RADIO NEWS

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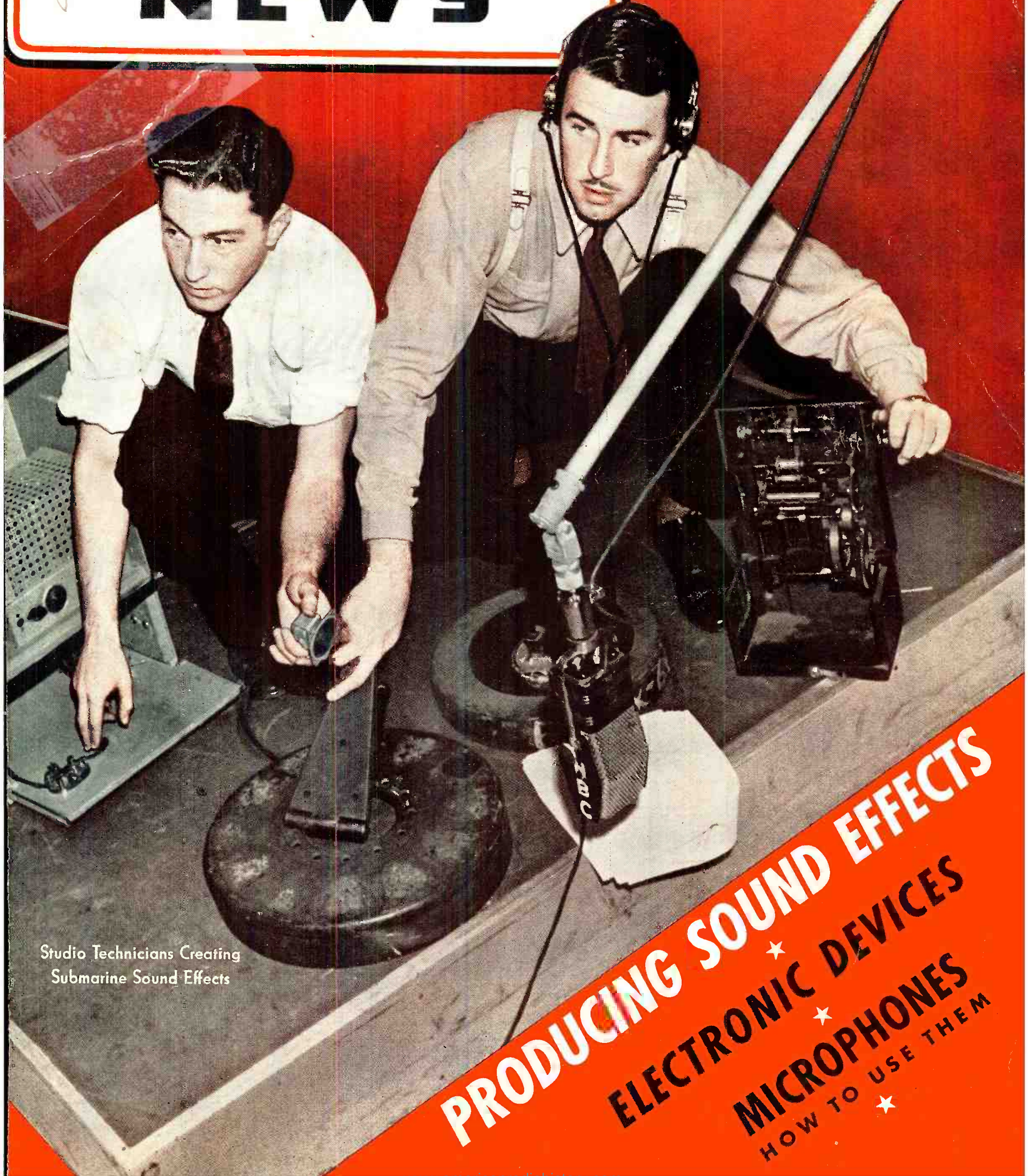

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Volume 29 Number 1

RADIO NEWS

JANUARY, 1943

★ *Leading the Industry Since 1919*

The Technical Magazine devoted to Radio in War, including articles for the Serviceman, Dealer, Recordist, Experimenter and Amateur

FOR THE *Record*

BY THE EDITOR

WE have had occasion during past months to discuss the problem of training with many men and women who are attempting to find their place in the radio field where they can be of greater service to this country in winning the war. Without exception, they have complained bitterly that the groundwork given in their classes was inadequate and that instead of receiving complete and informative material, that there had been an attempt on the part of instructors in general to touch only upon the high spots.

It is true that all of us must function at a pace far beyond our normal way of daily activity, and in our haste to accomplish the "impossible" in short periods of time, we must stop now and then to take stock of our accomplishments and to analyze our own particular situations before plunging head-long into further activities which we might not be fully equipped to handle.

The average student feels that in the case of radio instruction, he is being pushed way beyond his ability to learn, and that upon completion of one of the so called "short-cut" courses, he has become a mechanical and electrical robot, grilled and directed along a narrow and specific course on radio fundamentals and theory, and in most cases has but a vague knowledge of radio practice when he emerges from the classroom upon completion of his course.

There is no short cut to learning, particularly in radio. One must become skilled in the art by applying the senses of "sight" and "smell" before he may become qualified to handle mechanical and electrical topics intelligently.

It has been stated, and wisely, that a good engineer uses 90% common sense and 10% basic knowledge. We have talked to many a radio man of late who has just completed what he thought would be a complete course in radio and has found that his total time spent in the classroom was not

(*Continued on page* 70)

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Member of the Audit Bureau of Circulations

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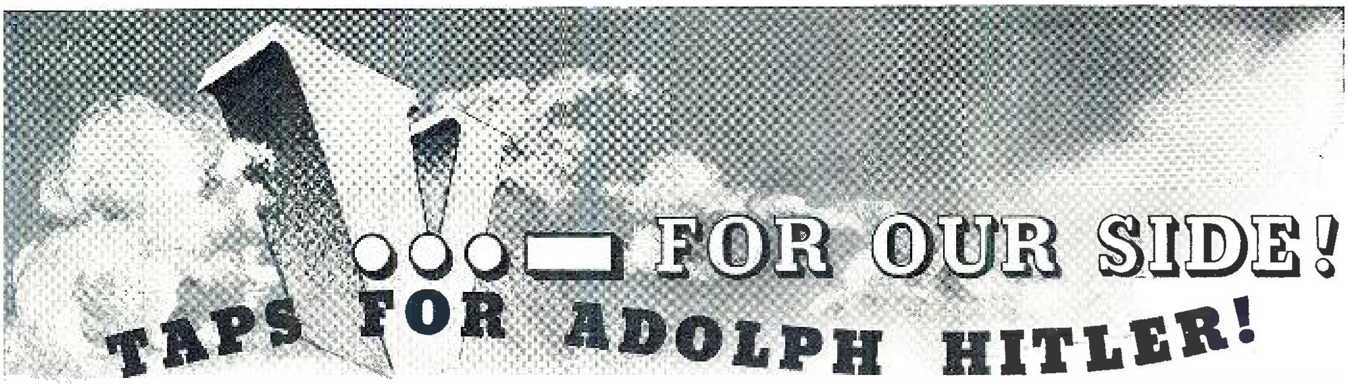
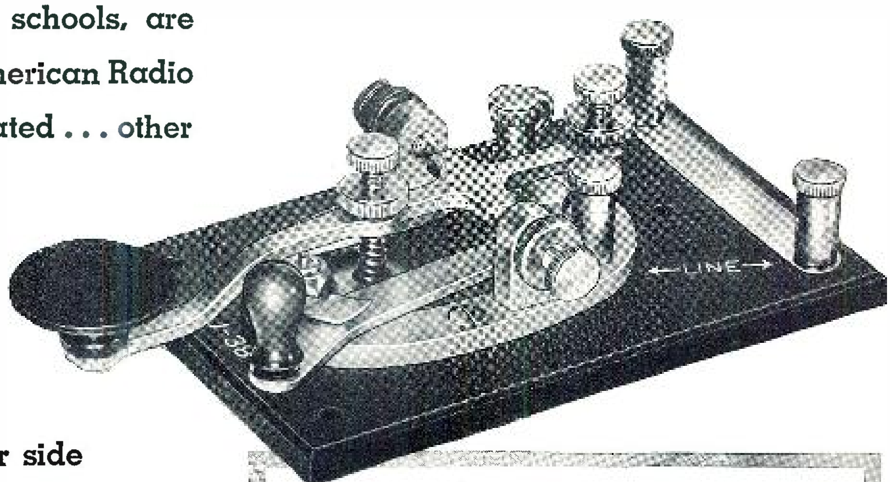


It wasn't so very long ago that they might have gotten their signals from a canny quarterback or the traffic light on the corner. Today, the long, lean fingers of thousands of Americans are tapping out messages in the Signal Corps—the first line at the front line.

Serving with the Signal Corps on all battlefronts, as well as in training schools, are telegraph keys produced by American Radio Hardware. Model J-38 is illustrated . . . other models, and there are many, include the J-37, J-44, J-45. Each one is utilized by both troops and students, helping to hammer home a • • • — Tap, tap, tap of victory for our side . . . and sounding taps for Adolph Hitler and his side. It's a beautiful rhythm, this victory tap, and daily it grows louder and louder and more encouraging. Along with you, we're mighty proud to be part of it!



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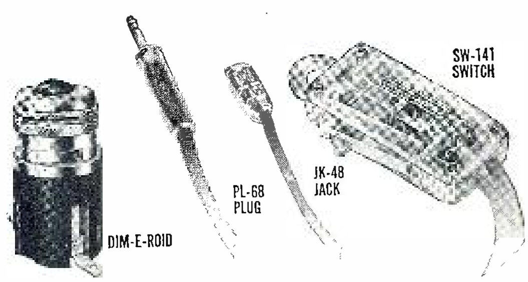

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METHODS OF MEASURING

by RUFUS P. TURNER
Consulting Engineer, RADIO NEWS

Instructors in military training classes will find this analysis of great value for teaching various methods for frequency measurements.

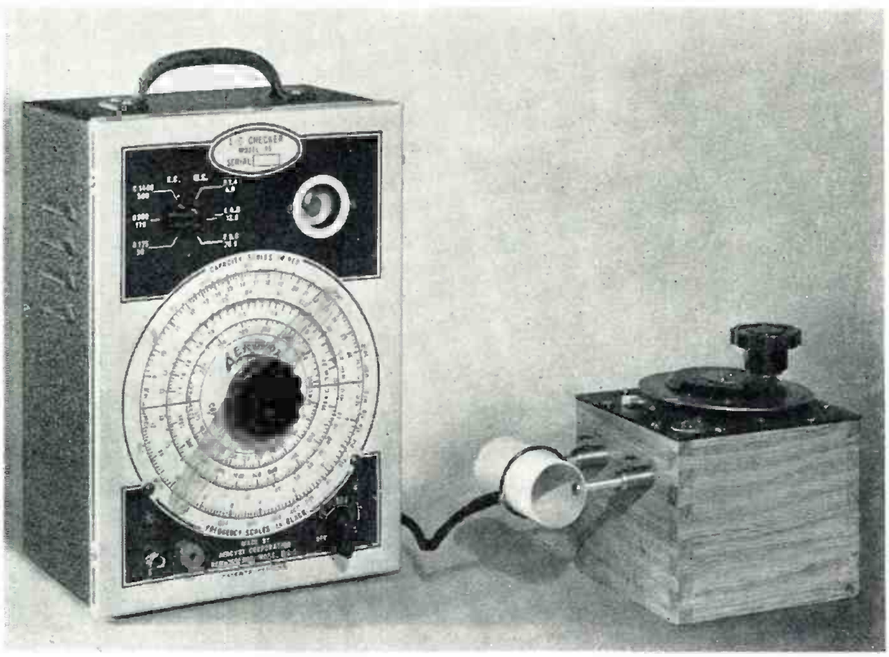
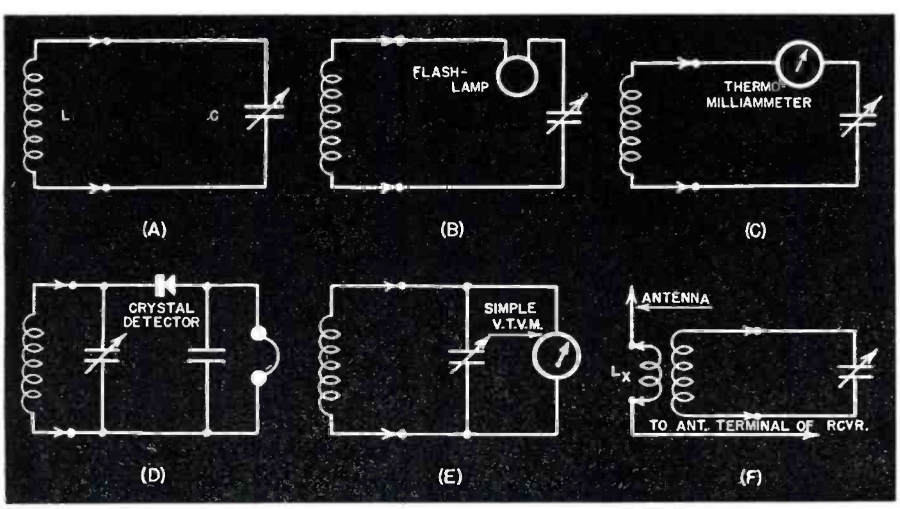


Fig. 1. A home-built wavemeter should be checked against a calibrated instrument such as this Aerovox L-C Checker, a popular service item.

Fig. 2. A representative group of simple wavemeter circuits.



IT is not the purpose of this article to review the interesting history of radio frequency measurements. However, in order to stress the background and importance of the subject, the following introductory remarks are apropos.

The measurement of radio frequencies dates back to the invention of tuning and is one of the basic r.f. tests. Analysis of circuit operation and the design of every radio system depends upon ability to determine the absolute value of r.f. alternations.

The task of concocting new and keener tools for frequency measurement has occupied some of radio's most gifted minds. And to recapitulate the growth of the frequency-measuring art would be to retrace the advancement of radio itself.

From humble beginnings with crude wavemeters, the art has advanced to the point of permitting present-day radio frequency measurements to be made with an accuracy of 0.00001 percent or better. This is one of the most accurate of all measurements in the scientific world.

For the benefit of radio and electronic workers, we will describe in this article the instruments now available for radio frequency measurements, methods of operating them, and the accuracy obtainable with each.

Absorption Wavemeter

The absorption wavemeter, known also as the absorption frequency meter, derives its name from the fact that it absorbs a certain amount of energy from the circuit to which it is coupled. This instrument identifies an unknown frequency by reference to its own inductance and capacitance values. Thus, it may be calibrated over the entire range of the variable element, or the frequency may be calculated from the wavemeter L-C settings at resonance with the signal.

The absorption wavemeter is the simplest possible device for determining radio frequency values. It consists, as is well known, merely of a coil and variable condenser connected in series, although it may also include some form of indicating device such as a flashlamp, thermal meter, or radio detector. The *Bureau of Standards* booklet *Radio Instruments and Measurements* refers to the absorption wavemeter as "the fundamental radio instrument."

In spite of its extreme simplicity of construction and operation, the wavemeter remains a highly useful device. It has retained a particular place among frequency-measuring gear, though more precise instruments oc-

RADIO FREQUENCIES . . .

cupy the other places. Certain applications, even in present-day radio and electronics, require the wavemeter either exclusively or for the first indication.

Figure 2 shows wavemeter circuits which cover most requirements and usages. The basic circuit is shown in A. Here, as in the other examples, the LC circuit may be adjusted to the frequency of the unknown signal, the point of exact adjustment being indicated by any of the several methods to be described presently. The coil is made plug-in in each case, in order that the frequency range of the instrument, with a single tuning condenser, may be extended over as much of the entire r.f. spectrum as desired. The dial of the tuning condenser may be marked off directly in kilocycles or megacycles.

Various means are employed in practice to indicate resonance with the unknown signal: When circuit A is used for checking a transmitter, the wavemeter coil is coupled to the transmitter tank (the actual separation between the two being the greatest possible for a reasonable indication) and the wavemeter tuned until a sharp deflection of the plate milliameter in the transmitter stage indicates resonance with the wavemeter. At this point, the unknown frequency is read directly from the wavemeter dial or obtained from a curve showing frequency vs. dial readings. Accuracy of the indication is increased by making the coupling between wavemeter and tank coils as loose as practicable.

Other methods of indication are likewise employed: Circuits B, C, D, and E may also be employed for transmitter frequency checking. These circuits differ from the one previously described in that they each embody some form of self-contained indicator, making it unnecessary to observe the meter in the transmitter. B employs a low-voltage flash-lamp which glows at maximum brilliance in indication of resonance. C has a series thermomilliammeter which shows maximum deflection at resonance, and E employs a vacuum-tube voltmeter to give the same type of indication.

Circuit D employs a crystal detector with headphones, and consequently may be used only in connection with modulated signals. Instead of a crystal, some wavemeters of this type now in operation employ a diode tube.

The sensitivity of circuits C, D, and E is considerably greater than that of A and B, hence much looser coupling must be employed with the former. If the meter-type indicators employed in C and E are sufficiently sensitive (1 to 5 milliamperes in C; 1 volt or less in E—all full-scale values), it is very likely that the wavemeter must be operated several feet away from the transmitter. This is true even for low-powered rigs. Circuit D may be operated many feet from the transmitter, and should so be operated at all times in order to prevent burn-out of the detector.

A signal being picked up from the air by a receiver may be measured with an absorption wavemeter. Any of the circuits in Figure 2 would suffice; however, best results are obtainable with A and F, since the indicating devices in the other arrangements are unnecessary, will not function, and may interfere somewhat with the measurement.

Wavemeter A is coupled to the receiver by placing its coil near the antenna input coil in the receiver. The wavemeter is then slowly tuned until a point is reached where the received signal is sharply attenuated or eliminated altogether. At this point, the

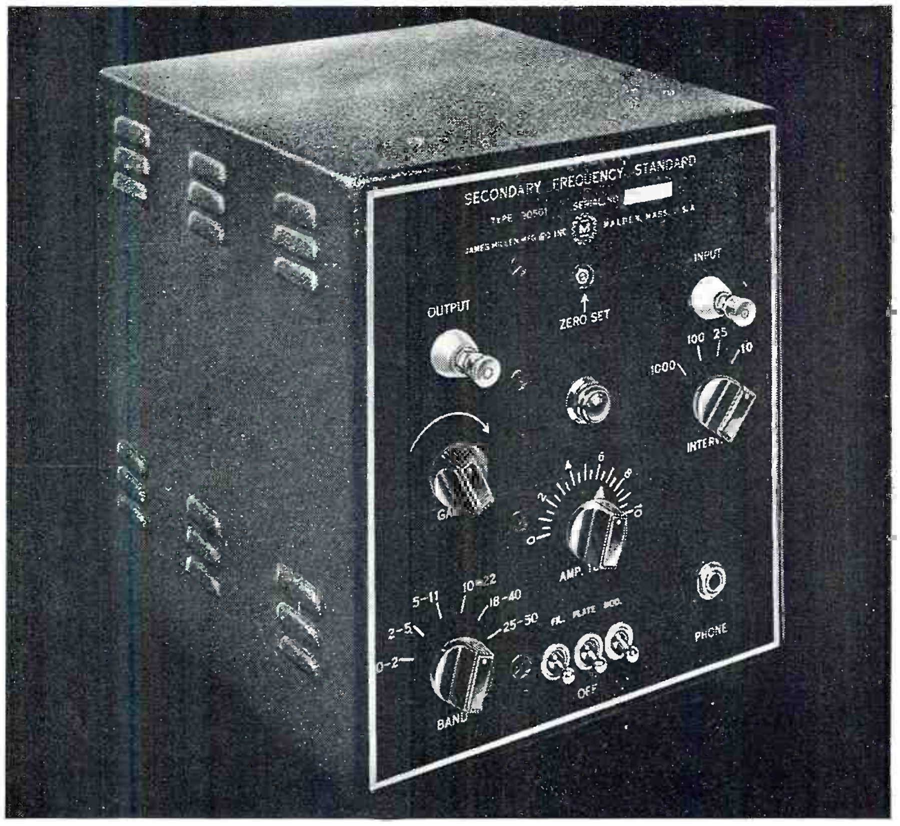
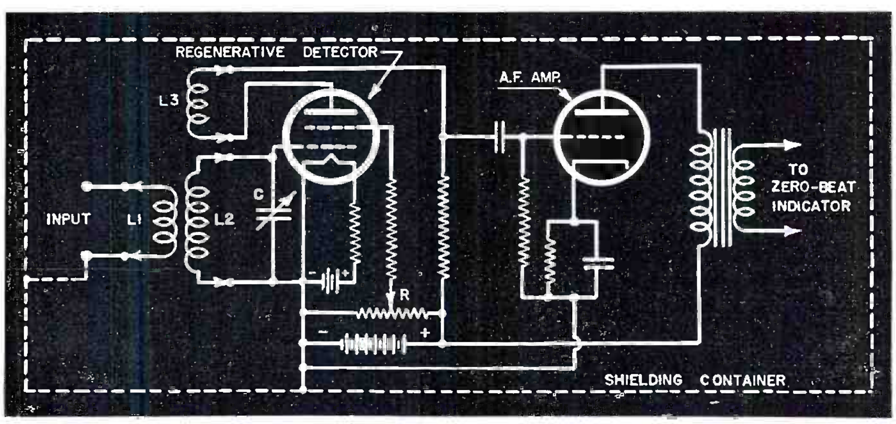


Fig. 3. A 100-1000 kc. crystal is the heart of this Millen Frequency Standard. Harmonics are used for spotting and other frequency checks.

Fig. 4. Circuit of a typical monitor (heterodyne detector) unit.



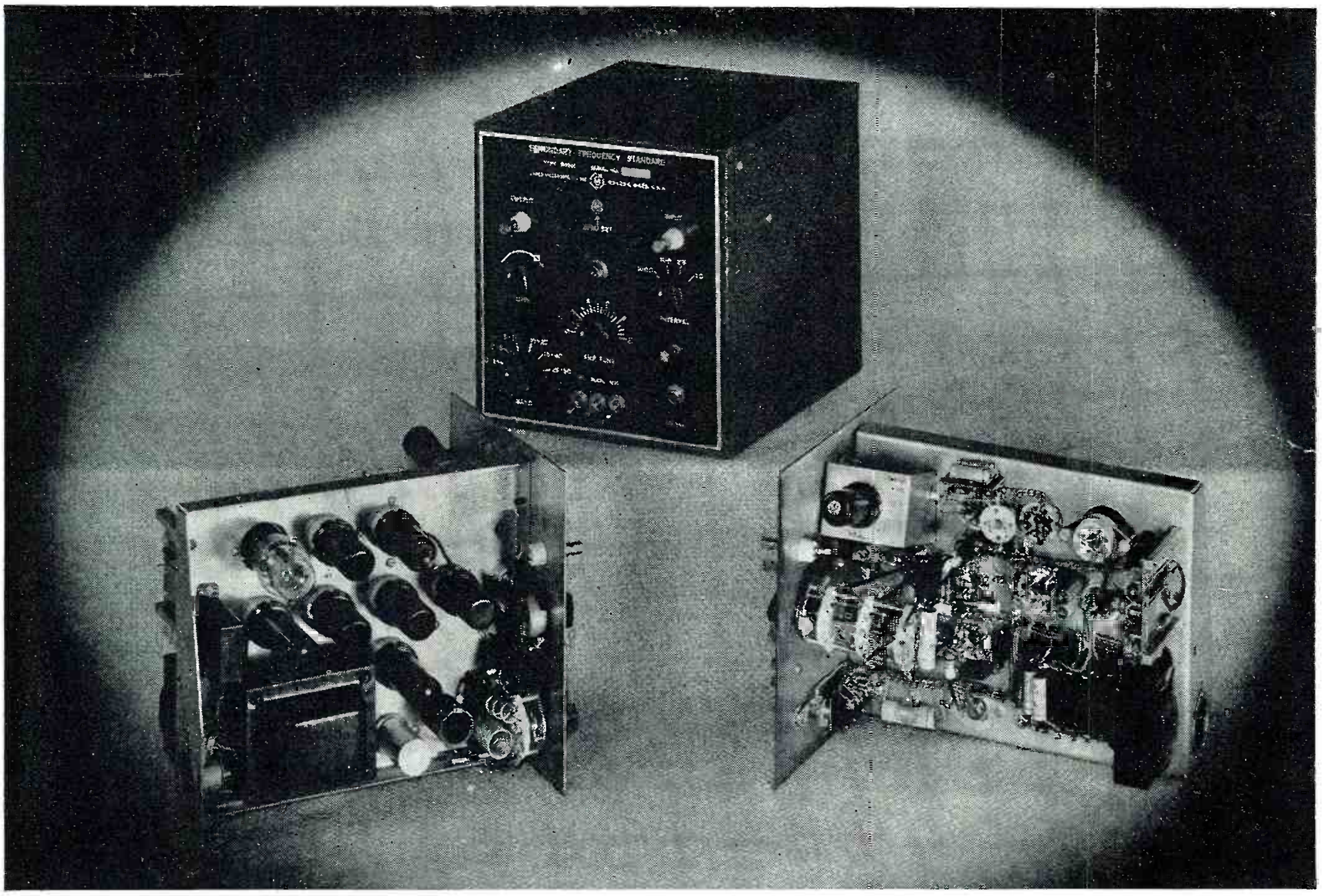


Fig. 5. Construction of a secondary standard requires great skill.

wavemeter is in resonance with the received signal. Passing rapidly through this point with the wavemeter results in a pronounced "plop" which is used by some operators as an indication of resonance as they rock the wavemeter dial back and forth. Sharpness of the indication may be improved considerably by loosening the coupling between wavemeter and receiver as much as allowable.

