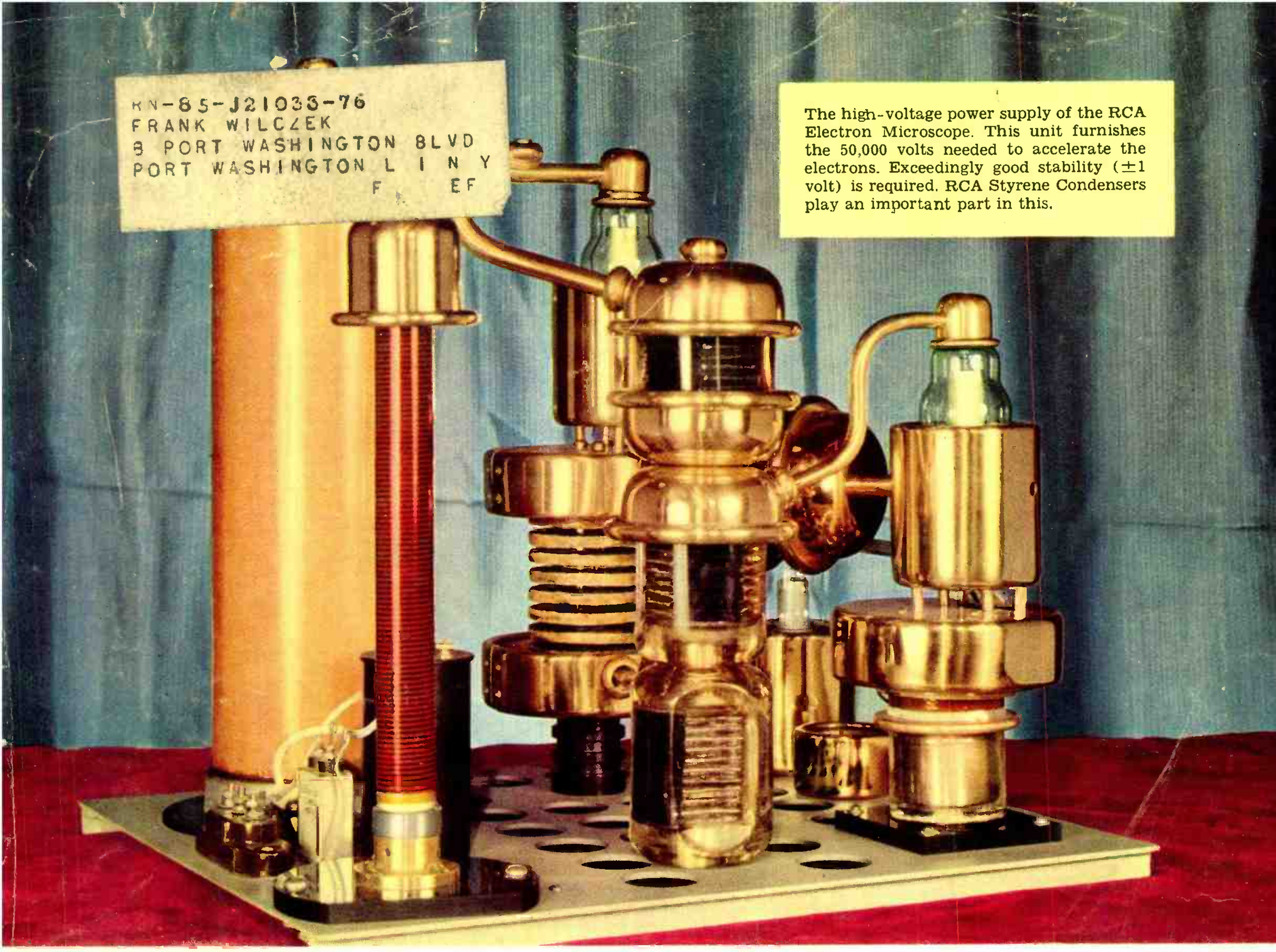


ARMY ★ E ★ NAVY

Electronic LABORATORIES, INC.
INDIANAPOLIS

E-L Auto Radio VIBRATORS



The high-voltage power supply of the RCA Electron Microscope. This unit furnishes the 50,000 volts needed to accelerate the electrons. Exceedingly good stability (±1 volt) is required. RCA Styrene Condensers play an important part in this.

RCA STYRENE CONDENSERS FOR ELECTRONIC EQUIPMENT

THE latest development in mica capacitors is a new type of Faradon Condenser in which the mica and foil "stack" is imbedded in clear styrene.

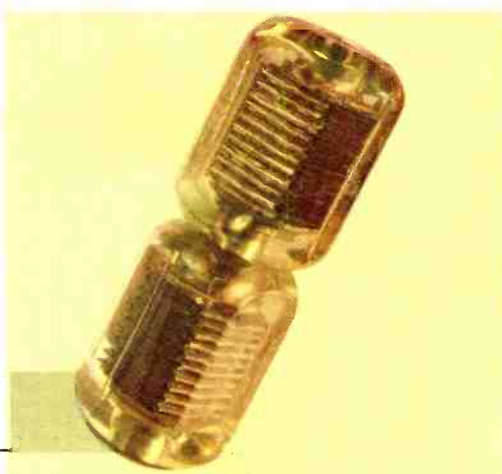
The use of styrene, instead of the usual wax, improves the "sealing," thus providing much better stability. Moreover, because the styrene has a lower power factor, the losses are less, and current ratings (for the same temperature increase) are higher.

At the present time limited to use in high-priority equipment, styrene capacitors are expected to find a wide range of uses in postwar transmitting, communication, and electronic equipment.

For complete information on Faradon Capacitors, for *any* purpose, write to the Engineering Products Department, RCA Victor Division, Camden, New Jersey.

BUY MORE WAR BONDS

A two-section styrene condenser from the power supply shown above. In some instances, these condensers can be used without case as shown here. Usually, however, they are mounted in standard cases.



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