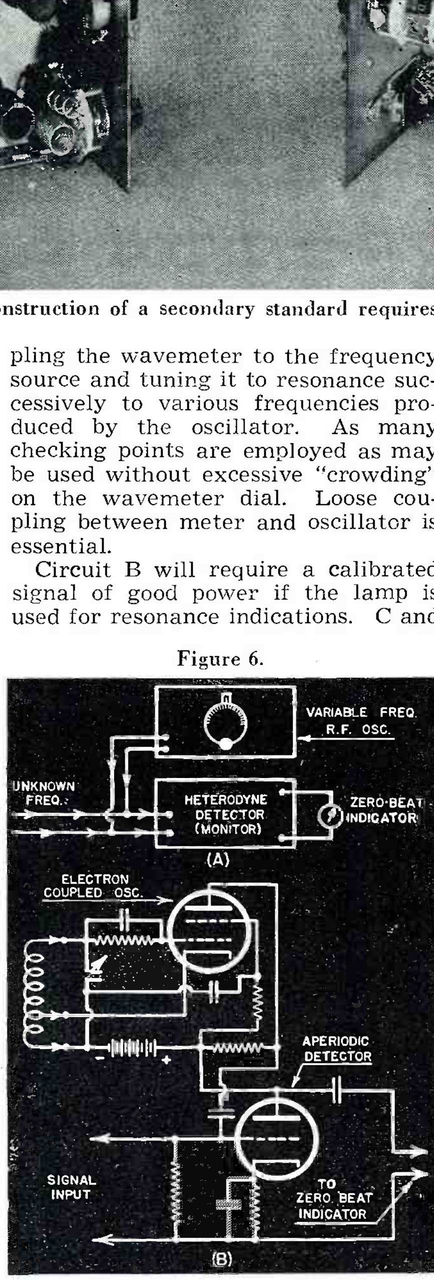
This system gives best results with regenerative receivers, and is applicable then only when the receiver coils are unshielded and accessible. For tuned r.f., superhet, and other systems employing shielded coils, intermediate frequencies, and the like, arrangement F is recommended. Here, the wavemeter is inserted as a calibrated *wave trap* between the antenna and receiver, being coupled through a 1- to 3-turn coil, Lx. The wavemeter is tuned to eliminate (or reduce) the signal, the frequency of which may then be obtained from the wavemeter calibration. If the indication is broad, covering several divisions on the wavemeter dial, coupling may be reduced by increasing the spacing between Lx and the wavemeter coil, by reducing the turns in Lx, or by a combination of both.

Calibration of Absorption Wavemeter

Wavemeters may be calibrated from an accurately-calibrated oscillator or similar frequency standard by coupling the wavemeter to the frequency source and tuning it to resonance successively to various frequencies produced by the oscillator. As many checking points are employed as may be used without excessive "crowding" on the wavemeter dial. Loose coupling between meter and oscillator is essential.

Circuit B will require a calibrated signal of good power if the lamp is used for resonance indications. C and E will require somewhat less power, while a modulated calibration signal (such as delivered by a service test oscillator or laboratory signal generator) must be used for circuit D.

Figure 6.



Circuit A is best calibrated by coupling into a regenerative receiver in the manner previously explained (the calibrating signals being fed into the receiver, and the wavemeter adjusted successively to these) or by coupling to a calibrating oscillator provided with a grid-dip meter (d.c. milliammeter in the oscillator grid circuit). The latter makes a very sensitive indicator, the meter taking a sharp dip as the wavemeter is tuned to the oscillator frequency.

A special adaptation of the grid-dip oscillator is the *Aerovox* L-C Checker which is owned by a number of radio and electronics workers. Absorption wavemeters may be calibrated directly with this instrument, as shown in Figure 1. The coupling ring is slipped over one end of the wavemeter coil or held close to it, the direct-reading Checker dial is set at a frequency point, and the wavemeter tuned until a sharp opening of the magic-eye indicator shows resonance with the frequency. A large number of checking points may be obtained within the wide Checker range of 60 kc. to 27 mc., and all of these points may be read directly on the Checker frequency dial.

Commercially-built wavemeters may now be obtained with a calibration accuracy of 0.25% or better.

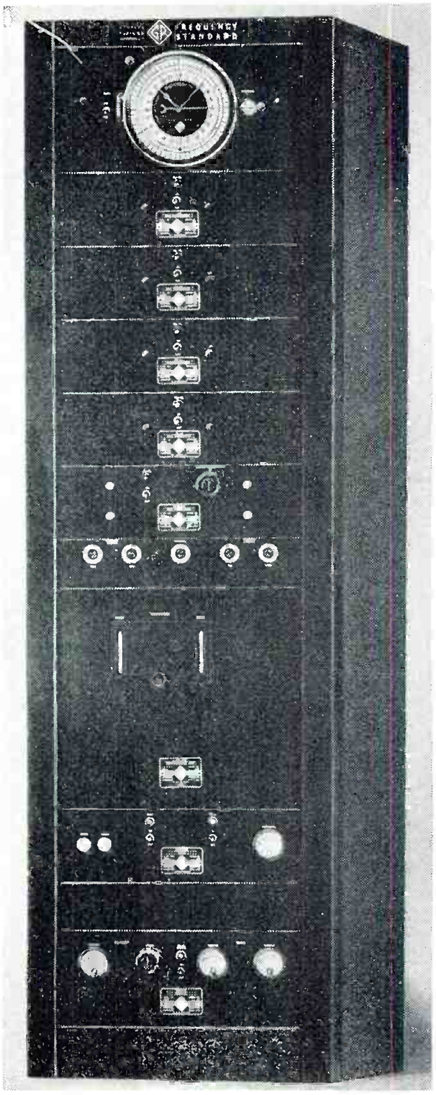


Fig. 7. Primary G-R Standard.

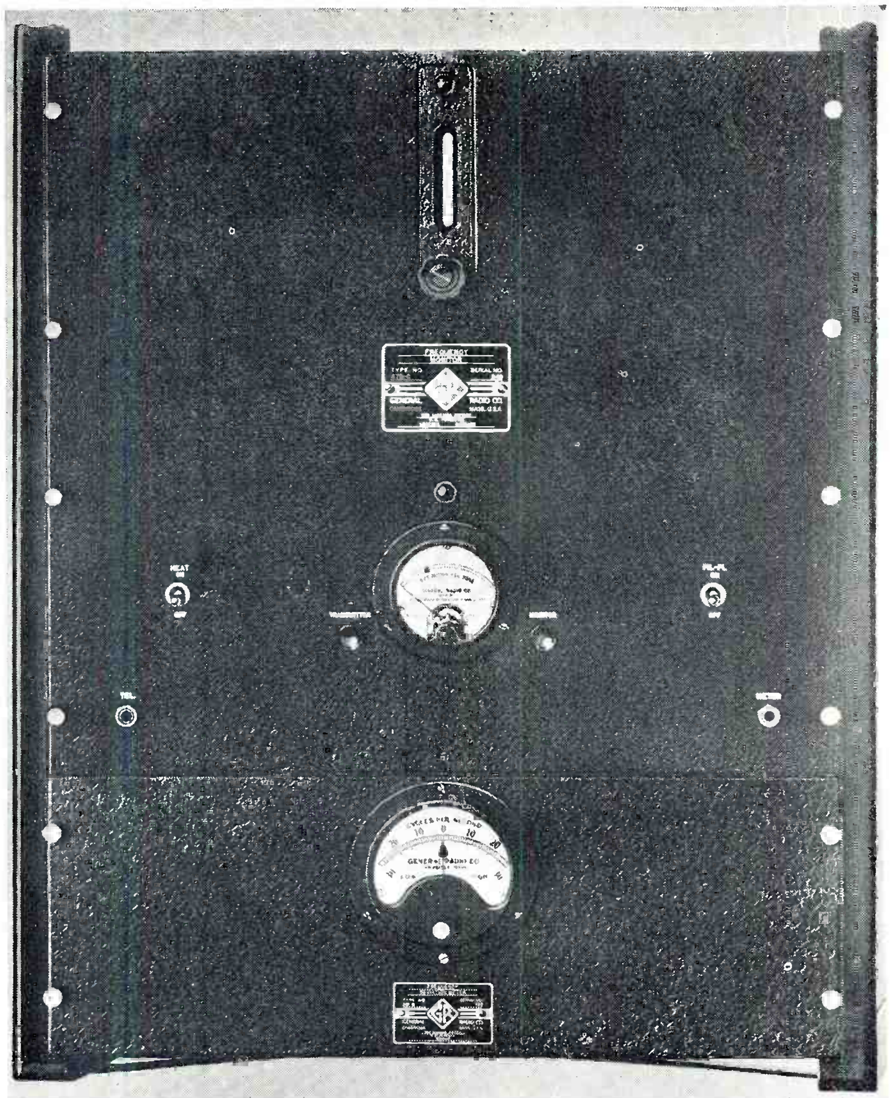


Fig. 8. **Frequency-Deviation meter for transmitter shift indication.**

These instruments are ruggedly constructed and are provided with vernier dials which are direct-reading in most cases and are designed to reduce errors of reading due to parallax and similar causes.

The loosely-coupled absorption wavemeter responds in general to fundamental frequencies only. This is a distinct advantage of the instrument. However, when sensitive self-contained indicators (such as shown in Figure 2, C-D-E) are employed, less vigorous, but definite, response is apt to occur also at harmonic frequencies, particularly when coupling approaches tightness.

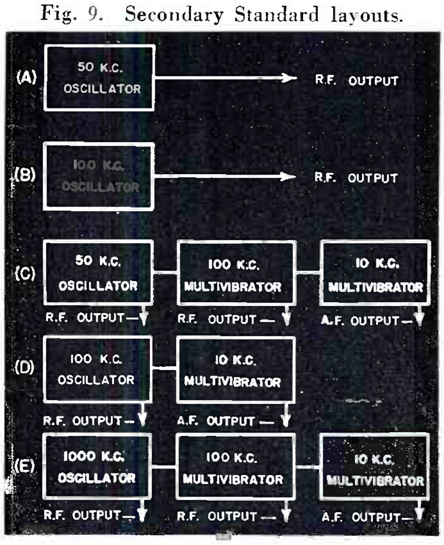
Calibrated Monitor (Heterodyne Detector)

Improved accuracy of reading plus ability to reset the frequency-measuring instrument with precision may be obtained through use of the heterodyne method. The simplest instrument employing this beat-note system is the heterodyne detector—known also by the term *calibrated monitor*.

Basically, the monitor is a simple radio receiver. It is regenerative in type and is usually entirely self-contained. Its single tuning dial may be calibrated and made direct-reading in frequencies, thereby enabling rapid identification of unknown signals. The signal is tuned in carefully, and its frequency noted from the dial reading at exact zero beat.

The device used to indicate zero beat in the monitor (headphones, output voltmeter, or magic eye) will by its own sensitivity determine the amount, if any, of audio amplification to be employed after the detector stage. At the same time, the frequency accuracy of the instrument depends largely upon the type of beat indicator employed. A sensitive output voltmeter or magic-eye indicator will permit closer setting to zero beat than will headphones.

Fig. 9. Secondary Standard layouts.



The monitor calibration may be referred periodically to standard-frequency signals, or a self-calibrator (generally in the form of a low-frequency crystal oscillator) may be made an integral part of the instrument for checking one or more dial points.

The circuit of a typical monitor (heterodyne detector) unit is shown in Figure 4. The arrangement consists of an *Armstrong* tuned grid type regenerative detector inductively-coupled to the input terminals. Regeneration is controlled by means of the screen-circuit potentiometer, R, which permits the detector to be operated at will at any point in the regeneration

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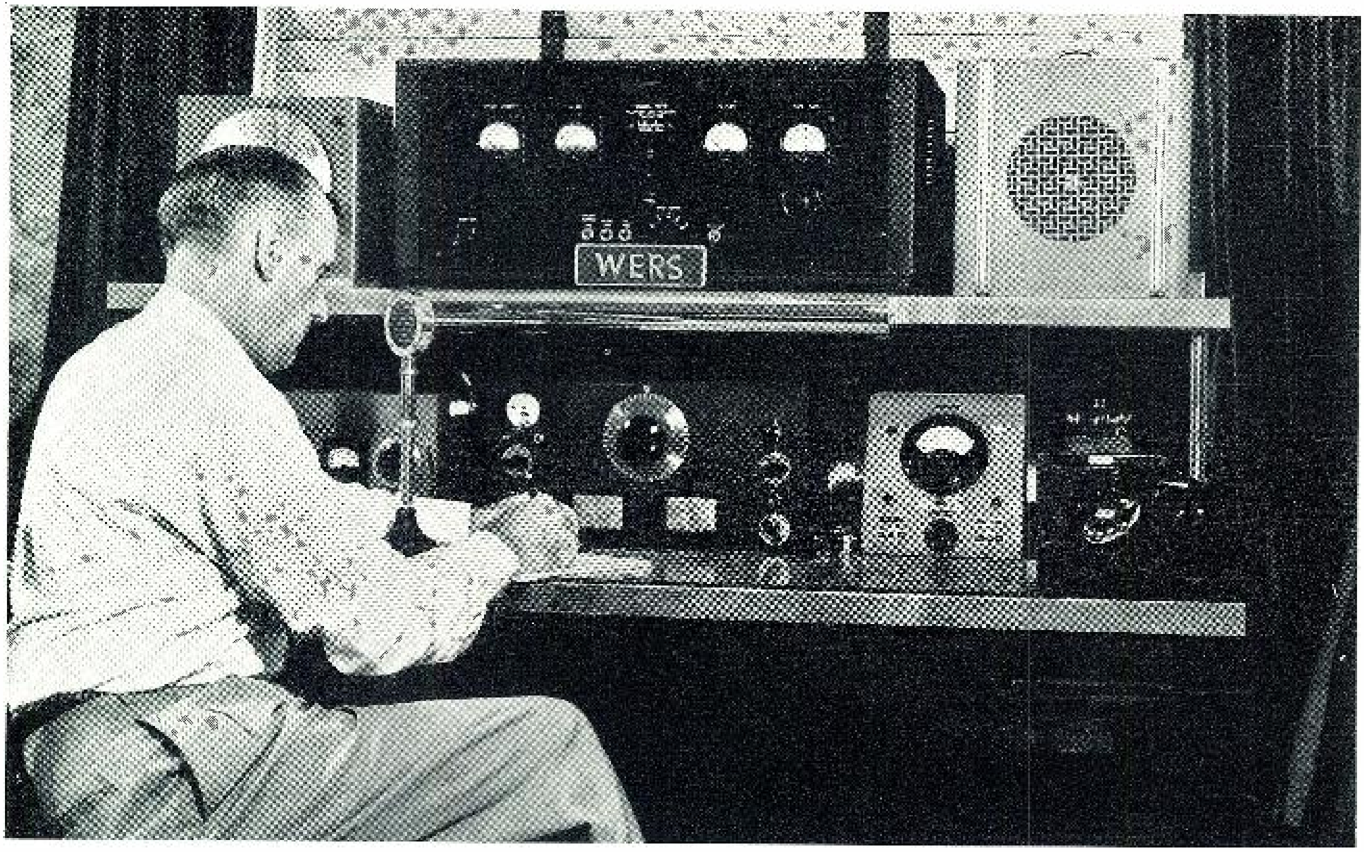


A well-planned layout for an efficient WERS station. Note telephone within easy reach.

A REPORT ON THE WERS

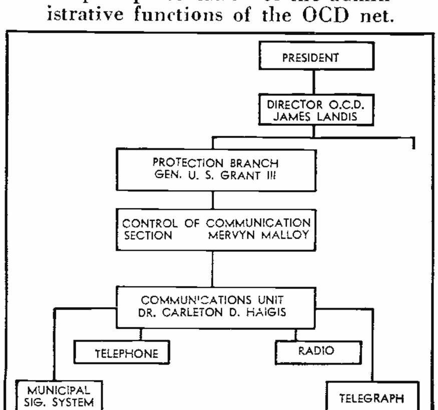
by LEWIS WINNER

Presenting the first thorough analysis of the War Emergency Radio Service system as it now prevails.

WHEN the *Federal Communications System* issued that fateful edict, calling all amateurs off the air, shortly after Pearl Harbor, disappointment was naturally rife, for the hams felt that certainly now they could really serve the nation. And they were right, but not under the then existing rules and regulations. That was quite apparent after the relaxation of the first cessation ruling, when endless infractions prevailed. Soon, however, after the final shutdown order went into effect, amateurs heard that some official system with amateur equipment and operators might be used, but under a drastic change in policy. Months passed and the rumors became stronger, until official announcements brought the rumor into an actuality, with the attendant establishment of the *War Emergency Radio Service*, or WERS as it is more popularly known today.

The *United States Office of Civilian Defense*, being fully aware of the remarkable results achieved by radio facilities in peace-time, naturally desired to provide means for their use in civilian protection in war-time. To this end the problem was presented to the *Federal Communications Commission* and the *Board of War Communications*. On May 28, 1942, after many conferences, the *War Emergency Radio Service* was formed and radio channels were allocated for its use.

Graphic presentation of the administrative functions of the OCD net.

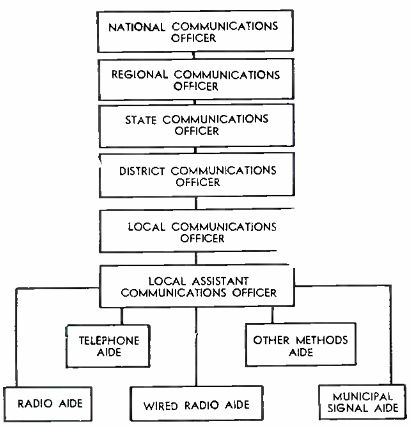


The problem of explanations, rulings and orders, which had to be expected, prevented the system from swinging into high gear immediately, or even soon after the order went into effect. Several months more thus passed, months that teemed with hard work, until the system finally began to show signs of life. Today the system is quite a healthy youngster, with promising indications of it soon becoming quite mature.

L. R. Jenkins, radio aide in Cumberland, Md. with part of equipment used for WERS net.

E. J. Watkins, T. R. Felts, A. J. Scallata, L. R. Jenkins, W. H. Thompson with UHF gear.

In the *Office of Civilian Defense,* there are nine regional offices, spread around the country, through which information, instructional data and essential official details to the *State Defense Councils* can be routed. To handle communications, the *State Defense Council* appoints a State Communications Officer and usually a State Radio Officer. The National Communications Officer, through the medium of the nine Regional Offices, provides information, planning guides, and instructional material for use by the various states and through them to their Local Defense Councils. Although there is no authority between the national office of the OCD and the State Defense Councils, a high degree of cooperative spirit exists at all times.



Organization chart of the various communications officers in order of rank.

The extent of the communications facilities in any community is predicated on its size. The local Communications Officer can expect full assistance from the regional OCD office on any problem that may arise.

In the states, all posts from the State Communications Officer down, are voluntary. The *State Defense Council,* of which this officer is a member, is, however, appointed either by state legislation or gubernatorial decree. Each municipality has its own local defense council. This is the administrative body on which specialized assistants serve.

The operating group in civilian defense is known as the *Citizens Defense Corps.* This is the group that carries out all the necessary operations in the event of an air-raid or in passive defense, involved in preparing hospitals, first aid stations, arranging for blackouts, etc. The local defense council appoints a commander of this group, who has full control of all activities of this group in his area. And one of those activities is communications. It thus becomes his duty to appoint a communications officer whose duties are to provide all of the basic and supplemental kinds of communication which are required for civilian defense control.

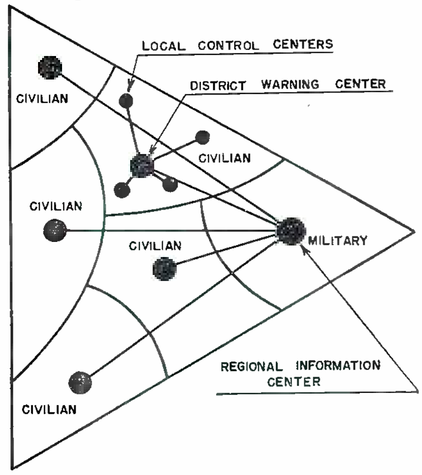
There are four defense command areas in the country. These areas, which have been assigned by the military authorities, are further subdivided into a number of air defense regions. In each of these regions is an information center established by the military where information from a number of observation posts established through that region, is received. For the purpose of warning the civilian population, each air defense region has been further divided by the military into warning areas. For instance, there might be ten warning areas in any one air defense region. From the information center, the military authorities issue orders to a point called the warning center in each warning area. At this point, military authority ceases, and civilian control is invoked.

The air defense regions have boundaries that are defined by the military. From the regional information center or filter center there is a direct line to the warning center. The telephone system has been adopted for this purpose as a basic medium of communications because of its completely available facilities. Of course, there is no reason why supplementary means of communication between warning centers and the state cannot be organized to hasten the speed in securing re-enforcements to an incident area if necessary. This point will be discussed later on.

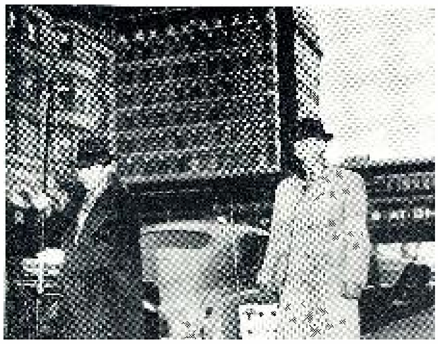
Then again, there is also a need for the existing communications facilities to be supplemented by adequate services between the various defense crews and between various fixed points within any community. Such extensive communications facilities are most urgently needed in heavily populated areas. In others, limited supplemental means will suffice.

Actually, therefore, local communications can be divided into three groups . . . (1)—communications between the control center and the in-

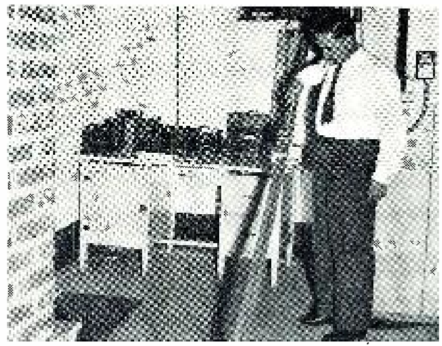
Typical WERS area setup showing relationship between military and civilians.



Col. H. S. Barrett, studying the wired radio installation, with designers.

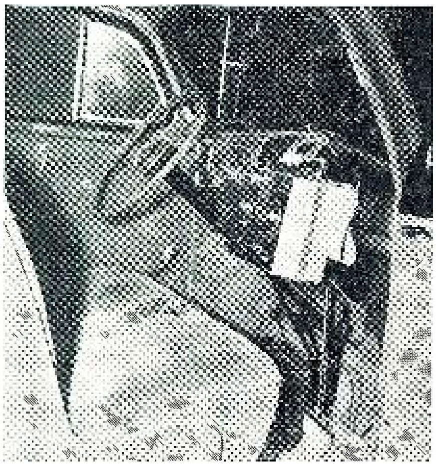


(Fig. A) WERS Operator using walkie-talkie. Note special car antenna.



Mr. Hunter shows a special lecher wire—used for frequency measurement.

A portable WERS mobile installation used in the Baltimore radio network.



cident area; (2)—communications between the control center and fixed points such as fire stations, police stations, hospitals, rescue crew headquarters, etc.; and (3)—communication channels to the warning center from the local control center for the purpose of calling reinforcements in the event that the community is unable to cope with the situation itself.

In the smaller communities, mobile channels between the control center and the incident may be confined to a single channel or to several, depending upon the size of the community. However, in larger communities several circuits may be necessary to handle the increased message traffic. For instance, one channel might be used for fire service, another for medical emergencies, etc. Similarly, the fixed channels between the control center and other fixed points may be extended by using one circuit for hospitals, another to fire stations, etc.

So that as few channels as possible are used to serve an area to avoid confusion, it is essential that the so-called "out" circuit from the control center to the warning center be set up with the full cooperation of the other communities in the area. These channels are, of course, radio controlled. In establishing these channels, the *Office of Civilian Defense* has recommended that an entire area be operated under one license so that equipment throughout the area may be pooled at one point should serious emergencies arise.

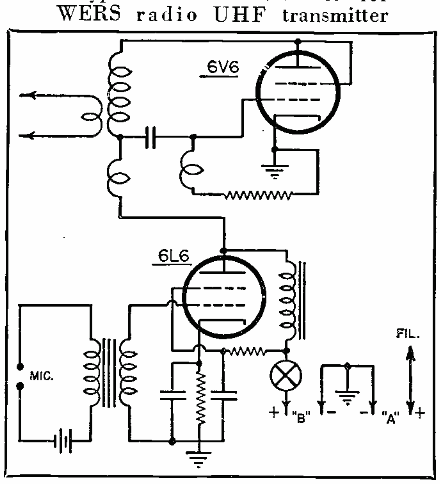
The rules and regulations of the FCC provide for the licensing of independent towns. This particular procedure, however, makes it impossible to transfer either operators or equipment outside of the boundaries of the community. The warning center plan with a singular license for one area is thus the better of the two. As a matter of fact, it is being used by many with greater success than those having the individual licenses.

Applications for authority to operate civilian defense stations have to be filed in the name of eligible applicants such as cities, towns or counties, and by no other agencies. Incidentally, the filing of these forms by the police departments, civilian defense councils, and other offices of local government, has been one of the causes of the delays in granting licenses. The license applications for stations have to be signed by the chief executive of the actual applicant which may be the mayor, city manager, etc.

To cover the operation of all fixed-portable, mobile, and portable-mobile transmitters, which are to be used in a single coordinated communications system, a blanket application may be submitted.

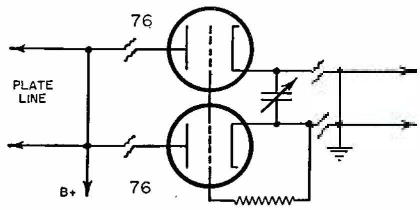
There are two classes of radio stations in the WERS. They are the *Civilian Defense* and *State Guard* stations which are intended to provide distinct and separate communication facilities on frequencies above 112,000 Kilocycles. The *State Guard* station

A typical oscillator-modulator for WERS radio UHF transmitter



licenses are only issued to the official State Guard or comparable organizations. These stations may be used only during emergencies endangering life, public safety or important property. Or, this service may be used for essential communications directly relating to State Guard activities *in instances in which other communications facilities do not exist or are inadequate.* *State Guard* stations may be used to communicate with other stations in the WERS or in the emergency radio service of the police, forestry, marine, fire, etc.

Stations in the WERS can be operated only by a radio operator holding a valid WERS operator permit for the station to which he is assigned. To obtain this, he must fill out a blank, citing among other things his citizenship and his present license. In addition, he must swear loyalty to the Government. The latter, as well as



Circuit diagram of the long line oscillator by J. Hunter.

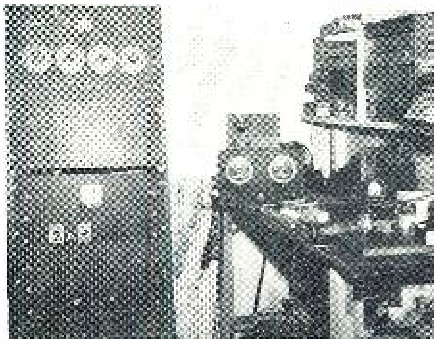
the technical qualifications of the applicant, must be certified to by a Radio Aide or, if the application is for State Guard stations, the communications Officer, who acts on behalf of the station licensee.

One of the most important persons in the WERS is the Radio Aide. He is the official designated by the station licensee to direct and supervise the operation of all the radio stations to be covered in the license. He must hold a valid operator's license of any class except the restricted radio telephone operator's permit. And, of course, he must be fully investigated as to his loyalty and integrity.

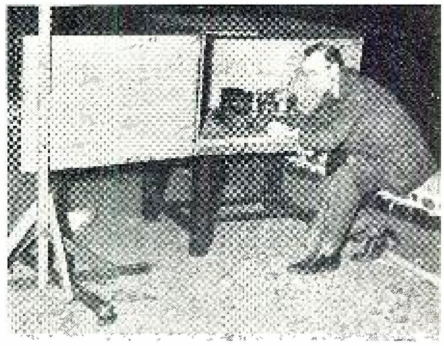
All stations in the WERS are allowed to use a maximum, unmodulated power input of 25 watts to the plate circuit of the final amplifier stage of an oscillator-amplifier transmitter or to the plate circuit of an oscillator transmitter.

At the present time, licenses are being granted for a period of one year,

A fireman at the controls of the 100 and 200 kc. transmitter unit.



(Fig. B) Typical control station unit and 2½ meter receivers used by WERS.



This transmitter is housed within a water-tight box on building roof.

with the expiration dates of stations in areas adjusted to a predetermined schedule.

So that equipment can be maintained, methods of operation perfected, and operating personnel trained properly, tests and drill periods have been assigned to this system. These periods are on Wednesdays and Sundays, during two-hour schedules.

One of the interesting features of this service is, that in many instances, the equipment used is of the home-made or composite type. The fact that the required equipment could be constructed in this way, eliminating the need of specially manufactured transmitters or receivers and thus avoiding any strain on the production facilities of the communications plants which are engaged in war work, was of material assistance in establishing the WERS.

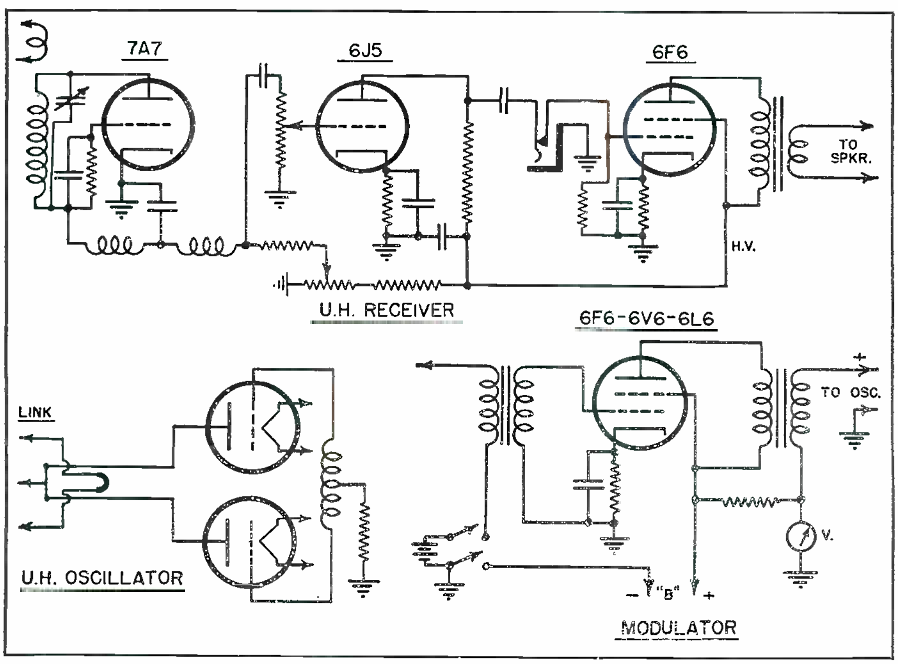
Thus far, licenses for operation of WERS units have been granted to many communities or areas in such states as Maryland, Connecticut, Ohio, New York and Indiana. And indications are that by the time this issue has gone to press, many more will have joined the march of the WERS.

Probably, two of the most representative types of WERS activities are to be found in the state of Maryland and New York City. This is particularly true in New York, where, because of the many thickly populated areas, a variety of skyscrapers, etc., many unusual conditions exist.

In New York City, the areas are known as the county control area, city control area and the precinct control area. Each are allied to each other, having fixed crystal controlled transmitters as their medium of radio communication. To provide the precinct areas with the necessary mobility of contact, portable and mobile receivers and transmitters are used. Incidentally, there is no restriction on the number of portable and mobile units that can be used as long as the FCC is notified of new units added and that they are all suitably operated by licensed personnel and within the frequency limits and power specified under law.

Although a large percentage of the operators involved are amateurs, an increasing number of commercial operators are joining the ranks. Many of these commercial operators are coming from broadcast stations, commercial transmitters, wire systems and laboratories.

Diagram of UHF receiver, modulator and oscillator, used in some units.



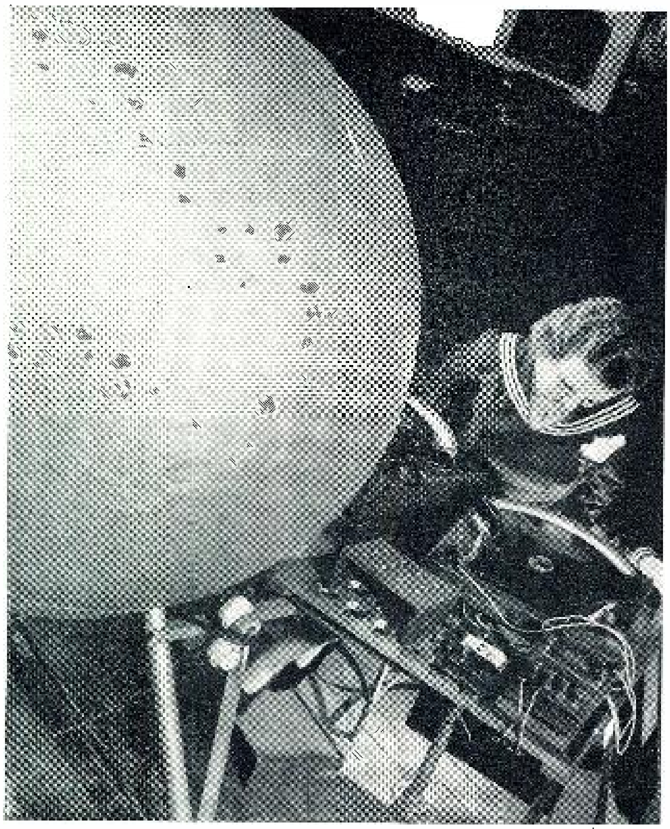
Explaining the design of a required radio unit for War Emergency service.

Mention was made of the problems met in small congested areas. Since, in such areas, it is necessary to have several mobile or portable units, the transceiver type of equipment cannot be used too successfully because of interference from the radiated signal. Accordingly, a new unit is being developed. In this special device will be a standard transmitter and a receiver. The receiver does not radiate any interfering signals. The composite units, although in the same casing, will be individual in their operation.

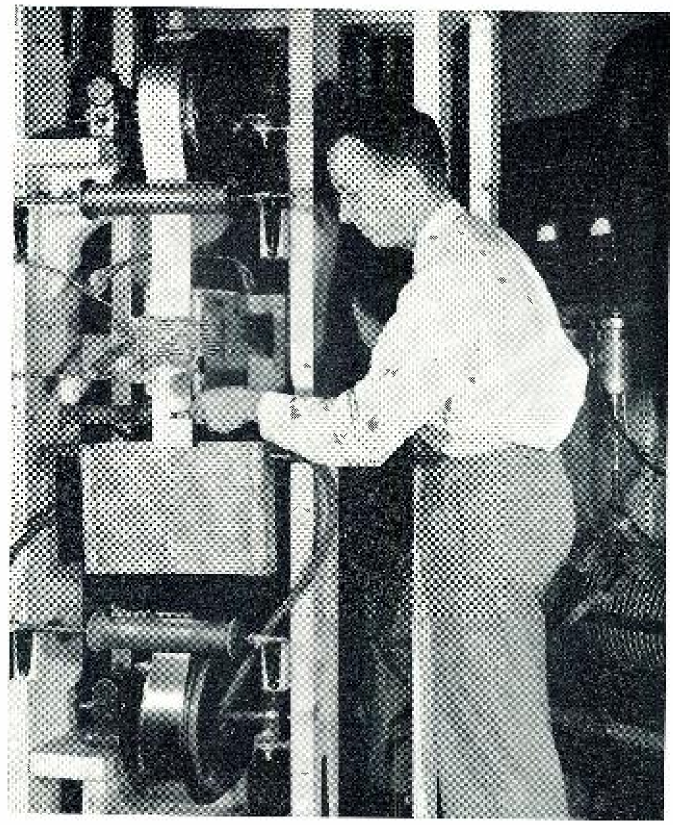
Directional effects prompted by tall buildings are another problem in a city such as New York. Changing locations of the antenna and antenna feeders have been helpful in avoiding the energy absorption of these steel structures. Reflection, another problem, has also been solved by the use of suitable antenna design.

One of the requisites of the WERS involves the donation or loan of the equipment to the area wherein the WERS is located. The provision is, of course, that the equipment be loaned for the duration, and as such, becomes the property of the community. In this particular instance, the equipment has been given to the City of New York, and is under the protection of the police department. Mobile

(*Continued on page* 54)



Miniature aircraft indicator lamps are tested in this huge iron sphere. Lamp output is checked by photocell.



Two hundred thousand waves a second have melted tin into evenly-distributed coating on this metal strip.

WARTIME PROGRESS IN ELECTRONICS

by ROBERT EICHBERG

Electronic Research Engineer.

New developments in electronic research are contributing in large measure to increase our war production capabilities.

SOME years ago, the medical world was astounded by the advent of short wave diathermy—a means of passing radio waves through the human body to produce internal heat for the purpose of "baking out" deep-seated aches and pains. Now diathermy, under a different name, has become front page news again, for it has been applied to metallurgy, to aid American armament.

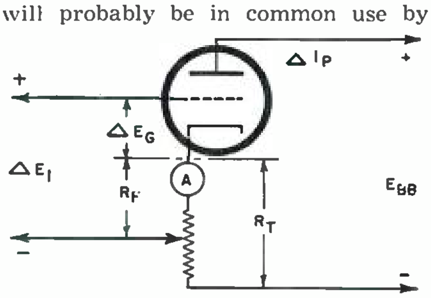
Still working as a heat treatment, it has been used for hardening steel and also for tin-plating metal. In the first application, it may recall some of the demonstrations at radio shows of yesteryear, where a coin, after being passed to the audience for inspection, was suspended in the center of a coil through which radio frequency currents were passed. An eddy current was thus induced in the coil, which the grinning demonstrator then offered to any member of the audience who could hold it. Many were the scorched fingers.

Not dissimilar is the tin-plating system which *Westinghouse* has announced. Strips of steel, to be tin-plated and made into cans which will contain food for our fighting forces and allies, are given a tin coating by means of electrochemical processes in the usual way. The coating, naturally, is rough and pitted, but it is deposited at the rate of 500 linear feet per minute—and soon the speed will be 1000 feet. Then came the bottle-neck: the metal was heated to flow the tin into a smooth, even coating, but the gas furnaces which did the job could handle only 150 feet per minute. Now, however, the electronic method, in which the tin passes through a coil energized by r.f. currents, can operate just as fast as the electroplating equipment, and the tin plating comes out shiny and smooth. As R. M. Baker, the engineer who carried out the experiments explains it, eddy currents melt the tin into an even coat, but he adds, "Shooting into the tin, the (radio) waves ripped electrons—so tiny you could put ten million million on an inch-long line—from the atoms of tin. These electrons, driven along by the current, smashed into one atom after another, creating heat at each collision. Multiply that process millions of times and the coating of tin flows smoothly."

This is hardly the way one would expect an engineer to talk, but he certainly produced a simple and effective process. The frequency of the waves used, by the way, is 400 kc.—and the first commercial installation is turning out about 60 tons of 14-inch tin-plated strips a day.

Another important contribution by the same company combines X-rays and stroboscopic photography, retaining the best features of each. So rapidly do the new ultra-high speed X-rays work that a single battery of four units can take four separate and distinct pictures of an anti-tank shell while it is travelling through the barrel of its gun—or piercing a sheet of armor-plate. The exposure is completed in 1/1,000,000 second, or about as long as it takes a modern bombing plane, traveling at top speed, to move a distance no greater than the thickness of the paper on which this is printed. The new X-ray tubes operate on an instantaneous discharge of 2000 amperes at about 300,000 volts; they can readily penetrate an inch of steel with sufficient intensity to expose a photographic plate in one microsecond.

After the war, devices of this sort will probably be in common use by

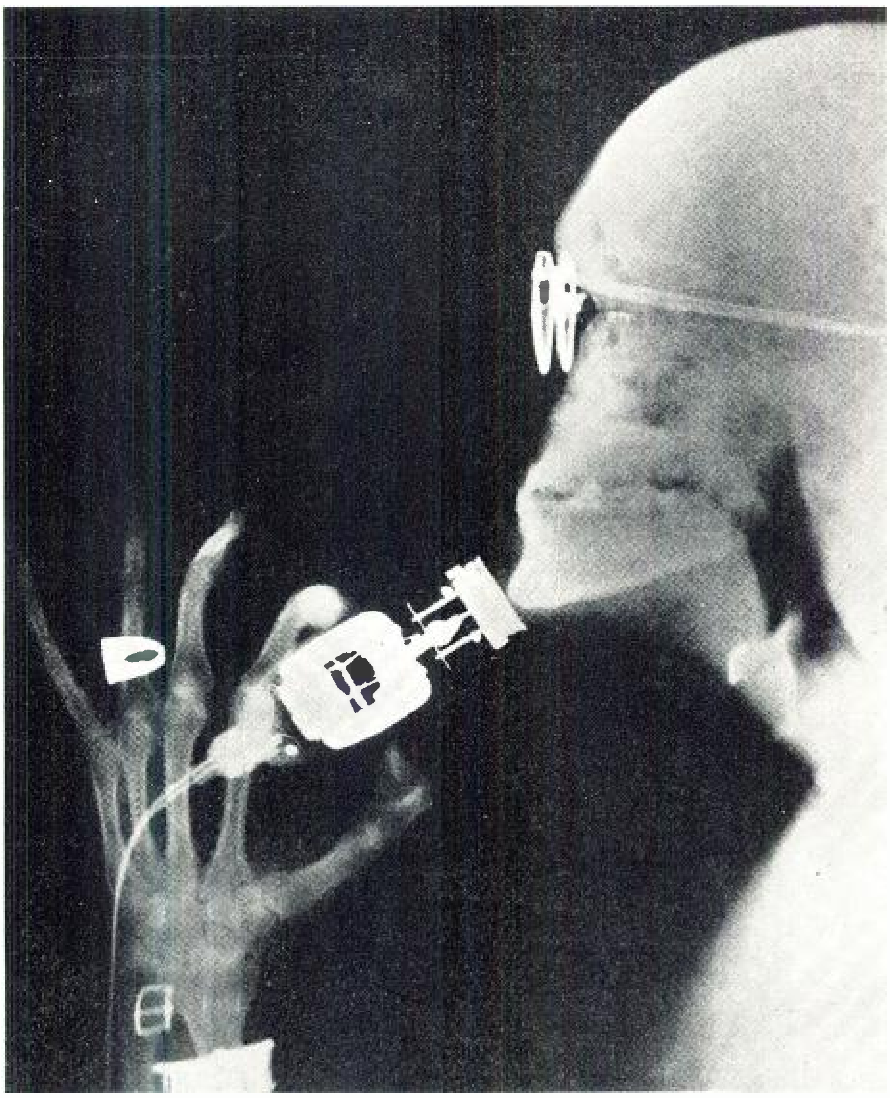


Basic circuit of VTVM.

industry, for they will make it possible to see, more easily and more quickly, hidden defects in the internal structure of metals, while those metals are in motion. Thus, a tiny flaw in a giant flywheel, which "opens up" only when the wheel is revolving at high speed, becoming almost invisible when the wheel is at rest, will be detected.

Of similarly practical value is the self-calibrating vacuum tube voltmeter which M. A. Honnell, AIRE, of the *Georgia School of Technology,* describes in a recent issue of the Proceedings of the Society of Radio Engineers. Usable as a d.c. voltmeter or ammeter, or as an r.f. voltmeter and ammeter when a diode voltmeter is added, this instrument is simply constructed and requires but two precision parts: a calibrated potentiometer and a 0-1.5 milliammeter on which the 1 mil point is accurately marked.

The theory is simply explained by



X-ray taken with Westinghouse tube of average man shaving with electric razor.

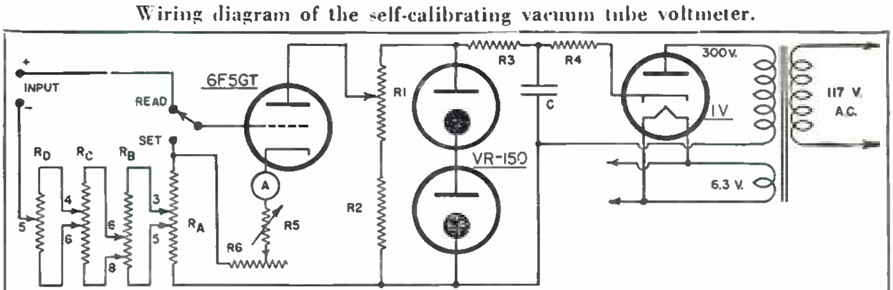
the basic circuit. The voltage increment $\triangle$ Eg, acting from grid to cathode, causes change in the plate current according to the formula

$$\triangle \text{Ip} = \frac{\mu \triangle \text{Eg}}{\text{Rp} + \text{Rt}}$$

where μ is the amplification factor of the tube, Rp the dynamic plate resistance of the tube, and Rt the total resistance of the external plate-to-cathode circuit. The change in the plate current, $\triangle$ Ip, flowing through the potentiometer and meter, produces the voltage drop $\triangle$ IpRf, the polarity of which is opposite to $\triangle$ E_1. The net incremental grid-to-cathode voltage is defined by

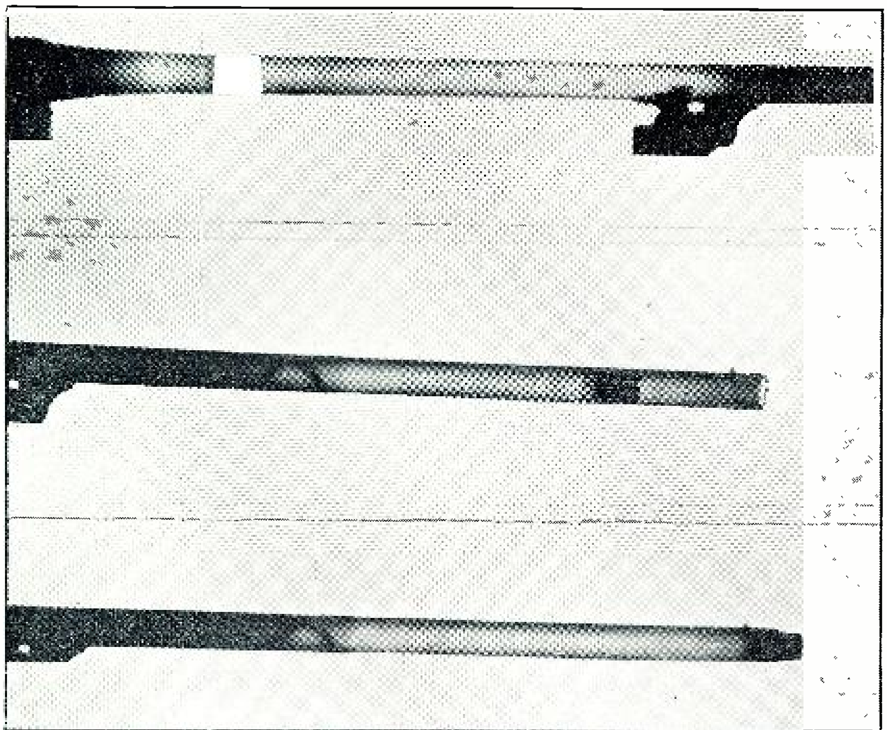
$$\triangle \text{Eg} = \triangle \text{E}_1 - \triangle \text{IpRf}.$$

Wiring diagram of the self-calibrating vacuum tube voltmeter.



R_1—5,000 ohm Pot. 2 w. wire wound, Mallory
R_2—25,000 ohm Res., 5 w. wire wound, Ohmite
R_3, R_4—5,000 ohm Res. 1 w., IRC
R_5—250 ohm Rheostat 2 w. wire wound, Ohmite
R_6—2,000 ohm Res. adjustable in ten 200 ohm steps, wire wound 2 w., Ohmite
C—16 mfd. @ 450 w.v. Electrolytic Cond., Aerovox
Tubes—6F5GT, 1V, two VR150, RCA

R_a, R_b, R_c, R_d—Thomson-Varley Pot.
R_a—11-10,000 ohm Res. ½ w., IRC
R_b—11-2,000 ohm Res. ½ w., IRC
R_c—11-400 ohm Res. ½ w., IRC
R_d—Calibrated 800 ohm Pot.
A—0-1.5 ma. D.C. meter.
Switches shown with these resistor banks are two-gang, ten position switches connected so as to bridge over two resistors in series.



The flight of a shotgun charge—taken with ultra-high speed X-ray.

Substituting the second equation in the first,

$$\triangle Ip = \frac{\triangle Ei}{\frac{Rp + Rt}{\mu} + Rf}$$

As μ, Rt and Rp are constant as the point of balance is reached

$$\triangle Ip = \frac{\triangle Ei}{k + Rf}$$

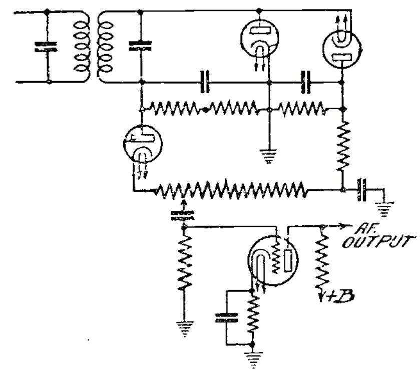
$$\text{where } k = \frac{Rp + Rt}{\mu}.$$

The detailed working circuit shows how such a VT voltmeter may be built. The plate voltage is not critical: it may change from time to time without affecting the accuracy of the instrument, so long as it remains constant while the measurements are being made. Also, a change of vacuum tubes will not cause any variation in the accuracy of the meter readings.

The potentiometer, RA, RB, RC, and RD, is of the Thomson-Varley type. It is most easily constructed by using three banks of eleven resistors each, together with a set of calibrated tap switches; the 800-ohm calibrated potentiometer, RD, must also be a precision instrument. The two glow discharge tubes are used to maintain the plate voltage constant while the instrument is in use.

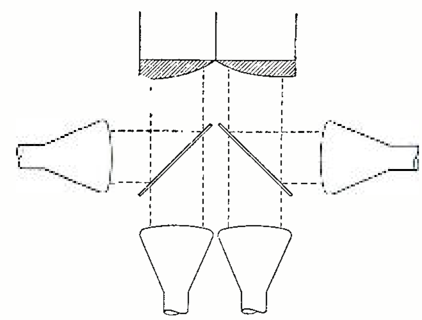
To set up the Honnell VT voltmeter, a 100 megohm resistor is connected across the input. R5, R6 and R1 are then adjusted so that the 0-1.5 mil meter shows the same (1 mil) reading when the 100 meg resistor is in the circuit, and when the input is shorted. When this condition is established, the instrument is ready for use.

Operation is as simple as construction and set-up. The SPDT switch in the grid circuit is pressed to "Set" position, and R5 adjusted to give a 1 mil reading on the meter. Then the voltage to be checked is applied to the input terminals, and the potentiome-



No. 2,301,607.

ter (RA, RB, RC, RD), is adjusted to return the meter reading—upset by the test voltage—to 1 mil. The value of the "upper half" of this potentiometer, in ohms, then equals the applied voltage, which may be read ac-



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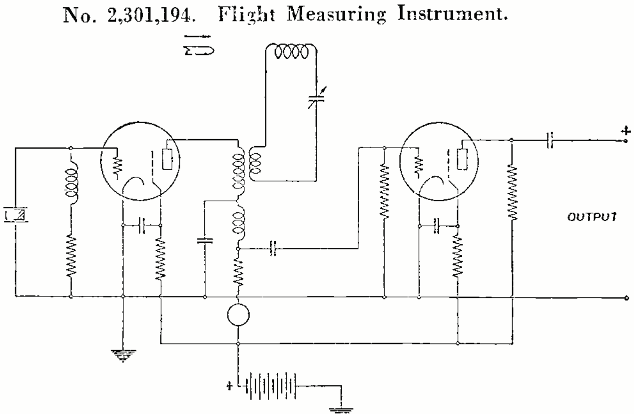
curately to four places.

While a Thomson-Varley potentiometer is recommended by M. Honnell, he adds that any potentiometer which maintains a constant total resistance, irrespective of setting, may be employed. It should, however, be accurate to within 0.1%, he says.

The article in *Proceedings* tells how the Honnell meter may be used in a.c. measurements, and as an am-

(*Continued on page* 73)

No. 2,301,194. Flight Measuring Instrument.



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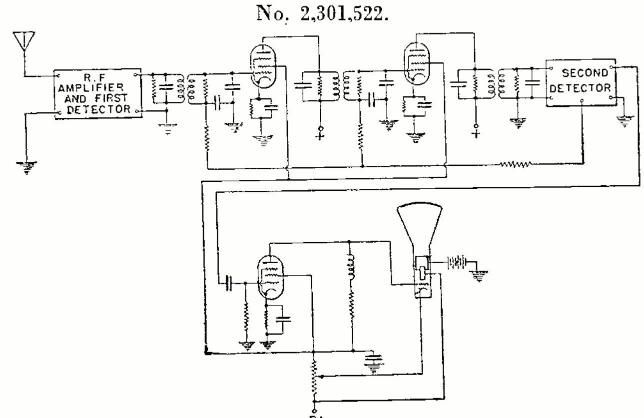
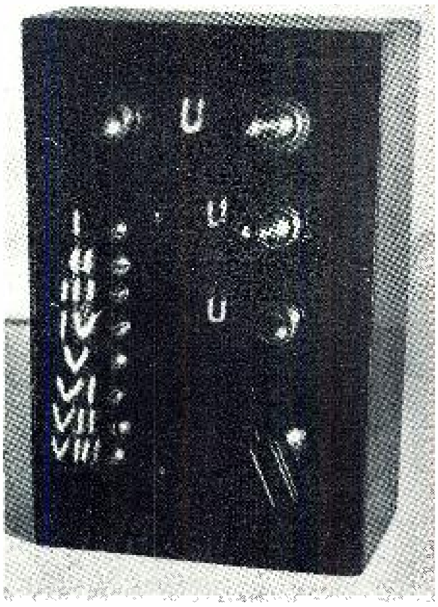




The completed power supply is housed in a small wooden or metal cabinet.

EXPERIMENTERS' POWER SUPPLY

by **HOMER L. DAVIDSON**
Ft. Dodge, Iowa.

An inexpensive low-current supply for general shop work and to operate smaller receivers.

FILAMENT VOLTAGE CHART

Terminals	Sw #1	Sw #2	Sw #3	Res.	Voltage @ .3 amp.
4-6	U	U	U	22	6.6
3-6	U	D	U	44	13.2
4-6	U	D	U	66	19.8
2-6	D	—	U	88	26.4
4-6	D	U	U	110	33.
3-6	D	D	U	132	39.6
4-6	D	D	U	154	46.2
1-6	—	—	D	176	52.8
4-6	U	U	D	198	59.4
3-6	U	D	D	220	66.
2-6	D	—	D	264	79.2
4-6	D	U	D	286	85.8
3-6	D	D	D	308	92.4
4-6	D	D	D	330	99.

IN EVERY radio circuit that the radio experimenter creates, eventually the heater, plate and grid voltages are involved, and if these different voltages were at one's finger tips, experimenting would be much easier and less expensive. Upon this idea the author constructed a small universal power supply. It has many uses for the radio serviceman as well as the radio beginner or experimenter. This supply has the appearance and operation as that of any tube tester and can be mounted directly into your panel board if desired, although this unit was constructed in a separate container.

To receive different filament voltages without the aid of a power transformer, this little "A" and "B" universal supply is based around a universal a.c.-d.c. line cord or dropping resistors which consist of different resistance values totaling 330 ohms. Various resistance ranges may be had with the use of a toggle switch cut "in-and-out" system.

One must remember that the heater supply voltages of this small universal unit cannot be applied on other vacuum tubes than those having a .3 ampere current rating unless a shunt resistor is placed across the tube heater; thus allowing all excess current to pass through the resistor. The filament current ratings of all vacuum tubes can be found in most vacuum tube chart manuals.

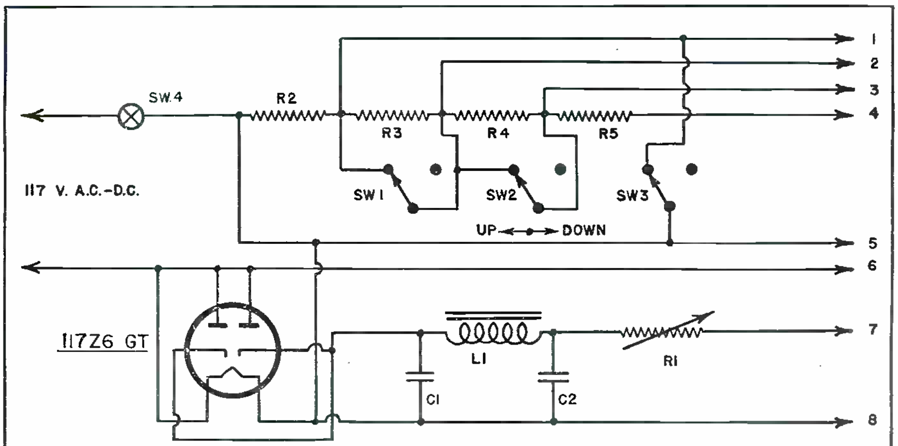
To construct a simple "B" power supply without using an additional heater resistor, a 117Z6-GT bantam tube was chosen whose heater voltages are taken directly from the 117-volt a.c.-d.c. power line. The little "B" supply will produce approximately 90 volts of direct current, and with a variable *Bradleyohm* resistor, the voltages can be lowered to zero. The humless filter circuit consists of a 200-ohm filter choke, a variable resistor, and a 20 μfd. dual electrolytic condenser. It is best to select a small midget condenser. Mount this condenser on the removable back panel beside the rectifier tube.

Construction

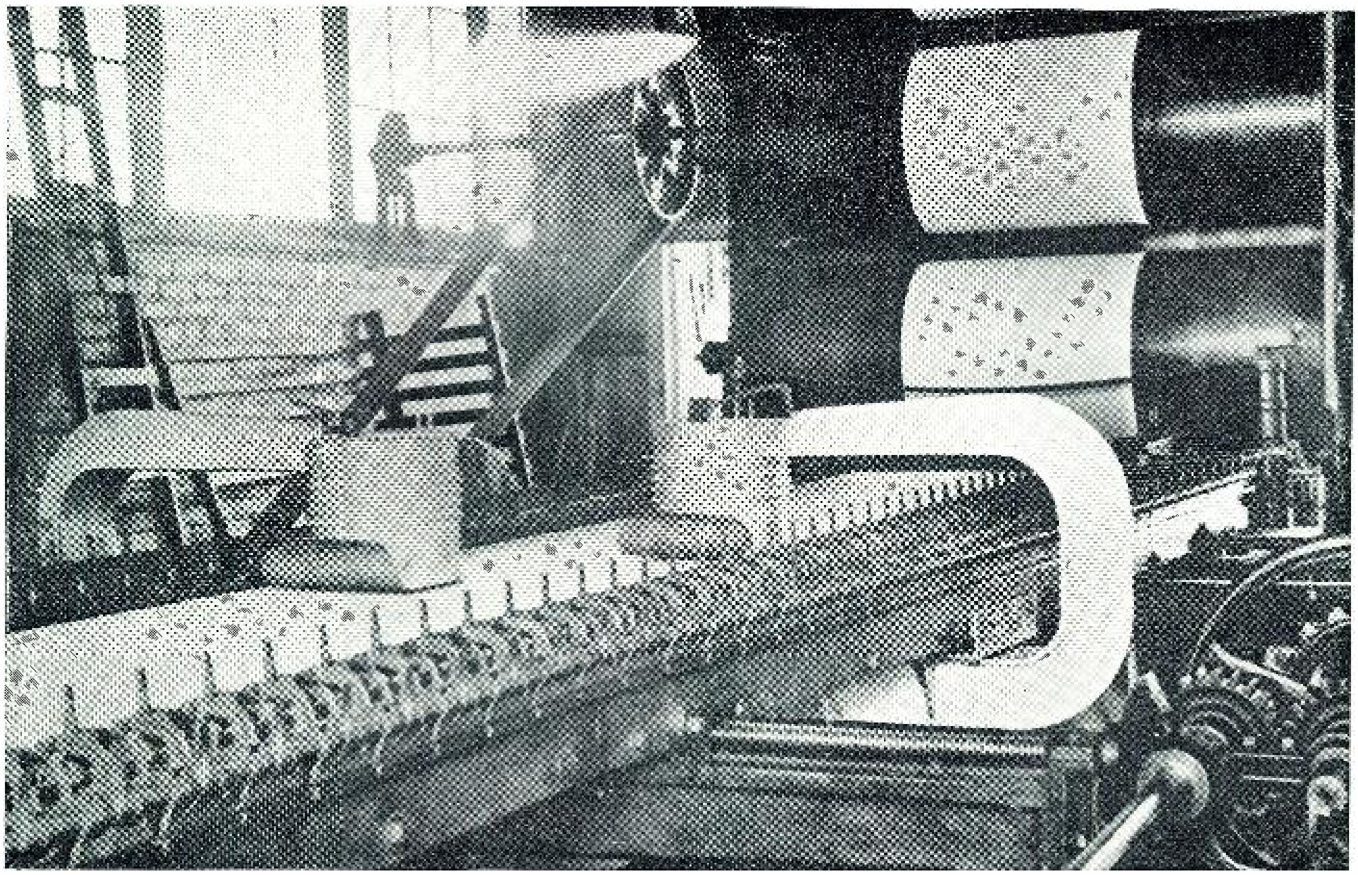
The small cabinet measures 7″ high, 5″ wide and 3″ deep. The sides cut from ¼″ plywood, and the front panel of masonite. Before nailing the front panel to the plywood sides, drill three ⅜″ holes equally spaced from top to bottom. Then drill one hole in line with top hole at the left for the a.c.-d.c. line switch. Select a sharp carving tool to carve the designated "up" and "down" letters beside the three

(*Continued on page* 75)

Circuit diagram for the experimenters' power supply.



R_1—2,500 ohm 30 w. Rheostat, Bradley
R_2—176 ohm 16 w. Res., Ohmite
R_3—88 ohm 8 w. Res., Ohmite
R_4—44 ohm 4 w. Res., Ohmite
R_5—22 ohm 2 w. Res., Ohmite
C_1, C_2—20 & 20 mfd. @ 150 w.v. Elec. Cond., Aerovox
L_1—200 ohm, 140 ma. Filter Choke, Thordarson
Sw_1, Sw_2, Sw_3, Sw_4—SPST toggle switch, Mallory
1—117Z6GT tube, RCA



G-E photoelectric weft-straightening control equipment with photo-tube amplifiers.

Electronic Beam Control

by S. R. WINTERS
Washington, D. C.

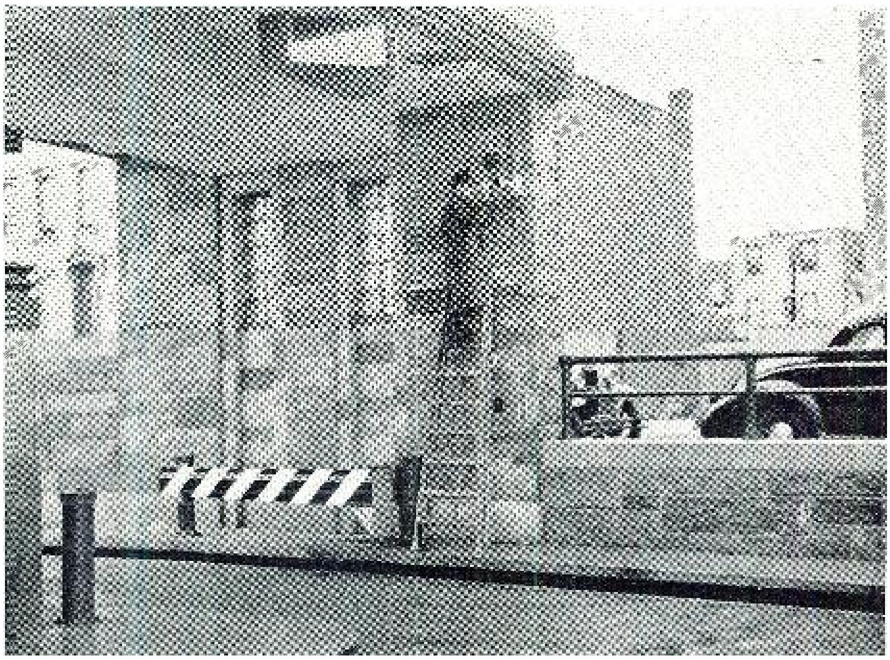
American Industry owes much to electronic apparatus that is being developed by our radio and electrical personnel.

AN electron-beam control equipment that counts, divides and pieces together circuit values in orderly fashion has been designed by Robert M. Page of Washington, D. C. Furthermore, this device provides a radio circuit that generates voltage steps by increments—which current is terminated in one direction by a rapid return in the opposite direction. And, as if science had theoretically dictated the lengthening of the yardstick, this invention increases the scale of the horizontal axis in the cathode-ray tube—removing severe limitations now imposed upon the cathode-ray screen by construction difficulties.

This many-sided electron-beam control apparatus may act, at different times, in the capacities of an aperiodic counter-circuit for a scale from two to ten, or more, utilizing two electron tubes; as an aperiodic frequency divider that will produce radio output in the absence of an input or controlling voltage; as an integrating circuit that will bring together positive signal conditions and reflect a running indication of the integrated values; and provide a multiple-line-sweep circuit in which a single-time-axis cycle is broken into equal sections, these appearing as spaced parallel lines on a cathode-ray screen.

The added advantage of actually lengthening the horizontal axis in the cathode-ray tube is claimed by the inventor. Mr. Page repeats the common knowledge that the cathode-ray oscillograph is used widely for indicating voltages to be studied with regard to wave form, magnitude, and similar characteristics. However, he contends that restrictions are imposed upon the area of the existing types of cathode-ray screens by difficulties involving their construction. Differently expressed, the axis of the present cathode-ray tubes is not of sufficient length to permit of precise determinations of electrical values involved in various experiments. The equipment about to be described, according to claims of the inventor, greatly increases the scale of the axis of the cathode-ray tube—thus removing its previous practical limitations.

Of the two diagrams illustrating this article, Figure 1 shows a circuit having one electron tube of the sharp cut-off "Pentode" type, known to the radio trade as RCA1851, 1852 or 1853. This tube is so biased as to be kept in a non-conducting condition in the absence of a signal across the input



Photoelectric height-indicator at entrance to tunnel in New York.

leads. The other electron tube in this circuit (Figure 1) is a "Triode," but a "Pentode" would be an acceptable substitute. However, tube (5), in Figure 1, should have a high mutual conductance, the purpose of this being apparent as this particular circuit is outlined in detail.

The two inductances are connected respectively, to one side to the plate (8) and grid (9) of the tube, and at their other sides the inductances are associated with the terminals of a capacity unit, whereby a high-frequency oscillating circuit is formed. The two resistance units are connected, respectively, to the plate-connected, and the grid-connected sides of the capacity element, and the resistors are connected in common by a lead to a potentiometer—and thus connected to the cathode of tube (3) in Figure 1. The source of current is connected by leads to the potentiometer and by still another lead to one of the inductance units, and thereby to the plate.

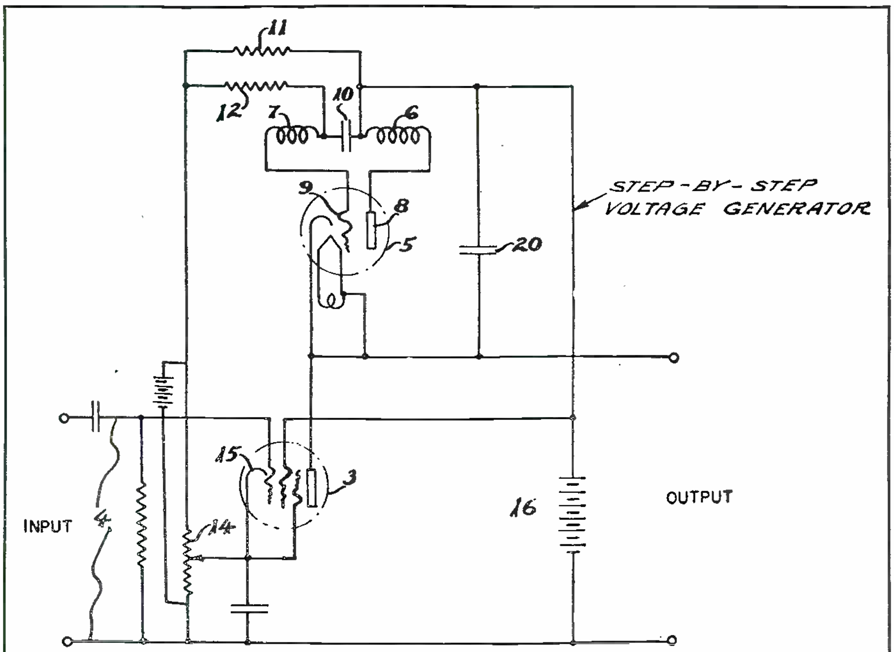
The designer of this circuit points out that when the electron tube (3) is put into a conducting condition by a radio signal applied through input (4), a certain amount of radiant energy passes through the tube and is stored in the capacity unit (20). And, furthermore, if the successive radio signals applied to that tube are of virtually equal magnitude and duration, there will be an increase of the potential across the capacity element, varying by substantially equal steps or changes in value. The tube 5, in Figure 1, is biased to be kept in a non-conducting condition until a predetermined voltage is built up across the capacity unit. Then the tube assumes a conducting condition and the energy stored in the capacity element will be instantaneously dissipated by feeding the energy to the oscillating circuit, connected to the plate and grid elements of the tube. The number of steps by which the capacity unit is charged may be varied through controlling the increment of energy added at each step, and by choice of the potential to which the oscillating circuit, connected to tube 5, will be put into operation to discharge the capacitance through the tube. This capacitance, according to results of actual tests, is discharged in a jiffy—in less than 10^{-6} second. The above-described cycle may be repeated over and over, so long as the radio signal is applied through the input, indicated by the numeral 4, in Figure 1.

As uncanny as a mechanical robot, and as precise as the multiplication table, this apparatus can function either as an automatic counter or frequency divider. In such roles, the input pulses that render tube 3 conducive, in the above described circuit, must be uniform in energy content, but within certain tolerances, they may be regularly or irregularly spaced in time. A variable scale of counting may be obtained, and if the desired unit of counting be arbitrarily designated as X, then the circuit parameters (a constant which enters into the equation of a curve) should be so selected that the capacity unit is charged to the potential required to put tube (5) into operation by the electric energy fed by X input pulses. Manifestly, this also effects a frequency division on the scale of 1 to X, where X is any whole number from 1 to 10, or more. Taking any specified set of circuit and signal conditions, X may be varied by the potentiometer, which governs the bias of the electron tube (3) (in the diagram).

For the sake of a theoretical discussion of the action of this circuit, Mr. Page indicates that the voltage steps, by increments, by which the potential is built up, across the capacity unit, are disregarded, and only the return voltage, derived from the discharge of the capacity element, is utilized. This, we are told, is accomplished readily, inasmuch as the return voltage is in the opposite direction, and of greater amplitude—comparable to the voltage steps whereby

(*Continued on page* 60)

Fig. 1. Basic diagram of a late electronic counter.



3. Vacuum tube.
4. Input leads.
5. Tube (as a triode).
6 & 7. Inductances.
8. Anode.
9. Grid.
10. Capacitance.
11. Resistors.
12. Resistors.
14. Potentiometer.
15. Cathode.
16. Source of current supply.
20. Capacitance.

Interior of sound effects studio shows transcription tables and mechanical gadgets.

PRODUCING
SOUND EFFECTS

by ANDREW R. BOONE

The sound effects you hear through your radio are the result of methods perfected by the studio engineers. Military shows are made realistic by new techniques and special recordings.

Velocity microphone and earphones used for special sound applications.

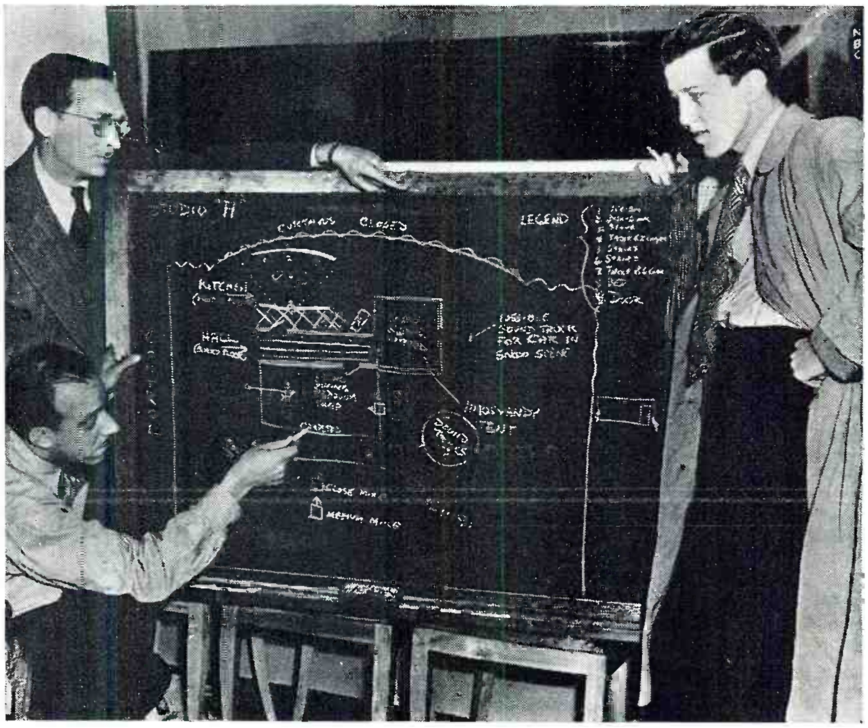
"SUPPOSE," asks Ted Scherdeman, "four men and a girl are talking in the control room of a submarine—how will they sound to the audience?"

Instead of guessing the answer, Scherdeman, a veteran producer for the *National Broadcasting Company,* carried four men and a girl to San Diego, walked into a submarine and heard the results for himself. Next he carried the cast of "Latitude Zero" to a submarine set used for a recent Hollywood picture, and had the actors walk through their parts, reading lines on deck, in the conning tower and in the engine room. Soon, to make the scenes real, there was standing in a studio at radio station KNX, a tunnel made of thin sheet steel, 12 feet long and wide enough for four to walk abreast. One end was open, a two-way velocity microphone hanging at the other in front of an empty oil drum, which rested atop a small, portable room.

Just as movie actors develop their roles, these radio characters talk while walking into the tunnel. The metal shell kicks their voices around, helping create for listeners the "metallic picture" of a sub. Meanwhile, the mike picks up both the direct sounds from the tunnel, and the cavity resonance of the drum. When the script calls for an intimate conversation within the captain's quarters, actors step softly into the adjoining room, close the door and talk directly into a uni-directional microphone which picks up the dialogue without catching stray sound reflections from the soft walls.

Scherdeman devised the submarine set, and turns out all sorts of sets and contraptions in order to give a new meaning to sound. He wants it to be real and authentic. Anything which

Here is an actor manipulating the submarine controls "far under sea."



Engineers study proposed set and decide on best technique needed to handle the job realistically.

adds realism may eventually turn up on one of his sets, from bungalows and giant metronomes to cores from paper rolls. He has characters address each other, rather than speak directly into the mike. His actors move from place to place, much as on the legitimate stage, talking as they go.

Aided by Joe Kay, a veteran engineer of the networks, Scherdeman solves some problems on the spot. "Three giant octopi attack the sub," he read in a recent script. Next evening, an assistant, standing atop a tall ladder, beat and brushed the metal shell with two palm fronds. Pioneering in sound is not always so easy, however.

Scherdeman and Kay tried and discarded 17 hookups before hitting upon a simple means of achieving a voice in the air lock. Now the actors talk through a small, square hole cut in the side of an oversize metronome shell. This is nothing more than a tiny, live room, with the mike hung near the center. Hard-surfaced walls reflect the sounds, focusing them at the mike.

When the submarine engineer reports to the control room, another actor talks down a seven-foot cardboard tube placed directly against a microphone. As for a voice reaching the sub by radio from a plane flying overhead, the broadcaster speaks over a ribbon mike connected to a pair of ear phones. One of these is directed toward the broadcast mike which carries the distant voice to the network.

The undersea telephone, leading from a diver's helmet to the sub's interior, gave the producer more trouble than any underwater effect. Finally, he bought a $1 dynamic speaker from a mail order house, had an actor speak guttural sounds into a ribbon mike, amplified the sounds and fed them into the inexpensive speaker which was held against one end of the paper tube. A velocity mike at the other end picked them up and relayed the voice to the mixing panel in the control room.

Scherdeman tries all sorts of tricks to put sound on the air exactly as one hears them in nature. When preparing for a program including a marathon dance, he laid a plywood floor 40-ft. square on the stage and moved the orchestra into the audience seats. By manipulating the controls, he moved listeners back and forth between shuffling feet and the music.

To pick up such intimate "scenes" as handlers rubbing weary muscles, he erected a tent on the stage. A professional masseur worked over the limbs and back of an actor, stretched

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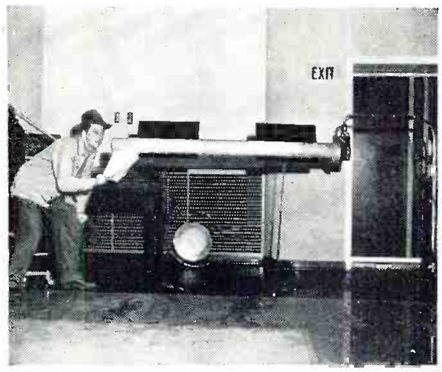
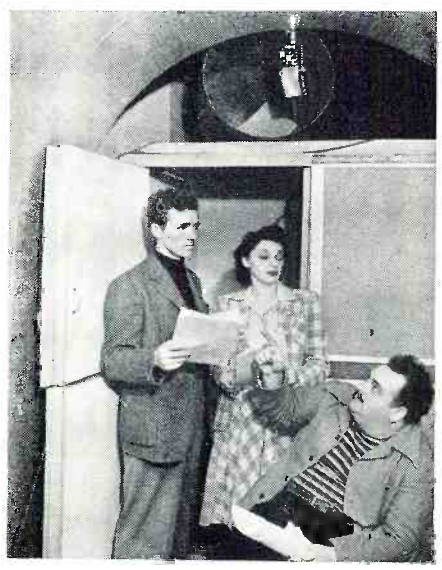
A moment of suspense. Without sound effects, scenes like this would be quite uninteresting.



A 7 foot cardboard tube and mike produces effect of engineer in sub talking to the control room.

Another setup utilizing many odd contraptions for sound effects. Note galvanized-iron walls.



ELECTRONIC PUMP BENDS ELECTRONS

by SELDON SUMMERS
Washington, D. C.

The use of a magnetic field in conjunction with a pump creates a spiral-shaped path for many of the electrons.

A NOVEL electronic vacuum pump, which includes a magnetic field, performs such unbelievable feats as lengthening and bringing closer together the electron paths, as well as bending the electrons. These tiny bits of electrical matter are caused to follow spiral-

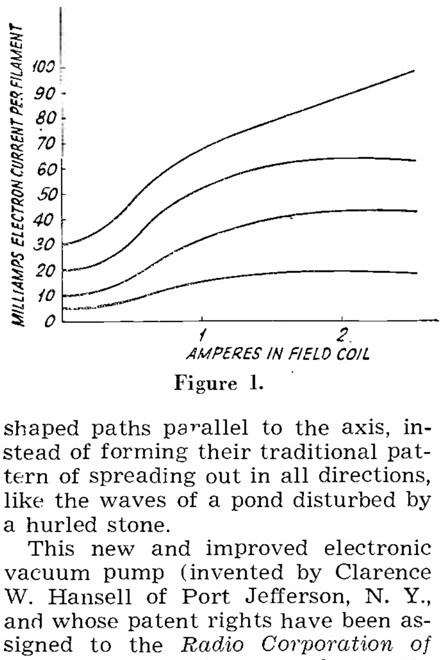


Figure 1.

shaped paths parallel to the axis, instead of forming their traditional pattern of spreading out in all directions, like the waves of a pond disturbed by a hurled stone.

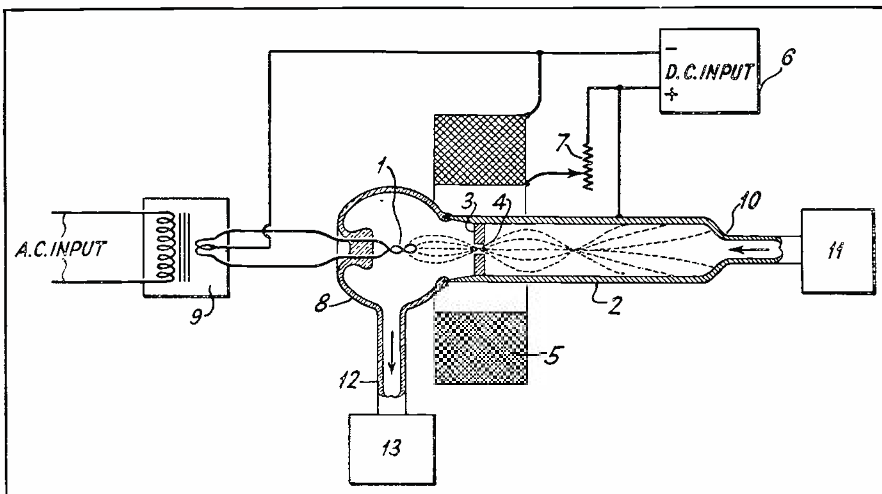
This new and improved electronic vacuum pump (invented by Clarence W. Hansell of Port Jefferson, N. Y., and whose patent rights have been assigned to the *Radio Corporation of America*) means, in terms of scientific and industrial progress, a stepped-up pumping speed and an increased vacuum. The use of a magnetic field in conjunction with this pump not only creates a spiral-shaped path for many of the electrons, but there is enhanced the probability of the electrons colliding with gas molecules. This causes an increase in ionization, with a consequent augmented pumping effect for any given filament-electron emission current.

Correspondingly, the final degree of vacuum is heightened because of the greater ratio of the average electron path to the mean electron free path in the gas molecules. Each electron, by virtue of this electron-lengthening, closer-spacing and bending vacuum pump, is more likely to collide with a gas molecule—because the electron path is longer. For instance, at one micron pressure in air, the average free path of an electron is about 25 inches.

The inventor of this electronic pump conducted certain experiments in which he bent electrons at will and caused them to travel desired paths. (Incidentally, it has been determined that the Washington Monument is perhaps the most spectacular deflector of radio waves, bending them with predictable certainty.) Mr. Hansell sandwiched a metallic shield, having a central hole, between the filament and plate, and then applied a magnetic field with flux lines parallel to the axis of the pump. By means of this arrangement, the electrons straying in undesired directions, away from the axis, were compelled to return to the vicinity of the latter—or to produce spiral-shaped paths passing through the hole in the metal shield. In practical service, this shield may be connected to, or form a part of the tube plate—and after entering the latter, the electrons continue to pursue spiral-shaped trails until they invade a region of decreased magnetic field. The latter maneuver permits the electrons to land upon the surface of the vacuum-tube plate.

More about the electronic vacuum pump itself: As illustrated in Figure 2, there are the usual filament and plate elements, both of which are so arranged that when electron current flows between them, in the presence of gas, the latter will be ionized. Then the electrons move toward the filament in such a manner as to pump gas out of any chamber or container to be evacuated—thus electronic tubes are coming to the assistance of the pumping industry. The plate of this electronic device consists of a metal tube, which is closed at one end by the previously described metallic shield. This has an opening of from 0.01 to 0.5 centimeters in diameter,

Fig. 2. Basic diagram explains theory of action.



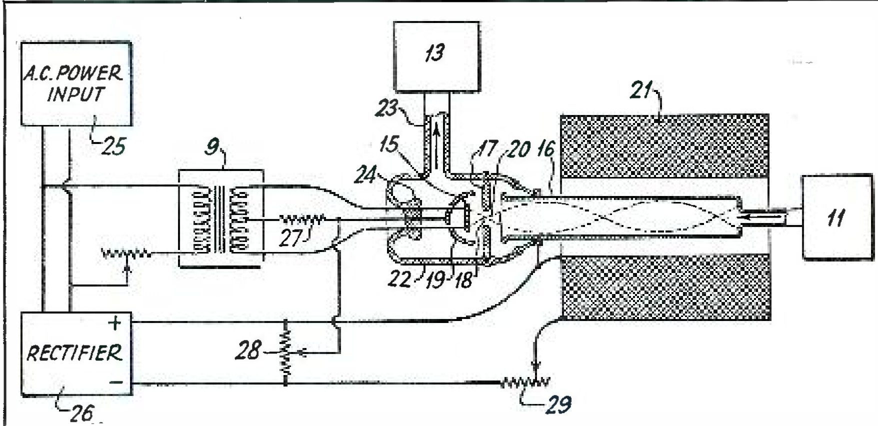
1. *Filament.*
2. *Plate.*
3. *Metallic shield.*
4. *Small opening.*
5. *Magnetic field coil.*
6. *Input source.*
7. *Field rheostat.*
8. *Glass envelope.*
9. *Transformer.*
10. *Point where the plate is tapered.*
11. *Object to be pumped or evacuated.*
12. *Lower portion of envelope (8).*
13. *Rough vacuum pump.*

dependent upon the available electron current emitted from the filament.

Surrounding the plate of the electron tube and the above-mentioned metallic shield is a magnetic-field coil which is electrically connected to a source of direct-current. A field rheostat is connected in series between the direct-current input and the field coil. This arrangement varies the magnetizing current and the strength of the magnetic field. At one end of the tube-like plate of the electron tube there is a glass envelope to which the metal plate is sealed, at a point adjacent to the field coil. The filament is supported practically in a central position with regard to the axis of the field coil and it faces the tiny opening in the metallic shield. The filament is heated by a source of alternating current from a transformer, the center point of the secondary winding of which is associated with the minus side of the direct-current input. The positive side of the latter is connected to the plate. The far end of the metal tube constituting the plate is tapering to receive the outlet from the chamber of other container to be pumped. The lower section of the glass envelope is also arranged for connection to an outlet which makes fluid connection with a conventional rough pump.

The preferred model of this invention is illustrated in Figure 4, which shows a field coil surrounding a long insulating tube. The latter is connected electrically to and extends from a first diaphragm plate to a second plate, which is kept at an appreciably higher direct-current potential than the previously mentioned diaphragm plate. The long, insulating tube, referred to above, is lined with an extremely thin layer of high resistance conducting material. This is somewhat like the so-called "metallized resistors" employed in radio. Such high resistance conductors insure a virtually uniform electric field within the long tube. This field lengthens the electron paths and increases the electron velocities. Additionally, it is responsible for all ions produced by the collision of the electrons and molecules in traveling toward the filament. An extra advantage favoring use of this long tube with a potential gradient over its entire length, is that secondary electrons created by collision of the primary electrons and molecules of gas with the conducting material lining the tube are speeded up toward the plate. Moreover, they are caused to add to the production of the ionization of any gas in the tube.

In order to curtail the electronic bombardment of the filament and shield it from the effect of infrequent electric arcs, two resistance units are provided, through which the emission current from the filament must pass. These resistances are sufficiently high to limit the emitted current from the filament to values below the available electrons "shot" from the filament. In addition to the filament shape and



9. Transformer.
11 & 13. Same as Figure 2.
15. Heavy filament.
16. Plate.
17. Ring-like member.
18. Aperture.
19. Shield.
20. Broken Lines.
21. Field coil.
22. Envelope.
23. Stem.
24. Press or stem for supporting shield.
25. Power source.
26. Rectifier.
27. Resistance.
28. Variable resistance means for applying to shield. Variable negative potential.
29. Variable resistance.

Fig. 3. Modified embodiment of the invention.

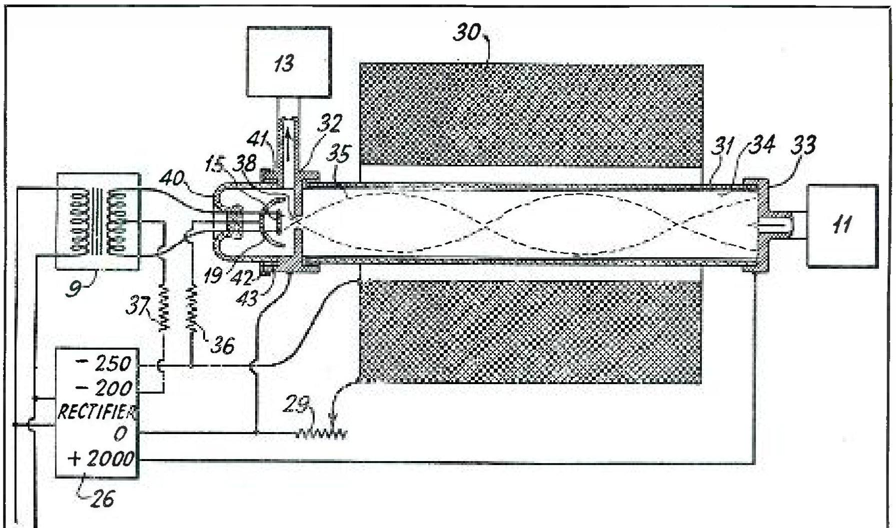
arrangement, there is a shield and first plate orifice to offset the tendency of ions to strike the filament. Instead, they bombard the above-mentioned shield—this being constructed with adequate mass and heat radiation to withstand any bombardment of electrons.

As a further safeguard for the tube and circuit, one of the resistance units is connected in series with the shield and the negative side of the rectifier, so that a restricted amount of current can flow through it. This resistance unit, however, is very much smaller than its companion resistor, which is identified with the filament circuit. An envelope is so placed on the metal plate structure that this portion of the vacuum pump, on which the filament and shield are positioned, may be interchangeable. This affords new elements as required, by providing a flange, a metallic band clamp, and a gasketed joint. This may take the form of a mercury seal, a low-melting-point fusable alloy seal, such as woods metal. Such a set-up facilitates the renewal of worn-out tube filaments, since the above-mentioned joints are actually a part of the rough pump and not the high-vacuum pumping system.

Another modification of this invention is shown in Figure 3. A heavy filament is mounted symmetrically with regard to the axis of the tube plate, which takes the form of a long thin metal tube. Sandwiched between the filament and plate elements is a metal diaphragm or ring-like unit, having a tiny opening. Immediately behind the filament is placed a nega-

(*Continued on page* 53)

Fig. 4. A still further improvement of the embodiment.



Numbers 9, 11, 13, 15, 26, 29—same as figure 3.
31. Insulating tube.
32. Diaphragm plate.
33. Second plate.
34. High resistance conducting material.
35. Electron paths.
36 & 37. Resistance elements through which emission current from the filament may pass.
38. Plate orifice.
40. Envelope.
41. Flange
42. Metallic band clamp.
43. Gasket joint.

The MULTI-SERVIMETER

by ROBERT F. SCOTT, W4FSI

This versatile instrument is a natural for training radiomen as well as being ideally suited for general radio servicing.

WE are aware that radio servicemen of this country are being taken away from their jobs to become servicemen with a different and more important job to do. This is leaving quite a gap in the ranks of the servicemen. There are others who are willing to undertake the task of keeping the radios of this country in tip-top shape but they are handicapped and discouraged by the lack of low-cost, priority-free, servicing equipment.

We have undertaken the task of designing suitable servicing equipment that is within the reach of all. This equipment has wide range applications in the field of radio servicing and is free from priority limitations. The Multi-servimeter can be built by anyone having a well-stocked junk-box or the parts may be purchased for a very low cost at the "bargain counter" of practically any radio supply house. Included in this device are the following instruments:

1. Channel Analyzer
2. Condenser Tester
3. Vacuum Tube Voltmeter
4. Resonance Indicator
5. Continuity Tester
6. Low Frequency Receiver
7. Audio Amplifier
8. Audio Oscillator
9. Radio Frequency Amplifier

This Multi-servimeter will make it possible to save much valuable time in trouble-shooting in a defective receiver or amplifier. A few minutes spent in a stage-by-stage analysis will accomplish more, in most cases, than hours of point-to-point resistance testing. This device will enable you to locate the defective stage wherever it may be located in the receiver. The power supply, oscillator, i.f., a.f., or r.f. stages may all be checked with equal ease. Condensers whose quality is doubtful may be tested while still in the circuit, providing, of course that there are no external shunting resistors across the condenser.

The power supply consists of the conventional full-wave rectifier filtered by a single section filter. The filter uses condenser input and the speaker field is used as the filter inductance. It was necessary to use an 8 μfd. electrolytic condenser to insure ample filtering action. A 50,000 ohm, 10 watt, variable resistor is used as a "bleeder."

The test section consists of five tubes. A 6K7 is used as the input tube for the i.f. and r.f. tests. This stage has a tuned antenna circuit that is used when the set is used as a low frequency receiver. This coil is tuned by one section of the triple section 365 μμfd. tuning condenser. This condenser is placed above ground by placing a .006 μfd. mica condenser in series with the rotor and ground connection. It is isolated from the chassis by rubber bushings. The 6K7 is resistance coupled to another 6K7 that is resistance coupled to the parallel diodes of the 6Q7. The 6Q7 is also used as first audio amplifier and a source of AVC voltage. The first audio amplifier is resistance coupled to the 6F6 output tube. The 6U5 is used as a tuning indicator and resonance indicator, as well as VTVM. This Magic-Eye will also indicate oscillation and presence of AVC and other minute voltages.

Panel view of the Multimeter shows location of various knobs and parts.

The signal generator is an electron coupled 6K7 that oscillates on a fundamental frequency that can be varied from about 150 kc. to 600 kc. The harmonics of this oscillator are strong enough to be used to align sets having a 1500 kc. i.f. These harmonics can also be used to adjust the tuning of short wave tuning circuits of an all-wave receiver. This oscillator may be modulated by the output of the audio oscillator. This modulation is applied to the screen-grid of the r.f. oscillator and the percentage of modulation is adjusted by the Modulation % control (R27). The output from the audio oscillator may also be made available for audio tests and other purposes.

The Condenser Tester is simply a ½ watt neon bulb. This device can also be used to test resistors for intermittent or open circuits. The continuity of chokes, transformers, coils and wiring may be tested. When testing paper and mica condensers, the prods are applied to the condenser and the neon bulb observed as the final connection is made. If the condenser is OK, there will be a flash as the condenser takes a charge. If the lamp only glows and there is no flash, the condenser is leaky and should be discarded. If there is a bright continuous glow, the condenser is shorted. No glow will indicate an open condenser.

Polarity must be observed when testing electrolytic condensers. The working voltage must also be noted and the high-capacity, low-voltage electrolytics, that are used in low-voltage power packs and cathode by-pass circuits, cannot be tested by this method. A good electrolytic, of the high-voltage type, will cause intermittent flashes of about 10 times per second. A condenser that flashes more than 20 times or has a continuous faint glow should be discarded as leaky. The short and open tests are the same as for the paper and mica condensers.

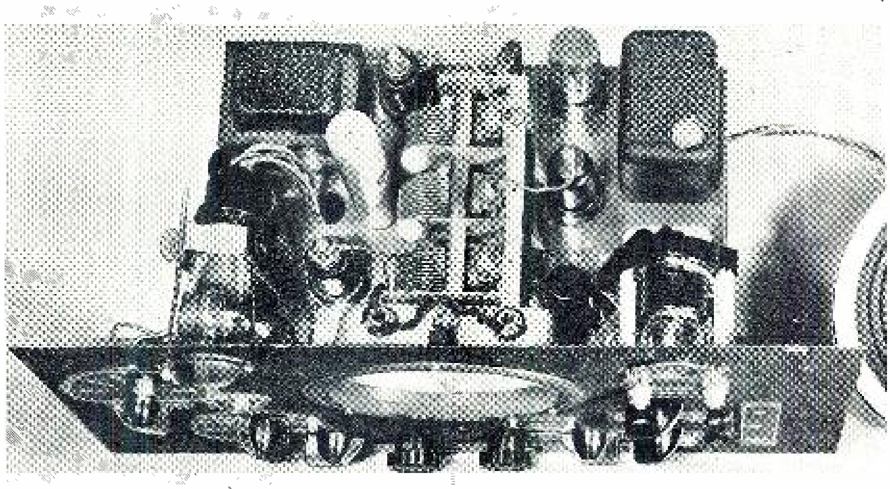
When testing chokes, transformer windings, coils, and resistances, a steady glow will indicate continuity. Intermittent flashes will indicate poor contacts or intermittent shorts or opens. No glow of the neon bulb will indicate an open circuit.

Controls and Their Uses

The dial plates for all of the controls may be made by two methods. The first way, is to draw a full-size scale, using black India ink for this purpose, on a piece of Draftsman's tracing paper. This tracing is taken to a photographer who will make contact prints from the drawing. These prints should be made on semi-matte printing paper. The alternate method is to draw the scales on flat-black paper with white ink. After the dials have been finished, they are cut-out and mounted on the panel with Scotch cellulose tape.

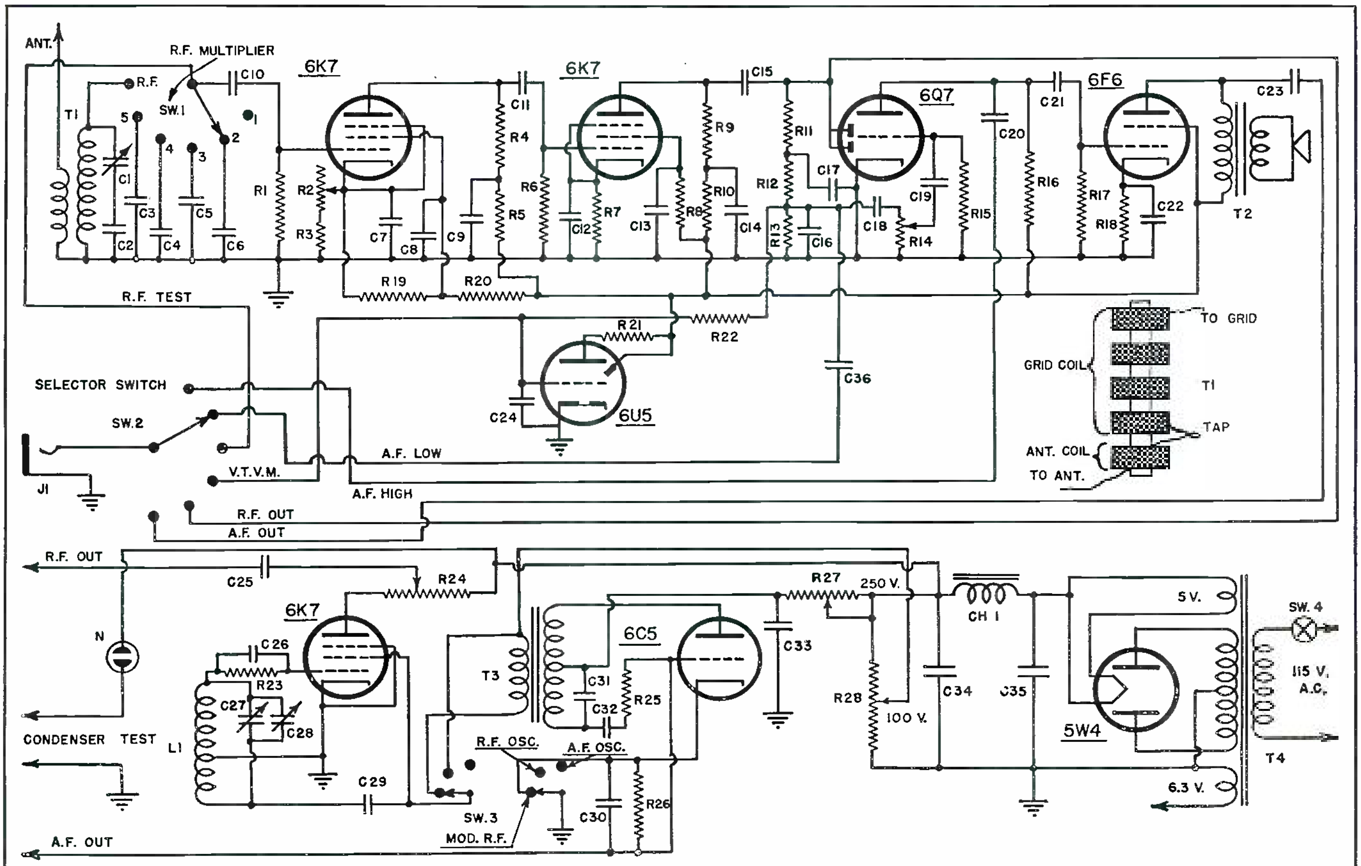
The TEST SELECTOR (SW2) is a six position, single circuit, rotary switch. This is used to couple the TEST JACK to the various test circuits. The TEST JACK is fed by a test prod that is made by mounting a small insulated phone tip on the end of a 24" piece of low-capacity crystal mike cable.

The RF MULTIPLIER (SW1) is also a six position, single circuit, rotary switch, that is used to limit the amount of r.f. and i.f. to the grid of the 6K7. This switch is also used to connect the coil and condenser combination to 6K7 when the set is used



Top view, showing layout of principal parts and the tuning eye assemblies. All wiring must be held in place to prevent any shift in final calibration.

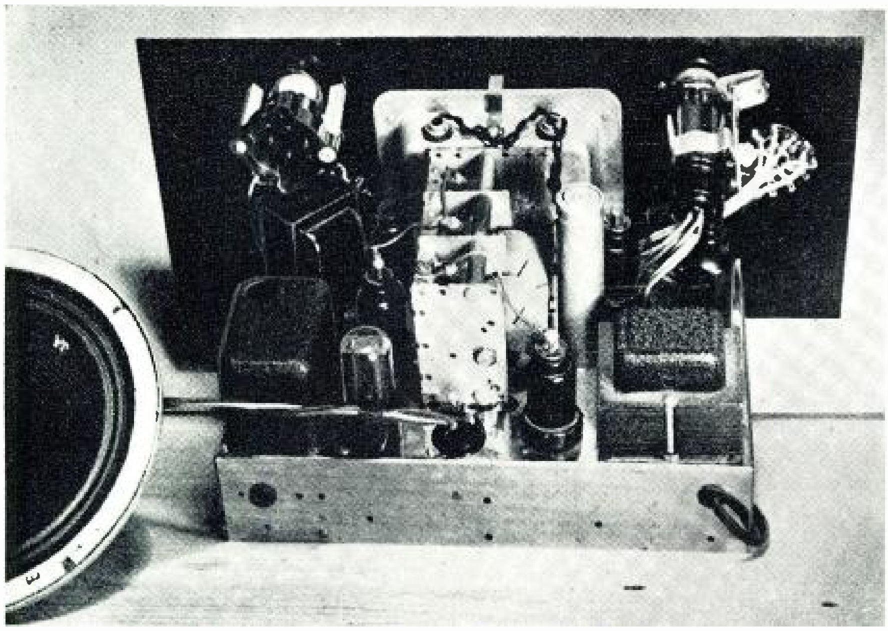
Schematic of the Multimeter gives full data for home construction.



C_1, C_{27}, C_{28}—3 gang Variable Cond., 365 mmfd. ea., Meissner
C_2—.006 mfd. mica Cond., Aerovox
C_3, C_7, C_8, C_9, C_{12}, C_{13}, C_{14}—.1 mfd. @ 400 v. Cond., Aerovox
C_4, C_{25}, C_{32}—.01 mfd. @ 400 v. Cond., Aerovox
C_5, C_{10}, C_{33}—.001 mfd. @ 400 v., Cond., Aerovox
C_6, C_{11}, C_{15}—100 mmfd. mica Cond., Aerovox
C_{16}, C_{17}, C_{30}—500 mmfd. mica Cond., Aerovox
C_{18}, C_{29}, C_{36}—.02 mfd. @ 400 v. Cond., Aerovox
C_{19}, C_{20}, C_{21}, C_{23}, C_{24}, C_{31}—.05 mfd. @ 400 v. Cond., Aerovox
C_{22},—20 mfd. @ 20 v. Cond., Aerovox
C_{26}—200 mmfd. mica Cond., Aerovox
C_{31}—16 mfd. @ 400 v. Elec. Cond., Aerovox
C_{35}—8 mfd. @ 400 v. Elec. Cond., Aerovox

R_1, R_6, R_8, R_{11}—.1 megohm ½ w. Res., IRC
R_2—10,000 ohm Rheostat wire wound 2 w., Mallory
R_3—350 ohm ½ w. Res., IRC
R_4, R_9, R_{12}—50,000 ohm ½ w. Res., IRC
R_5, R_{10}—5,000 ohm ½ w. Res., IRC
R_7—250 ohm ½ w. Res., IRC
R_{13}, R_{16}—.25 megohm ½ w. Res., IRC
R_{14}—.5 megohm Pot. with A.C. sw., Mallory
R_{15}—5 megohm ½ w. Res., IRC
R_{17}, R_{25}—.5 megohm ½ w. Res., IRC
R_{18}—350 ohm 1 w. Res., IRC
R_{19}, R_{20}—25,000 ohm ½ w. Res., IRC
R_{21}, R_{23}—1½ megohm ½ w. Res., IRC
R_{22}—2 megohm ½ w. Res., IRC
R_{24}, R_{27}—10,000 ohm Pot. wire wound 2 w., Mallory
R_{26}—6 megohm ½ w. Res., IRC

R_{28}—50,000 ohm variable tap. 10 w. wire wound Res., Ohmite
Sw_1, Sw_2—SP6T Switch, Mallory
Sw_3—2P3T Switch, Mallory
Sw_4—Line Switch on R14
J_1—Phone Jack, Mallory
N—½ w. Neon Lamp, G.E.
T_1—Ant. coil, 5 section 2.5 mh. R.F. Choke, Meissner
T_2—Output Trans. 7,000 ohms to V.C., Thordarson
T_3—Audio Trans. (see text), Thordarson
T_4—Power Trans., Thordarson
Ch_1—Speaker field coil, Utah
L_1—Osc. coil, 240 t. tapped 80 t. (see text), Meissner
Tubes—3-6K7, 6Q5, 6U5, 6C5, 6F6, 5W4, National Union



The Multimeter looks very much like a typical superhet receiver. Power transformer is mounted away from sensitive circuits to prevent hum.

as a standard broadcast receiver.

The R.F. GAIN CONTROL (R2) is used as a sensitivity control for the receiver and as a vernier control for the R.F. MULTIPLIER when it is in positions 1 to 5.

The AUDIO GAIN (R14) is the volume control for the audio section.

The TUNING control is used to select the frequency of the receiver and the r.f. signal generator. This control is connected to the tuning condensers through a good mechanical bandspread.

The SIGNAL SELECTOR (SW3) consists of a two-circuit, three-position, rotary switch. The switch is used to adjust the r.f. and a.f. oscillators to the different types of operation. The output of these two oscillators is fed out through the a.f. and r.f. pin jacks. The test lead for the output of these oscillators is made from a mike cable. The shielded wire is fitted with a phone tip and is plugged into the r.f. or a.f. jacks as the occasion warrants. The shielding braid is fitted with a phone tip to fit into the GND jack.

The R.F. CONTROL (R24) is used to attenuate the output of the signal generator. The sliding arm of this control is connected to the r.f. pin jack through a blocking condenser.

The MODULATION % control (R27) regulates the amount of modulation applied to the r.f. oscillator by the audio oscillator. The r.f. oscillator is screen-grid modulated. The modulation is varied by controlling the plate voltage to the audio oscillator. The transformer is an audio type transformer originally designed for single plate to P.P. Grids Class A. The original transformer was unshielded and the case from another transformer was mounted over it. The frequency of the a.f. oscillator is about 800 cycles.

The coil of the r.f. oscillator is wound with No. 32 enameled wire, wound in 1½" space on a 1¼" form. The coil has 240 turns, tapped 80 turns from the bottom. The entire winding cannot be put in the winding space available. The coil is started at the top, and the tap made. The lower end of the coil is "jumble-wound." This coil is tuned by a total of 730 μμfd. This capacity is made by connecting two of the tuning condenser sections in parallel. The leads in the oscillator should be as short as possible and made of bus-bar wherever possible. All parts should be firmly mounted.

If the builder exercised care in the construction of this unit of the Multi-servimeter, very satisfactory calibration is possible and the unit will hold its calibration over a long period of time. The coil must be well shielded. An efficient shield can be made from the can of an old i.f. transformer or r.f. coil.

If a little care is taken, the oscillator can be calibrated with surprising accuracy. This feat is accomplished with the aid of a well calibrated broadcast receiver, preferably a t.r.f. set. The SIGNAL SELECTOR (SW3) is turned to Modulated r.f. and the set is allowed to warm-up for about a half hour. The shielded wire from the r.f. pin jack is coupled loosely to the antenna post of the calibrating receiver. The shield of the wire is grounded in the GND pin jack and to the receiver chassis. The r.f. oscillator tuning condenser is set to some arbitrary setting and the receiver tuned until the signal is heard.

Two or more points will be found on the broadcast band where the signal is heard. The distance between these signals (in kilocycles) is equal to the frequency of the r.f. oscillator; i.e., if the signal is heard at 600 kc. and 1200 kc. the frequency of the oscillator is equal to the difference between the two, or 600 kc. Similarly, if the signal is heard at 700 kc., 1050 kc., and 1400 kc. the frequency of the oscillator will be equal to the difference between any two consecutive frequencies on the receiver dial. The oscillator dial is set at many points on the tuning dial and the frequency determined by the method just described. A calibration chart can be made from these frequency dial settings and any frequency can be returned to at any time. The harmonics of the oscillator become weak as the higher frequencies are reached but the signals can be still heard above 18,000 kc. This is sufficient to align even the all-wave receivers now on the market. It will be noticed that the signals are heard closer together on the short wave bands. This is perfectly normal operation. Two points 600 kc. apart on the broadcast band will cover over one-half of the band, while on the shorter wavelengths, the 600 kc. points are much closer together on the dial.

Checking Audio Amplifiers

Whether the audio amplifier is a part of a radio receiver, public address system or transmitter modulator, it can be checked quite effectively by using the Multi-servimeter. Fading, hum, distortion, feedback and oscillation may be located in a few seconds.

The audio test signal may be obtained from two sources. The sine-wave 800 cycle note from the a.f. oscillator or the output from the low-frequency receiver may be fed to the amplifier under test. The output from the receiver is obtained by placing an antenna on the tester antenna post and placing the r.f. Multiplier in the r.f. position. The Test Selector is turned to the a.f. OUT position and the signal fed from the test prod to the high side of the input gain or volume control. This signal may be applied from the speaker back to the input jack. If the signal is applied to both sides of an audio coupling condenser, the quality of the condenser may be judged by the difference in the signal. The different stages may be analyzed for gain by applying the test signal to the plate of a tube and then applying the signal to the grid of the same tube.

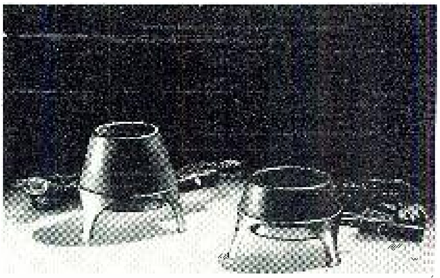
The difference in the volume should be very noticeable, and if it is not, the tube should be tested. The coupling resistors and bypass condensers should also be tested. Distortion, hum and oscillation may be checked by rotating the Test Selector to one of the a.f. positions. This position is determined by the gain of the stage to be tested. A test signal is applied to the amplifier and the test prod used to trace the signal from the microphone to the speaker. The stage where the trouble is introduced should be checked carefully. Poor transformers, poorly placed grid leads, poor shielding and poor power supply can all be guilty of causing the trouble. The effectiveness

(*Continued on page 66*)

WHAT'S NEW IN RADIO

Solder Pots

Small capacity Solder Pots are being manufactured by *Lectrohm, Inc.*, 5125 W. 25th Street, Cicero, Illinois,

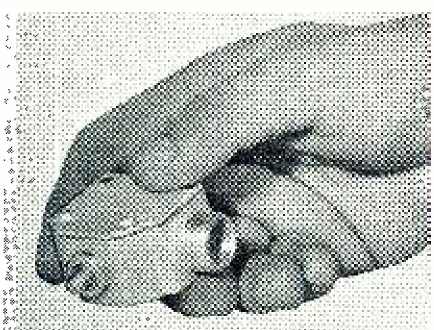


for continuous operation in radio, motor and similar electrical equipment plants where individual soldering melting pots are desired for each operator or for small repair and home-craft shops. They are sturdily constructed, consisting of a cast iron pot mounted, by a single screw, on a plated steel stand. A single heat, porcelain nickel-chrome heating element, which can be quickly and inexpensively replaced when necessary, heats the pot. These pots are available in two Models (Model No. 200—1¾ pound capacity and Model No. 250—2 pound capacity) for operation on 110 v., a.c. or d.c. A six foot Underwriters approved cord and attachment plug is furnished with each unit. Worthwhile savings are effected by Lectrohm Solder Pots through low initial investment, reduced current consumption and lower solder cost. Complete information and prices may be obtained by writing direct to the manufacturer.

Aircraft Limit Switch

A new lightweight limit switch, designed especially for aircraft applications, has been introduced by the *General Electric Company*.

The contact mechanism used is the G-E switchette. Snap action and dou-



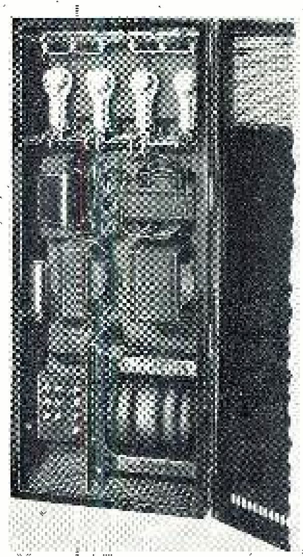
ble-break operation give the switch a high current rating. The switch is designed to meet all U. S. Army Air Forces' stipulations. The plunger operates with a 7/32 in. overtravel, which increases the number of applications for which the switch can be used.

The aluminum housing is made dustproof by the use of a gasketed cover. There is adequate space inside the housing for easy wiring. The switch is available in three contact arrangements: single-circuit, normally open or normally closed; and single-pole, double-throw.

Each form can be furnished with a contact air gap of .010, .020, or .030 in. The switch weighs .13 lb. Manufactured by the *General Electric Co.*, Schenectady, New York.

D.C. Power Supply

Operates from a.c. lines to provide continuous direct current for the operation of d.c. or battery-operated equipment. Pictured here is a model

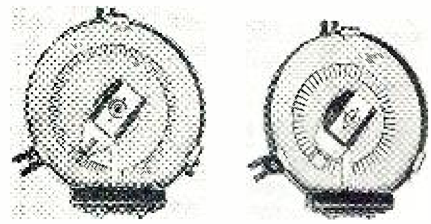


designed especially for railroad signaling equipment to eliminate the batteries and generators previously used. This unit employs gaseous type bulb rectifiers, has a two-section filter and a special "built-in" automatic voltage regulating device. It delivers 110 volts d.c. at currents up to 15 amperes. The input circuit is designed to permit use on a.c. lines of various voltages. The Power Supply shown was fabricated to meet a customer's special application. Height 48 inches, width 19½ inches, depth 12½ inches.

Units of this type are available in a variety of physical mounting styles and can be made for operation on various line potentials and frequencies. Manufactured by the *Standard Transformer Co.*, 1500 N. Halsted St., Chicago, Ill.

Ward Leonard Rheostats

Ward Leonard Pressed Steel Rheostats with solid Rectangular contacts provide a finer degree of control,



smoother operation, and certain economies where interpolating rheostats would otherwise be required.

Rectangular contacts are available in small and large sizes. Small rectangular contacts can be furnished on thirteen inch or smaller rheostats. Large rectangular contacts can be furnished on eight inch or larger rheostats.

Rheostats with rectangular contacts can be furnished with complete enclosures, fittings for conduit connections, motor drives and with accessories for floor, back-of-board, and concentric mounting. Fixed and adjustable stops can be provided.

These and other rheostats are listed in a new sixteen page Bulletin 60, available on request from the *Ward Leonard Electric Co.*, Mt. Vernon, N. Y.

New RCP Multitester

RCP Stock Model No. 423, a general utility Volt-Ohm-Milliameter, has won widespread industrial preference for

accurate production line tests and commercial laboratory measurements. This sensitive multitester is also used

(*Continued on page* 81)

Emergency Radio Receivers

by GUY DEXTER

Satisfactory radio receivers may be made easily by taking advantage of the innovations discussed within this article.

PLENTY of 1943 radio men never heard of a tubeless receiver. But we can readily understand that, because the price of tubes somersaulted around 1924, long before the present crop of servicemen had gotten the bug, and we then completely abandoned the simple crystal detector. Prior to that time, however, there were few men or boys in any neighborhood who had not built a crystal set, and many families relied upon this simple receiver for local broadcasts for sometime after tube prices dropped.

There were also other simple detectors in use in the early days; some preceding the crystal detector by a few years and others trying for contemporary recognition. They included (1) the electrolytic detector, (2) the contact rectifier, (3) the metallic oxide rectifier, and (4) home-made diode tubes improvised from automobile headlight bulbs.

"Horse-and-buggy" receivers employing the simple detectors are just as workable today as they ever were. And, although they are less sensitive than modern tube sets, the present war emergency may yet recall these simple sets from their resting places on museum shelves.

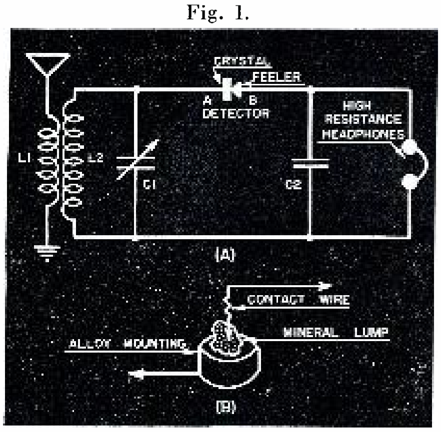
Threatened tube and battery shortages, and the possibility of power-line failures, remind us that cheap crystal sets require no power of any kind for operation and can pick up local stations within a 25- to 30-mile radius with good volume. And they operate on short waves as well as broadcast frequencies.

The home-made diode tube delivers almost as good a headphone signal as a crystal detector (in some cases, just as good) and requires only a 6-volt filament battery. At the same time, it does not require the constant re-adjustment common to the crystal.

The well-known miniature copper-oxide rectifier, used by radio men to make d.c. meters read a.c., may be used, as will be shown later, instead of the crystal. However, the relatively high capacitance of this device limits its sensitivity and restricts its high-frequency use. Inherently, it is not as sensitive a detector of radio waves as is the crystal.

The present value of simple sets built around these elementary detectors lies in their importance as emergency receivers. Such sets may be placed into immediate service when power lines have snapped out and "B" batteries are not available for the family portable. They may be carried into bomb shelters where electric power is not available. Particularly unique is the fact that they may be made so small in size as to be carried easily in a pocket or handbag.

Fig. 1.



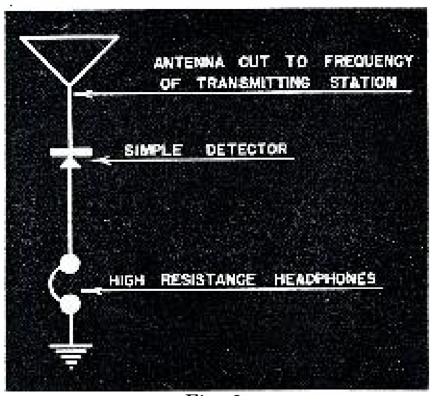


Fig. 2.

We shall describe in this article the theory and construction of the more efficient simple detectors and constructional details of several receivers incorporating them.

How the Crystal Detector Works

Best known and most widely used of all the early rudimentary detectors was the crystal type. These detectors are still obtainable in some of the large city ten-cent stores for about 25c complete with crystal.

Operation of the device is based upon the rectifying properties of small lumps of certain minerals which we have termed crystals. Common among these minerals are galena, iron pyrites, copper pyrites, silicon, graphite, bornite, zincite, calchopyrite, etc. Of the synthesized materials, carborundum is the best known.

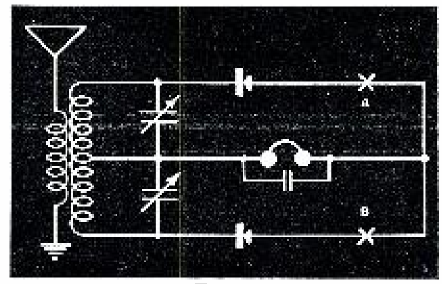


Fig. 3.

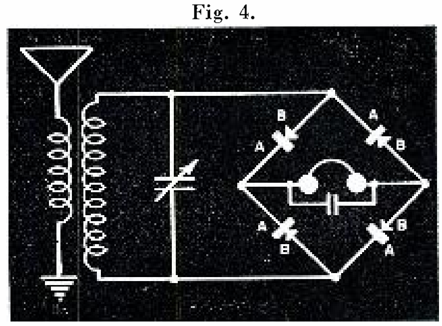
The "crystal" is not a perfect rectifier. Actually, it offers high resistance to current flow in one direction (although not cutting off current in this direction completely), while allowing more or less ready flow in the other direction. Inserted in a radio-frequency circuit, therefore, the crystal will rectify the r.f. alternations and deliver d.c. pulsations to a pair of headphones.

Crystal Sets

A circuit to obtain this effect is shown in Figure 1-A. The combination L1-L2-C1 comprises a conventional receiver input circuit of the coupled type. The primary coil L1 is the antenna inductor, serving to induce a radio-frequency voltage in the secondary L2. The variable condenser C1 tunes the circuit to the signal frequency.

The r.f. voltage developed across L2 is higher than that across L1 by a factor equal to the turns ratio of the transformer formed by the two coils. This voltage is presented to the circuit comprising the crystal and headphones, and is rectified by the crystal which, in turn, delivers d.c. pulses to the headphones. Capacitor C2 bypasses the latter for r.f. The crystal

Fig. 4.



detector is thus seen to act in the same manner as a half-wave diode tube rectifier.

Arrangement of the crystal detector is shown in Figure 1-B. The mineral itself is set into a metallic mounting, corresponding to part A in Figure 1-A, and contact is made to a single spot on its surface by means of a fine wire spring or "cat-whisker," corresponding to part B. The cat-

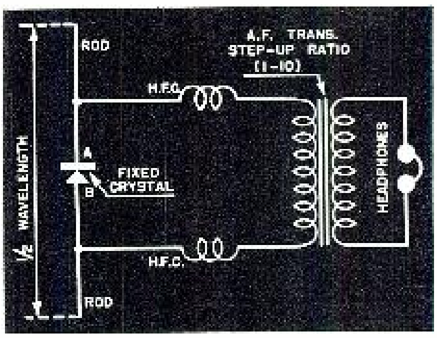


Fig. 5.

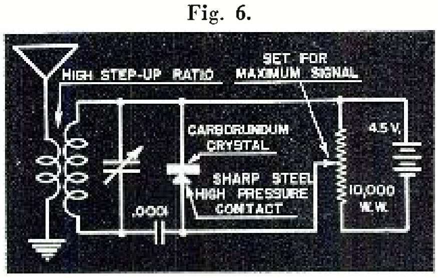
whisker is so mounted on an adjustable shaft that its pressure and position upon the mineral surface is readily adjustable. The metal in which the crystal is mounted is a low-melting point alloy, generally Wood's metal, which melts in hot water, since sensitive radio minerals have their rectifying action destroyed by heat.

Not all spots on the crystal surface give the same d.c. output. Some are pronouncedly better than others. It is necessary, therefore, that the operator try various points of contact and various contact pressures until loudest signals are obtained.

Different minerals require different types of cat-whisker. Galena, most sensitive crystal yet offered, requires a fine, pointed wire of brass or phosphor bronze resting lightly on the crystal surface. Silicon requires a stiff, moderately heavy pressure, blunt-end brass or phosphor bronze cat-whisker. With carborundum a sharp-pointed steel contact and considerable pressure is necessary.

Fixed crystal detectors are available which have a permanently, or semi-permanently, adjusted contact, pre-set at the factory to the most sensitive spot. These encased units may be wired directly into the circuit and practically forgotten. They require little or no adjustment over long periods and can withstand an amazing amount of abuse without losing adjustment. They make it possible to enjoy the simplicity of the crystal receiver without the nuisance of searching for sensitive spots.

Fig. 6.



The tuned circuit shown in Figure 1-A is conventional in every respect and may be designed to cover any desired band of frequencies. To cover the broadcast band, L2 will be approximately 230 microhenries, C1 a 0.000365-μfd. variable condenser, and L1 about 20 turns of No. 26 enameled wire wound around the end of L2. These dimensions correspond to a coil and condenser from a discarded t.r.f. receiver.

The detector parts (A and B) are connected in the circuit in the order shown in the diagram, as this arrangement removes the manually-adjusted cat-whisker from the r.f. portion of the circuit. C2 will be 0.001 to 0.002 μfd. capacitance. The headphones must be conventional high-resistance radio type components.

A simpler circuit is shown in Figure 2. In this layout, headphones and detector are connected in series in the antenna circuit without any tuning or coupling device. Because the latter components are eliminated, selectivity suffers. Response of the circuit is necessarily broad. If several strong local stations are in operation, it is likely that all will be heard simultaneously. However, the one whose frequency corresponds to the natural frequency of the receiving antenna (or lies closest to this frequency) will be loudest.

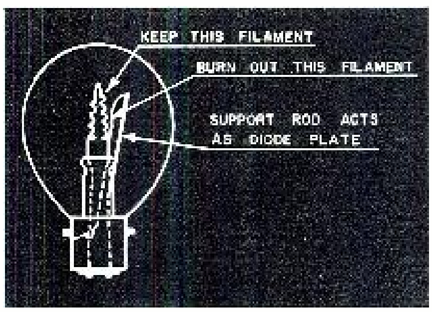


Fig. 7.

Figure 3 shows a push-pull circuit for obtaining full-wave rectification with two crystal detectors. Best results are obtained when the two crystal output currents are identical. If adjustable cat-whisker-type detectors are employed, independent adjustments may be made with the aid of a 0-50 d.c. microammeter inserted at point A or point B. Crystal spots are sought which give current readings of the same value at each of these points. If fixed crystals are employed, they may be matched for equal current output when selected from stock.

Each half of the tuned circuit corresponds to the single tuned circuit in Figure 1-A. Somewhat better tuning action is obtained by using a split stator condenser, as shown, than by tuning the entire coil with a single section.

Figure 4 shows a bridge-type crystal circuit for obtaining full-wave rectification without a special split tuned circuit. This circuit requires four matched-output crystal detectors, a requirement which at once precludes use of adjustable units. Matched *fixed* crystals are a necessity in this layout.

In any of the circuits shown for crystal operation, the tuning condenser may be omitted if the coil is provided with a generous number of taps and a means for switching these taps. The cost of the complete re-

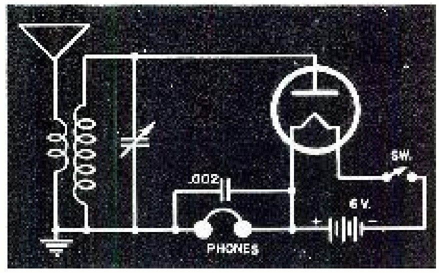


Fig. 8.

ceiver may thus be kept quite low—within a dollar (minus the cost of headphones) for the single-detector models.

An effective crystal circuit for fixed-frequency ultra-high-frequency reception is depicted by Figure 5. This receiver is operable even at the very short wavelengths of a few centimeters, and is highly portable. The two vertical rods comprising the di-pole receiving antenna are each cut to a quarter wavelength to serve as a tuned circuit as well. An arrangement such as the one shown offers interesting possibilities for portable (personal) use in short-range civilian defense communications employing the ultra-high WERS frequencies.

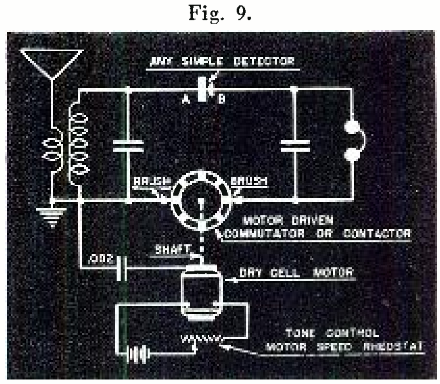
Special Carborundum Circuit

Receivers employing carborundum crystal detectors require special circuits such as the one shown in Figure 6. A "biasing" battery is needed in this circuit to place crystal operation at a critical point along the crystal characteristic curve where small r.f. input voltage alternations cause the largest possible d.c. output current fluctuations. Polarity of the battery is very important.

In general, carborundum crystals reduce the "spot-hunting" nuisance somewhat, the potentiometer being set for maximum audio signal strength. High-pressure contact is

(*Continued on page* 50)

Fig. 9.



PRACTICAL RADIO COURSE

by ALFRED A. GHIRARDI

Part 10 of the present series discusses the basic fundamentals of the construction and operation of the many various types of vacuum tubes.

F THE temperature of a metal is sufficiently raised, the movement of the electrons constituting the rotating portions is accelerated, and, if the heating is carried to the extent where the metal begins to glow, the movement of some of these electrons becomes rapid enough to cause them to leave the surface of the metal, as illustrated in Fig. 1.

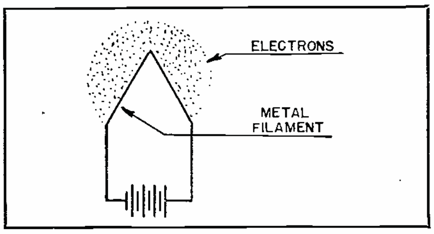


Fig. 1.

This "emission" action, which is accelerated when a metal is heated in a vacuum, is called the Edison effect, and was first utilized by Fleming in his two element tube. The body which emits the electrons is called the cathode.

All metals exhibit this characteristic, but those in use in radio tubes are usually tungsten or nickel in an alloy

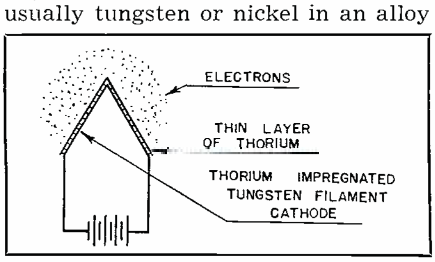
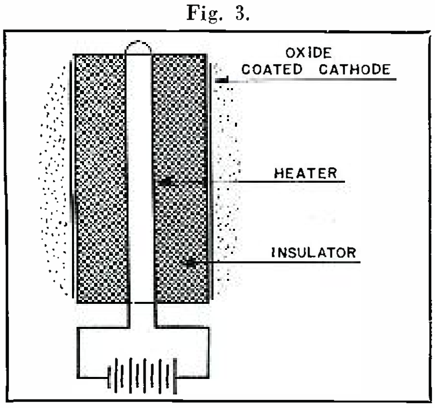


Fig. 2.

form. The ordinary tungsten filament cathode is usually one that has been impregnated with thorium during manufacture in order to give high electron emission at relatively low temperatures, and is used mainly in transmitting tubes.

When the tungsten is heated by an

Fig. 3.



electric current, some of the thorium is driven to the surface of the filament where it forms a layer one molecule thick, and the electronic evaporation or emission takes place from this thin layer of thorium as illustrated in Fig. 2.

A ribbon of nickel or one of its alloys coated with a thin layer of barium or strontium oxides is usually used for direct-heater types of the smaller sizes. The advantage of this type of filament are great emission and long life. The action of this filament is similar to that of the tungsten, but the emission is solely from the oxide surface and takes place at relatively low temperatures. The tubes commonly found in home radio receivers are of the indirect-heated cathode type, and consist of a heater element, usually encased in an insulating ceramic sleeve, inside a thin wall tube of nickel which has been oxide coated. The heat from the heater is transmitted through the ceramic to the nickel tube, and raises the temperature of the oxide coating sufficiently to cause emission. A cut-away drawing of this type of heater is shown in Fig. 3. In this construction, the oxide-coated nickel tube is the cathode.

So far we have dealt solely with emitters with no practical application. If we suspend a metal plate near the filament, as illustrated in Fig. 4, and

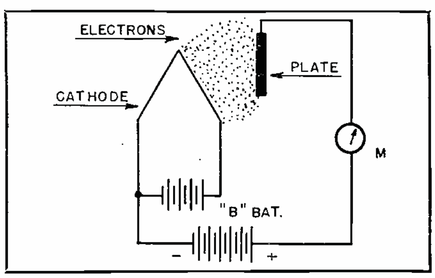


Fig. 4.

connect a battery so that a positive potential with respect to the cathode is applied to the plate, electrons will be attracted to the plate from the cathode, the number being attracted each second depends on the potential of the plate and the rate at which the electrons are emitted from the cathode. The electron flow takes place from the cathode to the plate, back through the circuit to the cathode. This flow of electrons is known as the plate current and can be measured by a suitable meter M in Fig. 4.

As electrons leave the cathode they form a sort of cloud of negative charge in the vicinity of the cathode which tends to repel those electrons leaving the cathode. This screening effect is known as the space charge effect. As the plate voltage is increased, the increased voltage tends to neutralize this space charge, allowing a greater number of electrons to flow.

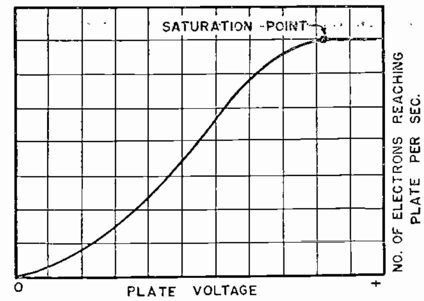


Fig. 5.

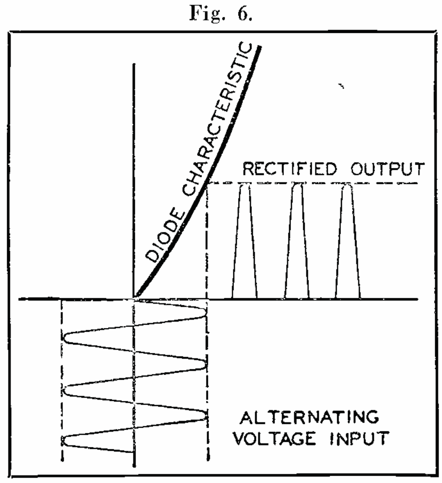
For a given cathode temperature there is a definite limit to the electron flow. This is called the saturation point. Raising the cathode temperature will increase this flow within the limits of the available emission. A typical graph showing the relation between the number of electrons reaching the plate per second vs the plate voltage is shown in Fig. 5. (Occasionally the small current which flows in a diode tube with zero plate voltage is caused by some of the electrons being emitted from the cathode with sufficient velocity to reach the plate.)

As the plate voltage reaches its maximum operating point, it will be noted that the plate current tends to level off due to the emission reaching the saturation point.

Diode

If the plate is made negative with respect to the cathode (by reversing

Fig. 6.



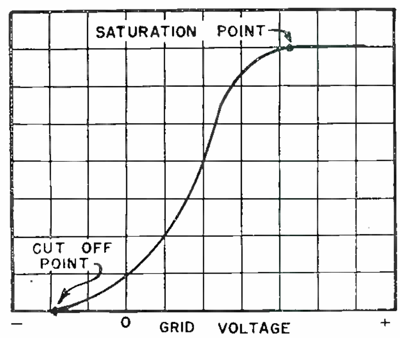


Fig. 7.

the plate battery connections), no electrons will be attracted to it and no current will flow. The tube thus acts as a unidirectional device, permitting current to flow in only one direction. When an alternating voltage is applied to the plate, current flows only when the plate is positive with respect to the cathode. Such current is said to be rectified. A graphical analysis of such action is shown in Fig. 6.

The most common uses of diodes are as rectifiers in power supply circuits and as detectors in receivers where it is necessary to handle relatively large signals with small distortion.

Triodes

Dr. Lee DeForest discovered that by placing a grid-like element between the cathode and plate of a diode, the flow of plate current could be controlled by varying the potential on the grid. Such a tube is called a triode, and is the basis of almost all modern tubes. The action may best be ex-

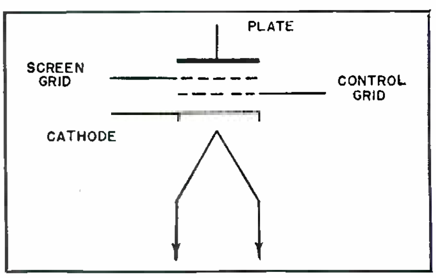


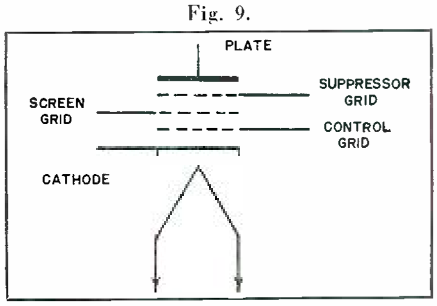
Fig. 8.

plained by considering the grid as an element which may either aid or retard the flow of electrons from the filament. If the grid is made sufficiently negative with respect to the cathode, it will tend to prevent electrons from leaving the cathode and the plate current will drop to zero or a low value. If the grid is made positive with respect to the cathode, the flow of electrons from the cathode will be accelerated and the plate current will increase. An example of how the plate current varied with a fixed plate voltage and various values of grid bias may be seen in Fig. 7.

By either moving the grid closer to the filament or decreasing the spacing between the grid wires, it may be made to have a greater effect on the plate current. In this manner we may use a relatively small grid voltage to control a comparatively large plate current.

As any two of the elements in a vacuum tube form a condenser, there is a certain amount of capacitance between these various elements. These interelectrode capacitances, while small, frequently cause trouble when the tubes are operating at radio frequencies, inasmuch as the grid plate capacitance acts as a coupling medium between the input and output circuits. It is possible to either neutralize this capacity by means of a bridge circuit, or resort to another form of tube called a tetrode such as is shown diagrammatically in Fig. 8.

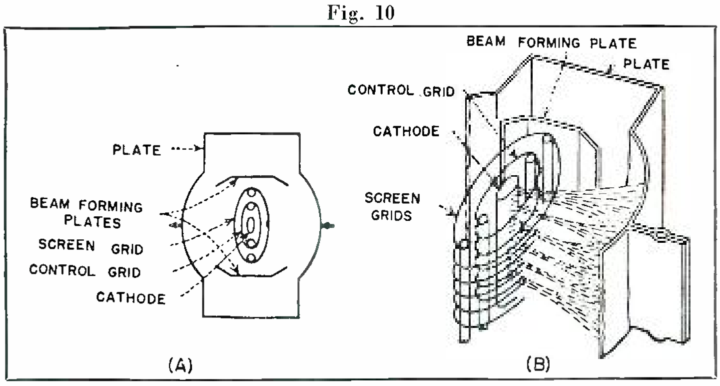
Fig. 9.



Tetrodes

The control-grid plate capacitance may be reduced greatly by employing a fourth electrode in the tube, which is known as the *screen*. This is another grid placed between the control grid and the plate as shown in Fig. 8. It is operated at some positive potential lower than that of the plate, and is by-passed to the cathode through a condenser. It is constructed so the flow of electrons is not materially obstructed, yet it serves to establish an electrostatic shield between the plate and grid, since the by-pass condenser effectively grounds the screen for high-frequency currents and thereby assists in reducing the control grid-plate capacitance to a minimum value. In general practice the use of the screen may reduce the control grid-plate capacitance from an average of 8 $\mu\mu$fd. for a triode to 0.01 $\mu\mu$fd. or less for a similar screen grid tube. Also, since the screen voltage largely determines the electron flow in the tube, small changes of plate voltage have little effect on the plate current.

Fig. 10



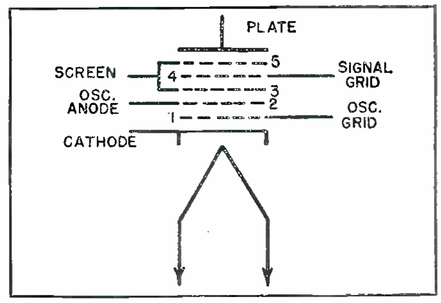


Fig. 11.

This is desirable from the point of view of stability.

Pentodes

Electrons bombarding the plate at high speed, may dislodge other electrons from the plate. This electron emission from the plate caused by bombardment of the plate by electrons from the cathode is called *secondary emission,* because the effect is secondary to the original cathode emission. In two- and three-electrode types, these vagrant electrons usually do not cause any trouble because the plate is the only positive electrode present in the tube to attract them. They are, therefore, eventually drawn back to the plate. In the case of screen-grid (tetrodes), the proximity of the positive screen to the plate offers a strong attraction to these secondary electrons, and particularly so if the plate voltage swings lower than the screen voltage. This effect lowers the plate current, and limits the permissible plate swing for tetrodes.

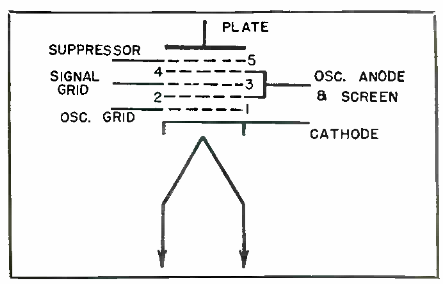


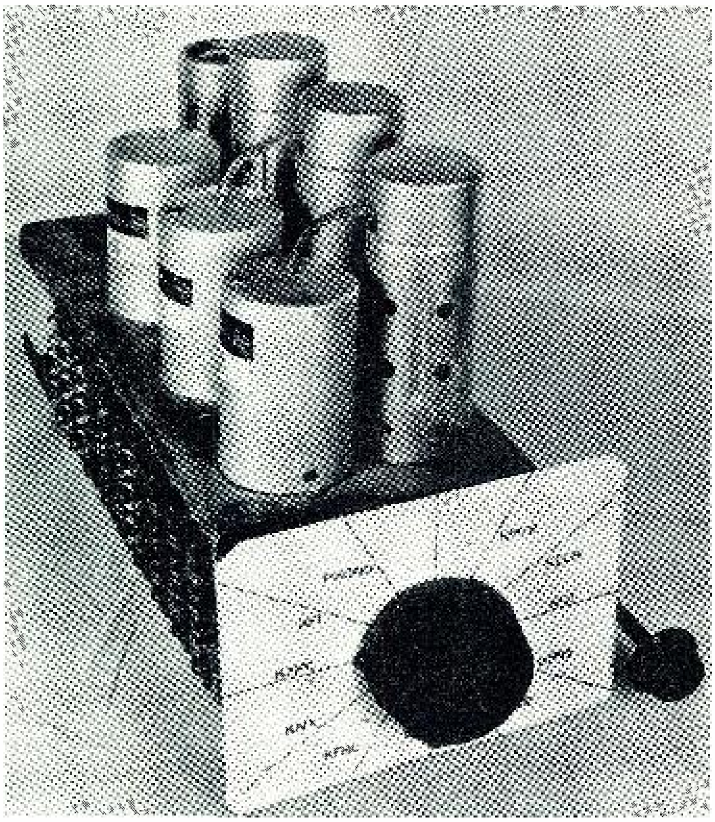
Fig. 12.

The addition of a fifth electrode (another grid called a suppressor) between the screen and plate, and either maintained at cathode potential, or in any case negative with respect to plate and screen, eliminates this difficulty. The secondary emitted electrons that would normally be attracted to the screen are driven back to the plate by this negatively charged suppressor grid, with the result that the plate current is not reduced by secondary emission and the amplification is much greater. A typical pentode tube is shown in Fig. 9.

The suppressor is utilized at the present time in pentodes for two dif-

(Continued on page 5)

A Pre-Set Broadcast Receiver



The tuner is constructed on a separate chassis.

by

A. K. BRUMBOUGH, JR.
Inglewood, Calif.

★ ★ ★

Ample stocks of parts are still available from most jobbers for building this set. It has unusual and original electrical circuit features.

★ ★ ★

WHEN failure of the family broadcast receiver caused one of those crises familiar to every married man, the writer was faced with the necessity of acquiring a new receiver, preferably without noticeable dislocation of the budget. However, the better-half has little patience with our dilletante efforts at radio construction, so we took a careful look at the commercial jobs available.

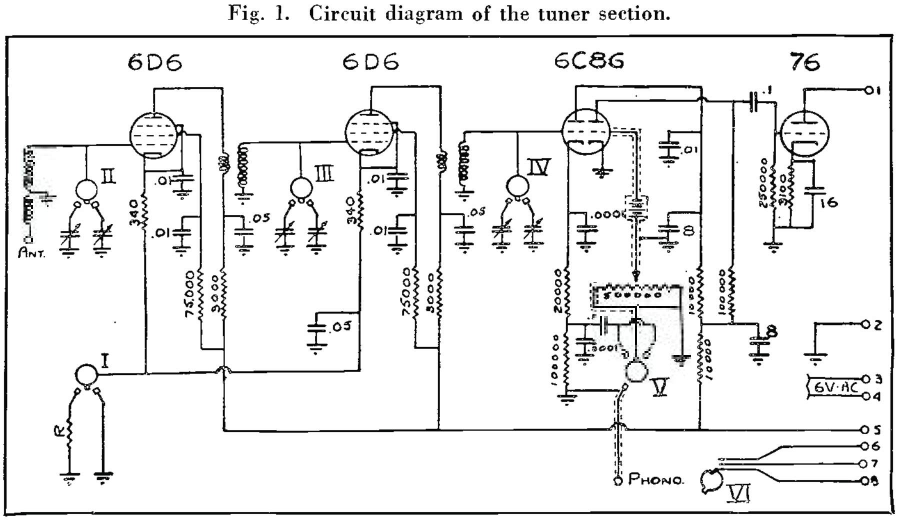
It was soon apparent that none of the receivers that we studied would exactly meet our requirements because either too little or too much was offered. None of the low priced sets had satisfactory audio systems; all the money had been put into the tuner, with a 6V6 and a six-inch speaker tacked on as an after-thought. We then looked for a man-sized audio system and found it all right, fastened to an all-wave front end, enclosed in a gorgeous cabinet and bearing a staggering price tag. Finally we gave up and decided to build our own receiver to meet our own ideas.

For our purposes we needed only a simple tuner, preferably of the push-button type, coupled to a good quality amplifier and speaker. Reception could be limited to strong local stations only as we had a communications receiver for long distance work. Simplicity of operation was of paramount importance. We had to guarantee that *this* rig would *not* require the master's touch.

With these ends in view, we canvassed our available materials and worked out the arrangement to be described. The now acute shortage of radio parts was already seriously felt so we were unable to get the things we wanted—we had to use what we could get. For this reason we are not giving a detailed parts list, feeling that any other constructor will be in the same difficulty and will have to exercise ingenuity and good judgment to build a similar job. However, we would not even bring this receiver to notice had we not felt that its duplicate could not be built even in these times. The important things are the basic ideas rather than the exact parts used.

Our speaker, output transformer and power supply were salvaged from a long extinct *Majestic* 103A. We

Fig. 1. Circuit diagram of the tuner section.



knew that comfortable, if not perfect, reproduction could be secured from this equipment, using Class A 45's for the output stage.

The tuner is a departure from conventional construction; we wanted push-buttons but could find none which filled the bill and had to devise a substitute. Rotary tap switches looked like the best bet and were tried. We built an arrangement that worked and soon found that the enforced change led to advantages which were not at first apparent. Taking advantage of the flexibility of design permitted, we ganged six switches to one shaft, combining in one knob the functions usually assigned to several controls. As finally constructed, the receiver has only two knobs, a main control and the volume control.

Fig. 1 shows the circuit of the tuner. Switches with 12 positions numbered I, II, III, IV, V, and VI are all mounted on a common shaft which is fitted with a spring detent. Numbers II, III and IV, control the selection of the station to be received by cutting in

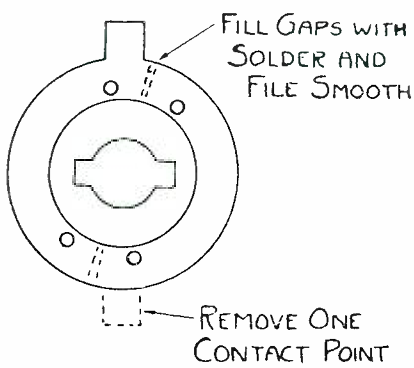
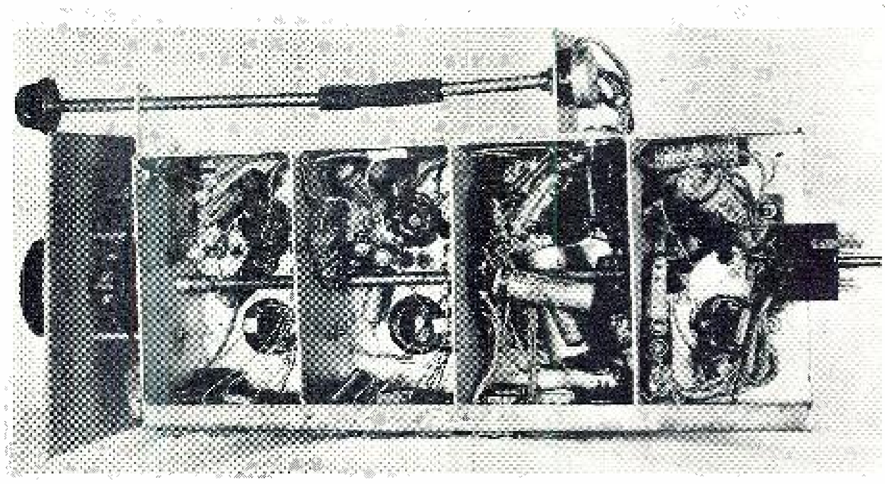


Fig. 3. Section of wafer.

preadjusted padding condensers. These condensers are bakelite mounted, three to a strip, 35μμfd. trimmers; loaded as required with small fixed mica condensers. Coils used are: antenna and r.f. interstage. The circuit is straightforward, well by-passed, TRF, using one-half of the 6C8G as an infinite impedance detector. We first used diode detection with an 85, but found that we were unable to get satisfactory selectivity at the high frequency end of the band. Unloading of the third r.f. transformer by substitution of the present detector resulted in a really remarkable improvement.

With the diode detector we used AVC but the infinite impedance detector does not supply AVC voltage. It is common to use a 6B7 as the second r.f. amplifier and take AVC voltage off the diodes but we were fighting for selectivity and cooked up another arrangement to avoid any loading of the circuits. Switch I is used to control bias on the r.f. tubes by inserting cathode resistors in the circuit. Approximate value for each station is determined experimentally and the proper size resistor is then wired in permanently. Only two resistors were required in our case. Four of



Underside view of tuner chassis assembly.

the nine stations use only the 340 ohm resistors in each cathode return. Three other stations use a 1500 ohm resistor wired to three points of Switch I, while the two strongest stations require 2500 ohms to keep them in line.

Switch V accomplishes the change from radio to phonograph operation. The audio lead from the detector is connected to nine points on this switch. By some careful filing we arranged it so that all other contacts close before those on Switch V providing a desirable muting action which prevents loud clicks when changing stations.

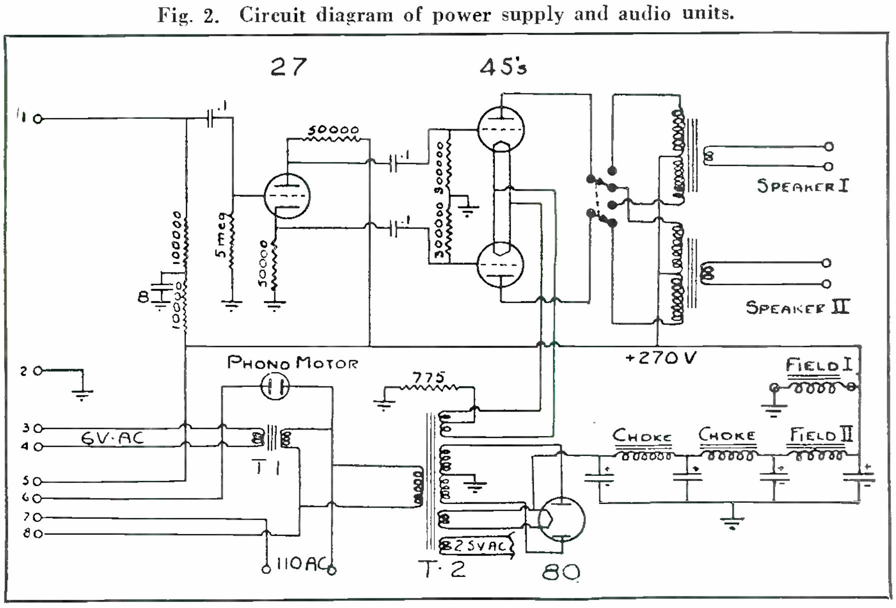
All the above switches are 5-position, two-circuit, wafer switches, altered as shown in Fig. 3 to operate as 12-position, single-circuit. The common operating shaft is ¼″ steel rod with brass lugs soldered in the right location to engage the switch wafers. Incidentally this soldering is a tricky job. After several futile efforts we finally sweated on pieces considerably larger than required and filed to the exact shape.

Switch VI is made of salvage parts according to Fig. 7. It controls the 110-volt a.c. for the receiver and the phonograph turntable.

A ¾ view of the completed tuner is shown in one of the photos. The main control knob is in the "off" position. Turning the pointer to any station shown turns on the receiver and tunes the station to give a fixed r.f. output. If the volume control is once set at a desired level, it may remain untouched for days of use. In the PHONO position the pick-up is substituted at the audio input and the turntable is started. With our pick-up the phonograph volume level is almost the same as that for radio reception. In the straight up position both inputs are disconnected and the turntable is stopped. This point is used for momentary standby and for changing records. The main knob was made from an old tuning knob by cutting off all the skirt except for a triangular section which serves as the indicating point. The panel was made from part of an ordinary manila folder lettered in ink and soaked in lacquer. Two panel lights are used. These are supported by the No. 12 wires used as leads, one to each side of the center line.

Along the left side of the chassis in the photo may be seen the 27 padders

Fig. 2. Circuit diagram of power supply and audio units.



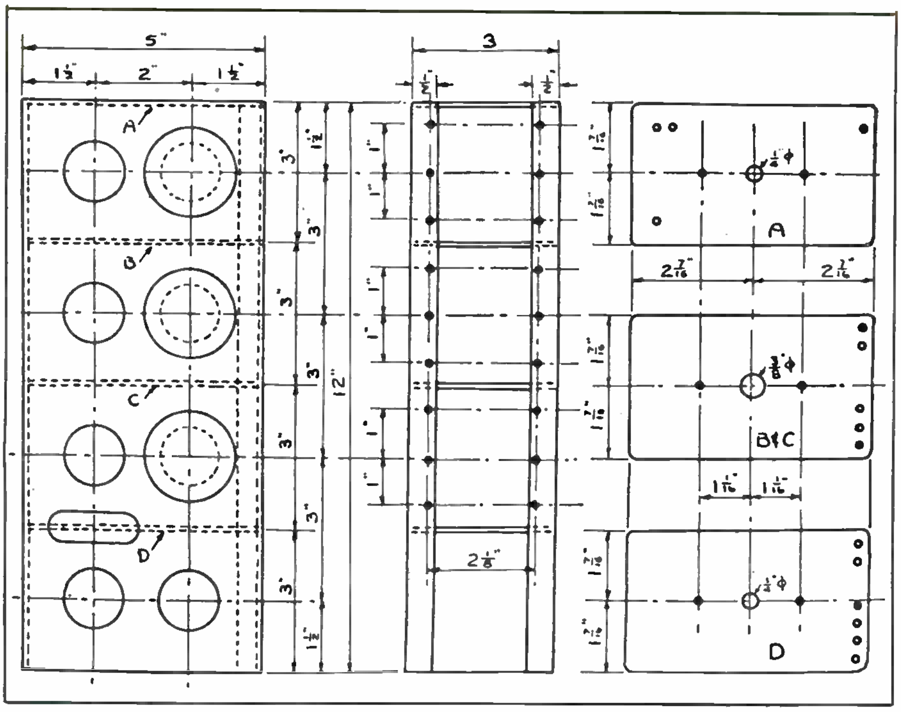


Fig. 4. Mechanical layout of the tuner chassis.

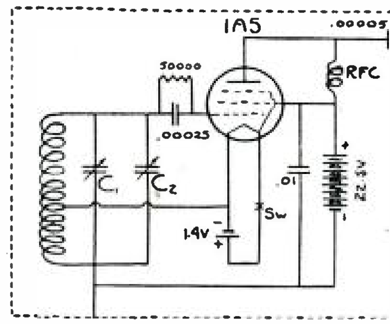
by which the stations are tuned. The antenna lead is brought in through the pin-jack seen between the first two coil cans. This lead must be dressed away from the padders or oscillation will result due to capacitative coupling.

Another photo shows the bottom view. The ganged switches may be seen clearly. It will be noted that each stage is enclosed in a separate compartment. This fact, together with careful bypassing, eliminates any tendency to instability. Bearings for the switch shaft are in the front and rear diaphragms only; in the two intermediates the hole must be enlarged to give clearance to the switch operating lugs on the shaft. In the front plate a ⅜" hole permits insertion of the shank of the detent plate which was supplied with the wafer switches. This detent serves as a removable front bearing and locks the control in its chosen position.

The mica loading condensers are supported by their own leads, each attached to its padder. Value of these condensers depends on the stations desired and must be determined experimentally after the approximate values are calculated.

The volume control was mounted as shown to permit the use of short shielded leads in the grid circuit of the first audio triode. This is the critical point for hum pick-up and no precaution is too great if good results are desired. In our opinion use of a C battery for bias on the first audio tube is far superior to the cathode resistor and bypass usually used, but when the time came no bias cells were available so we were forced to a substitute.

The — lead from the C batteries goes to the grid cap of the 6C8G. This leaves the other grid connection, that on the socket, for the r.f. input, resulting in short leads. With careful work the hum level can be brought down to almost nil. With no antenna connected the set is silent even with the volume control full on. In the standby position the first audio grid is floating, a condition which generally means plenty of hum; in our case it is barely audible. The original batteries are still in service, and after 13 months still show 4.5 volts. Incidentally, they may be checked on any high resistance meter, a VTVM is not required as in the case of bias cells.



C_1 - 365 mmf C_2 - 20 mmf
L - Broadcast Coil Tapped
⅓ from ground end

Figure 5.

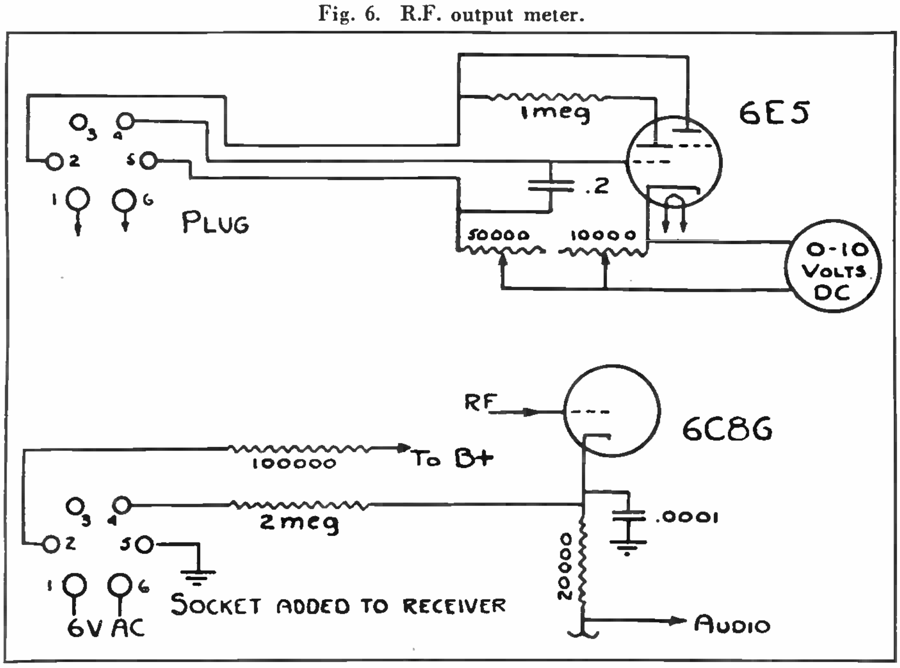
Layout of the chassis is shown in Fig. 4. It was constructed of 16 ga. steel with brazed joints and was cadmium plated after assembly. All holes except those for mounting the padder strips were drilled before assembly. Careful work is required to produce a rigid base correctly aligned to permit certain working of the ganged switches. All the small holes in Fig. 4 were drilled with a No. 28 drill to clear 6-32 bolts.

The power supply is conventional, except for the unusual number of chokes used. Had we had to buy these, or had space been limited, we would have reduced the number, but having the material and the room it seemed best to use all the smoothing possible. T-2 is the power transformer from the old *Majestic,* T-1 is a small 6 volt filament transformer supplying the tuner tubes and dial light. We made T-1 by rewinding a cheap bell transformer. Many alternative arrangements will suggest themselves to the experienced constructor.

The phase-inverter circuit was taken from an article in "Electronics" for October 1940 by C. G. McProud and R. T. Wildermuth. The reader may wonder why two speakers. This addition is a matter of family politics. The 12" speaker, which is necessary

(*Continued on page* 64)

Fig. 6. R.F. output meter.



Manufacturer's Literature

Our readers are asked to write directly to the manufacturer for this literature. By mentioning RADIO NEWS and the issue and page, we are sure the reader will get fine service. Enclose the proper sum requested when it is indicated. This will prevent delay.

New Carter Bulletin No. 100

The latest catalog now distributed by the *Carter Motor Company,* 1608 Milwaukee Avenue, Chicago, Ill., illustrates and describes many new and revolutionary motors and generators. Among the items of particular interest are the "super" dynamotor designed especially for aircraft, marine, police and all mobile radio equipment. Then there is the high voltage "super," an outstanding high voltage dynamotor for light-weight aircraft, marine and special communication equipment. The multi-output super dynamotor described represents the last word in engineering design, efficiency and dependability.

A new item is an original p.m. "magmotor" for police radio receivers, small aircraft transmitters, portable life saving devices and field communication equipment. Also included is the new magmotor hand generator designed for special emergency units, and which is playing so permanent a role in the service of our various military branches.

Performance charts and reference is given for all *Carter* products.

Murdock Bulletin No. 12

Published by the *Murdock Manufacturing Co.,* Chelsea, Mass., this old established firm is now engaged in the manufacture of headphones for our military service. Their new bulletin describes completely many types of head sets and phones and accessories of modern design and of advanced engineering.

New GE Bulletin

"Ignitron Mercury-arc Rectifiers in the Steel Industry" is the title of an attractive 28-page bulletin (GEA-3827) recently issued by the *General Electric Company.*

Profusely illustrated, the bulletin outlines various conversion-equipment problems in the steel industry, and discusses the characteristics and the various applications of ignitron mercury-arc rectifiers in meeting these problems. Among the subjects discussed in the bulletin in reference to steel mills are d.c. power supply, d.c. systems, 250-volt distribution systems, 600-volt continuous mill systems, and reversing mill systems.

Also discussed are the three types of conversion units commercially

(*Continued on page* 61)

24 YEARS AGO in RADIO

{ CONDENSED FROM RADIO NEWS, 1919 ISSUES }

U. S. Navy Airplane Sets

ONE of the great achievements in the year (1918) in radio was the ½ kw. Airplane Radio Transmitter used by the United States on their dirigibles and airplanes during the great war. It was designed for the purpose of compactness and durability as well as efficiency.

The panel of the transmitter was constructed of a sheet of black bakelite dilecto, reinforced by a bent wood frame extending around the curved section and metal angles on the sides and bottoms. Upon the front of the panel is mounted the wave changing device, the quenched spark gap, control switch and rheostat, also the meters. All wiring connections are made on the back of the panel. The panel complete weighs exactly 44.5 lbs.

The transmitter consists of several parts, the most essential being the propeller driven generator and the panel, which is supported within the fusilage. The set is of the 500-cycle quenched spark type with a specially designed wave changer adjustable for two wave lengths —425 and 600 meters.

The generator is air-driven. It consists of two generators enclosed in the same frame with both armatures on the same shaft—one a direct current generator supplying excitation current, and an alternator which develops the primary power used in the transmitter. The weight of the generator complete is 28.5 lbs.

The alternator is a 500-cycle machine and runs at 5000 R.P.M. It may safely be operated at an output of 500 watts. It is of the rotating armature type and has twelve poles and develops an open circuit voltage of 75-220 volts; it is controlled by a brake-control lever mounted in the fusilage. The brake consists of a steel brake drum integral with the propeller hub. To start generator it is only necessary to release the brake. The D.C. generator supplying excitation current for the alternator is shunt-wound and develops an open circuit E.M.F. of 150 volts.

Sustained Wave Radio Telephone and Telegraph Transmitter

THE time arrived in 1919 when the amateur's heart's desire was about to be fulfilled. He now had at his command the means and apparatus for obtaining a satisfactory radio telephone for moderate range transmitting. The success of this new art was due to the rapid development of the vacuum tube which was used as a radio frequency generator, also newly developed arcs suitable for sustained wave generation and means for operating the same on short wavelengths. In addition to these developments, the improvement of modulating means for this sustained wave generator, had made its application comparatively simple and readily applicable to amateur radio telephone and telegraph transmitters.

The generation of high frequency or sustained wave oscillations for this set comprised three vacuum tubes of standard make, such as the *Moorehead* type, all of which are connected in parallel. The writer had found by test that from a single receiving vacuum tube with high vacuum and high plate potential, it was possible to obtain about 5 to 8 watts of high frequency energy on wavelengths ranging from 150 to 600 meters with a normal filament current. It was then possible by the use of three vacuum tubes, as used in this set, that about 20 watts of high frequency energy be obtained, when operating the plate potential of the three tubes on 900 to 1,000 volts and a filament current of ¾ of an ampere, which is the normal current necessary to operate the tungsten filament vacuum tubes, such as the *Moorehead* type.

Try Out Airplane Signal

EXPERTS of the *Army Signal Corps* began experiments with a recent invention which they believed would prove valuable in making the airplane a commercial utility. Described as an "audible beacon," the new contrivance was designed as a signal which will advise the aviator not only of his own position regardless of weather conditions, but will serve as accurate marks for suitable landing places.

"The beacon" was said to be a combination of the radio telephone and the ordinary phonograph. Its operation was more or less automatic and could repeat a word or signal designating its position. For instance, one at Langley Field, the interdepartmental aviation base, might send out the call "Langley" at stated intervals.

Officials working on the invention believed that the next step would be the adoption of the sound-ranging device, then used by armies in connection with artillery fire, to enable aviators to determine without delay the distance and directions of the call of any one of these sending stations.

High Spark Frequency in the Amateur Field

THE 1919 radio amateur was continually striving to increase the efficiency and radius of his transmitting set. Restricted as he was to a wave length not exceeding two hundred meters and a maximum power input of one kilowatt, it was up to him to find other means of extending his radius of communication. One of the best ways to do this, as many experimenters found, was to increase the spark frequency of the transmitting set and make the other necessary changes essential to resonance. A large majority of the amateur stations thruout the country, holding long-distance records, owe the enviable performances of their sets to the good carrying properties of their signals due to the clear, musical and penetrating note of the high-pitched spark.

The reasons for this increase of range accompanying the use of a high spark frequency are easily understood after a little consideration. The modern long-distance receiving set then used the telephone as a means of making the radio oscillations audible. It was proven by experiment that the type of telephone used in wireless telegraphy was far more sensitive to high frequency currents than to those of low frequency. From tests made at the U. S. Bureau of Standards by Mr. L. W. Austin in 1919, a pair of wireless telephone receivers showed an increase in volt-sensitiveness of approximately one thousand, from 60 cycles to 900 cycles. The human ear also seemed to be more sensitive to sounds of high notes of the radio signals from atmospheric and other low tone interference. There appeared to be a practical limit to high frequency however, at about 500 cycles per second. Above this frequency there is not as material an increase in sensitiveness and also there is an additional difficulty for the amateur of excessive rotary gap-speed.

—30—

QRD? de GY

by JERRY COLBY

THAT is one essential public utility loss is the defense industry's gain in the case of Matt Murray, erstwhile Los Angeles Police Department radio technician. And radioman par excellent! Although Matt wasn't the Chief he filled in when the Chief was out on a binge or some such thing. Right now Matt is doing noble duty as a test engineer with *Consolidated Aircraft Corp.* down San Diego way. Sez Matt, "I felt that a few extra bombers for the boys would kinda stop them tripe so I pitched in to lend another shoulder to the wheel." And it looks like he's doing same. Good luck, OM.

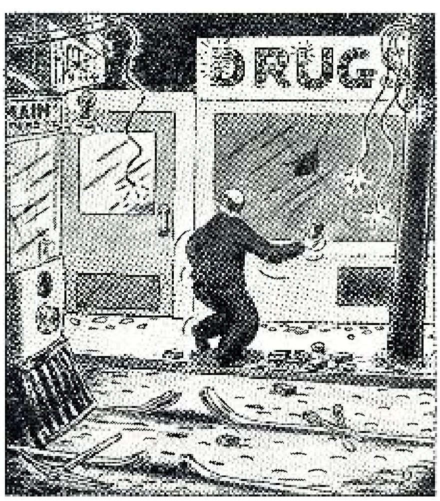
BILLET openings please note: Sam Greco, ex W8BW asks, "Where can an old ham op who has held an operator's ticket for the past twenty years and has a physical deformity not interfering with his getting around well enough to run a radio service business get a job? So if any of youse Personnel Managers can find a spot for a good radioman how's to drop us a line which will be forwarded. He may just have false teeth. Quien sabe?

AND Brother C. A. Waggoman out of Port Arthur, Texas, asks what'll he do with a First Class 'Phone ticket and a Second Class Telegraph ticket if his eyes or his ears or his age (40) might keep him out of the Navy? He would rather not get on a tanker inasmuch as "I have heard that a man from here is on one and only gets $90.00 as radiop and $25.00 as clerk." This t'aint the way we heerd it from the union bulletins. It seems that crossing bridges before they arrive is one sure way of getting gray haired and nervous indigestion. So for the sake of good health we'd suggest waiting for the *Navy* pill specialists to hand out their official NG. If any reasons for non-entrance should be observed it would then be soon enough to find a billet in the *Merchant Marine.* From all the reports we've had they can sure use a good radiop. So hang on to your tickets 'cause you'll be using them sooner than you think.

WELL, Brother Harold Craig seems to have gone and done it. Yeh, it must be in the air, spring or no spring. Although the institution of marriage is age old, the novelty of getting a knot tied is still being relished by the best of men and Brother Craig seems not to be any different. This will not come as a shock to his many friends who have known the many bachelor years HC put in. And we hope that he has only smooth sailing days ahead and clear skys.

CB BOLVIN who has been holding down the midwest's correspondent billet for ye ed up and "took a duration leave from the PD and went to work for this outfit *(War Department, Aircraft Radio Labs).* Am doing inspectional work at contractors plants in the Chicago area at present. He sez, "Re the priorities, it's true that the PD usually ends up with what they need but sometimes it is a long wait these days. An "A-10" is wastebasket stuff for most manufacturers now and that is the rating the Police Departments get. "A-1-A" is the only thing that gets action, and I could tell you about plants which won't even accept anything lower than "A-1-K" for their books. Don't feel badly when the tire Board doesn't give. There are many departments in Uncle Sammy's own organization wondering what they did to deserve the ratings issued to them. . . . From up Lake Michigan comes the report that the Navy has taken over at WMW, Manitowoc, Wisconsin, and that they wanted the gang there to take a cut in pay. I don't get it. Whatever the real dope is,

(*Continued on page* 80)



"Removing local interference."

TECHNICAL BOOK & BULLETIN REVIEW

"FREQUENCY MODULATION," by August Hund, Member of Navy Radio and Sound Laboratory, San Diego, Calif. Published by *McGraw-Hill Book Co., Inc.,* New York, N. Y. 368 pages plus index, 6x9. Price, $4.00.

Frequency modulation is a new development in the art of radio, and short cuts should be used only when the features that frequency modulation stands for are not violated. The main features are high fidelity transmission and a modulation system that avoids some of the interference otherwise occurring in the transmission by means of carrier currents. A thorough knowledge of the principle's underlying frequency modulation is essential to an appreciation of the design necessary for the apparatus. The purpose of this book is to present an engineering text on F.M. covering both basic principles and the design of commercial apparatus. The practical applications that are prescribed follow closely good present day engineering practice. The text is divided into five chapters and an appendix. The first deals with fundamental relations and discusses noise interference and wave propagation in the upper megacycle range of carrier frequencies, which are of concern in F.M. systems. Chapter 2 deals with auxiliary apparatus such as frequency modulators, frequency discriminators and amplitude limiters. Chapter 3 gives descriptions of all commercial F.M. transmitters manufactured in this country. Chapter 4 gives a detailed description of F.M. receivers. Chapter 5 deals with receiver and transmitter aerials as well as with features such as are being used in the range of frequencies assigned to F.M. stations.

This up-to-the-minute treatise is a most valuable reference and study guide, and should be included in every engineer's library. It will also serve admirably as an informative text book for the student.

"MYE TECHNICAL MANUAL," published by *P. R. Mallory & Co., Inc.,* Indianapolis, Ind.

This new technical manual has found wide application with students, servicemen, and engineers and by personnel of our Army, Navy and Marine Corps. It consists of 392 pages of up-to-the-minute and practical information. It bridges the gap between radio theory and actual practice. Many topics are discussed, and the contents of the book are profusely illustrated with colored drawings.

Chapters appear which deal with loud speakers and their use, superheterodyne first detectors and oscillators, half-wave and voltage-doubler

(*Continued on page* 62)

AVIATION RADIO COURSE

by PAUL W. KARROL

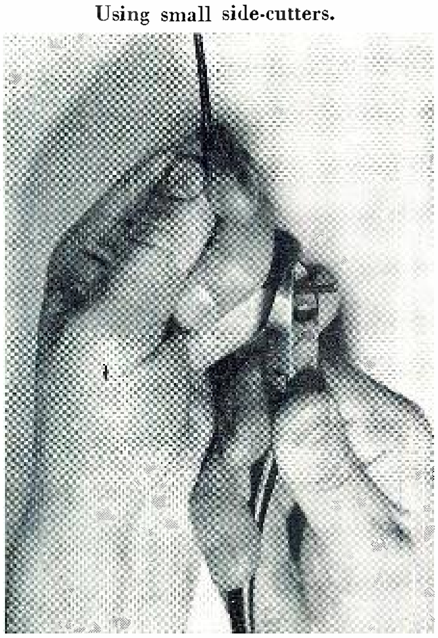
Part 9 of the series tells what techniques are employed by radio personnel at a typical airlines communications plant.

N AN aircraft radio factory, aircraft radio equipment is designed and constructed to the most exacting specifications and must be capable of performing in a manner suitable to specific service requirements. The conservative ratings involving distance coverage, equipment stability under stress, power capabilities, etc., are such in scope that under the most trying circumstances the equipment will render the service required. But regardless of the efforts taken to perfect design and set construction, aircraft radio equipment is only as efficient as its operator. The same applies to ground radio apparatus.

Operating the radio equipment aboard multi-motored aircraft is no simple matter and requires personnel trained specifically for the task because of the numerous considerations involved. The radio operator must know what is expected of him in the air before the aircraft he is to operate in, leaves the ground. This requires "ground schooling" and apprentice flight training. Formal class room instruction, working under the tutelage of experienced instructors, and actual supervised "flight-radio" operation (apprentice flight training) are prerequisite to becoming a qualified aerial radio operator.

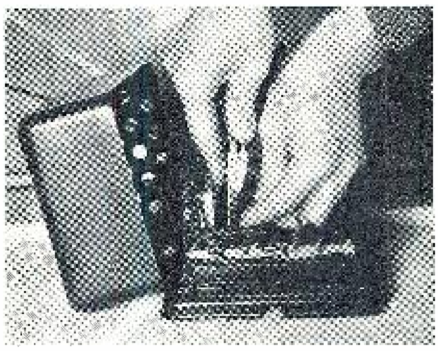
Equipment limitations must be known by the operator as well as the operating routine and procedure used by the agency by whom he is employed.

Using small side-cutters.



It is not enough that he know the International Morse Code and be proficient in its employment, but he must also know the thousand and one minor details which are positively essential to good operation.

In order to acquire the knowledge necessary for an aircraft radio operator's berth, a person should of course



Long-nose pliers for tight places.

learn the International Morse Code and attain a speed of at least 35 words per minute; that is, be capable of receiving and transmitting 35 words per minute, five characters to a group, for at least five minutes. He then must learn commercial radio procedure. This can best be learned by attending a school specializing in the training of sea-going radio operators. After studying enough theory to secure a Second Class Radiotelegraph License with phone indorsement, it will be necessary that he understand the equipment he is to operate and the station routine required by various agencies employing aircraft radio operators. The last two mentioned can be easily acquired by working with trained operators, as mentioned above.

The aircraft radio operator has a very responsible position. This may be readily understood by delving into his specific duties.

In addition to transmitting position reports to ground stations during a projected flight, he must receive weather and route information; dispatch messages for passengers and Captain of the crew; assist the navigator by taking radio bearings or transmitting to ground d.f. stations in order that they may take bearings on the aircraft and transmit these back to the aircraft; send reports to craft at sea and in the air, such as weather information, position of other craft, whether in the air or on the sea, etc.; and take care of distress work.

The military aircraft radio operator's duties are very similar to those given above. With a maximum of two weeks training he could readily qualify as a scheduled aircraft (commercial) radio operator, if he possesses the proper code speed.

An ocean going radio operator would only need, on the average, about one week to qualify as an aircraft radio operator because his duties closely parallel those of the air operator. On the other hand, it would take a ground radio station operator who has no knowledge of the code (such as those found in some broadcast stations) at least five months if the study of code is pursued diligently.

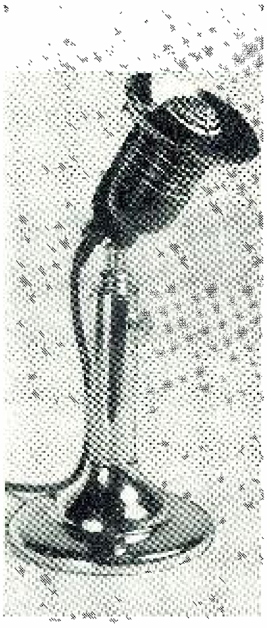
When an aircraft radio operator climbs into his plane, settles himself before his operating table, arranges his log, checks his equipment, and awaits the take-off signal from the Captain, you may rest assured that he knows exactly what he is going to do during the whole trip; of course, barring unforeseen exigencies.

As soon as the aircraft leaves the ground he calls the ground station and makes a final check on his equipment. The pilot does likewise with his equipment which consists usually of a receiver, transmitter, interphone system, etc. (The co-pilot will ordinarily assume the duties of "command radio operator.")

At regular intervals (or when necessary due to the urgency of traffic) the radio operator will contact the base station just left or another station enroute, and send position reports (position as taken by navigator after last contact); reports on the weather;

(*Continued on page* 77)

Stripping wire with side-cutters.



Inductor mike.

MICROPHONES— HOW TO USE THEM

by **WILLARD MOODY**

An interesting analysis of representative types of microphones that is designed to apply to all makes and models now in professional services.

ALEXANDER GRAHAM BELL transmitted a complete sentence between two points in March, 1876, and proved the carbon mike would work. Fig. 1 shows a drawing of such a mike, the familiar single button carbon transmitter. Even today, because of its high sensitivity, this mike is often used in communications. The modern telephone is an example of a highly refined carbon transmitter. Manufactured from anthracite coal, the carbon granules in the mike may number as many as 3,000, which tends to make the resistance vary uniformly when sound is impressed on the diaphragm.

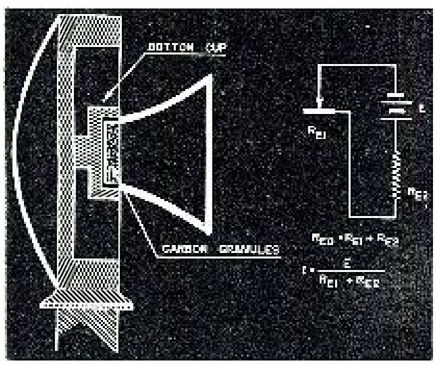


Fig. 1. Cutaway of single-button mike.

A typical carbon mike has a response which is fairly flat from 100 to 1,000 cycles, with a peak at 1,500 and a gradual loss of voltage output from 2,000 to 5,000 cycles per second. The front and rear electrodes of such a mike usually are mounted in a cup like arrangement, using a mica washer which is clamped rigidly in position and is fastened to the front electrode. This electrode is free to vibrate when sound is impressed on it. The moving diaphragm is secured to the front electrode stud and is held in position by damping springs, which serve to prevent the diaphragm from resonating at its own mechanical period. This cuts down on distortion.

A typical mike of good quality is the *Stromberg Carlson* Model 6, which has an output of —20 db with reference to a standard power level of .006 watt. Its current is 15 ma. at 1.5 volts and it has an impedance of 100 ohms. As most mikes are rated on the basis of standard pressure of 1 bar (one dyne per centimeter^2) we may assume this mike gives rated output for 1 bar sound pressure input. Talking into a mike in an average conversational tone at a distance of about 10 inches results in the development against the diaphragm of a 1 bar pressure. In such mike circuits a steady d.c. current flows, an alternating current and harmonics. The diaphragm is stretched tightly to make its mechanical period higher than any frequency in the band of audio frequencies which are to be reproduced. The more the diaphragm is stretched, however, the greater is the loss of sensitivity.

Double Button Mike

Distortion can be reduced by using a push-pull arrangement which cancels the even order harmonics. A mike of this kind has a curve which is fairly flat from 90 to 7,000 cycles in a typical case. The carbon hiss, however, makes such mikes unsuitable for broadcast transmission. A drawing of this mike is given in Fig. 2. A .002 inch thick duralumin diaphragm is usually used, with the carbon buttons in contact with a gold plated spot on the diaphragm. Because the diameter of the carbon granules is .005 inch, they stay in place and don't fall out, yet are free to move in the cup. The *Universal* XX has an impedance of 400 ohms, output of —50 db with .006 watt level, requires a 3-volt battery and has an overall range of 100 to 4,000 cycles.

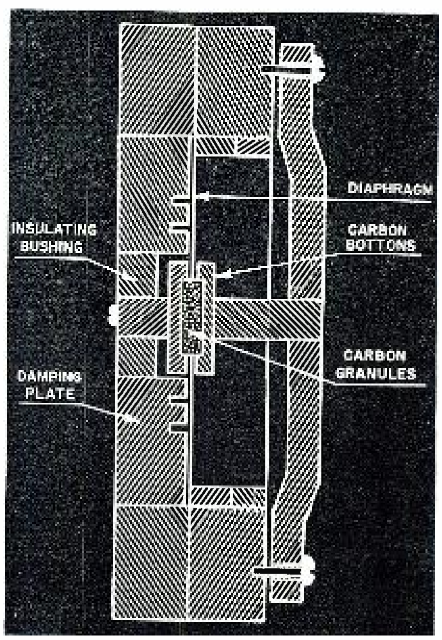
Carbon Mike Troubles

The resistance of each button circuit must be balanced to prevent distortion. Packing may be caused by too great pressure between points of contact or by "sticking" due to excessive current. Decreased resistance and sensitivity of the mike indicates packing which then requires that new carbon granules be installed. In radio broadcasting, loud musical passages cause carbon mike packing, and for this and other reasons such mikes are not used in studio work but find application in the field of special events. A milliameter in each side of the mike circuit permits easy balancing.

Condenser Microphone

This form of mike is seldom used in

Fig. 2. Double-button mike construction.



modern radio. A drawing of it is shown in Fig. 3. Having a high impedance, it must be built into a head containing a stage of pre-amplification to avoid severe losses in a cable coupling the mike to the audio input. The capacity usually is about 220 to 400 $\mu\mu$fd. and the steel plug, and diaphragm of .0018 inch duralumin, are separated about .0015 inch. The diaphragm is stretched close to its elastic limit to get the resonant mechanical frequency above the highest audio frequency to be reproduced. The output is about —60 db and varies with temperature.

Dynamic Microphone

This type is shown in Fig. 4. Sound pressure produces movement of the diaphragm which has a coil attached and a voltage is induced in the coil as the result of cutting the magnetic lines of force set up by the permanent magnet. This voltage is,

$$e = Blx$$

where e = voltage output
B = flux density of electromagnetic field, gausses
l = length of wire in the coil
x = velocity of the moving coil

The W.E. 630-A is typical, has an output of —80 db with reference to a level of 1 volt per bar. Its impedance is 30 ohms and range is from 40 to greater than 10,000 cycles per second. Because of the spherical shape it is sometimes referred to as the "8 ball." The pick-up characteristic is non-directional.

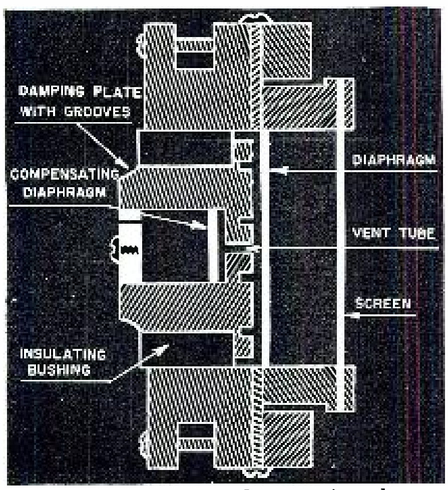


Fig. 3. Cutaway of condenser microphone.

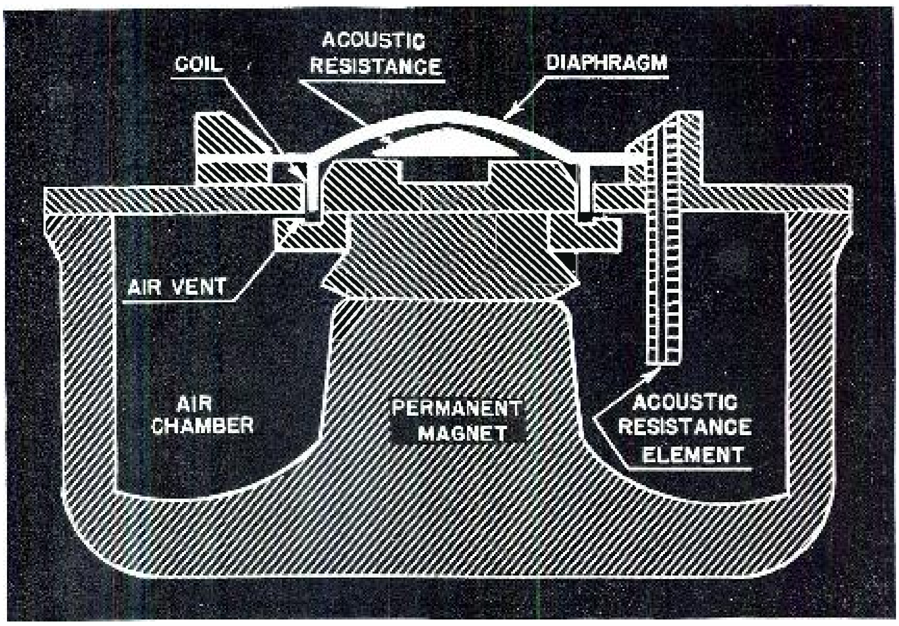


Fig. 4. The dynamic microphone uses a permanent-magnet.

Inductor Mike

Voltage is generated in a conductor secured to the moving aluminum diaphragm and a bolt of silk forms a mechanical-acoustic resistance. To increase rigidity, the diaphragm is slightly concave with supporting edges corrugated to give correct compliance. A strong magnet supplies the field flux in which the .07 ohm conductor moves. The impedance with transformer is 250 ohms and output is 70 db with reference to a 12.5 milliwatt level. (RCA 50-A.) The mike is rugged and not affected by ordinary shock.

Velocity Microphone

In Fig. 5 is an example of this type mike. Pressure type, open to air on one side, it is terminated in an acoustic impedance on the other side and has a cardioid pick-up pattern, similar to that of a loop antenna with sense antenna connected. Typical of this form is the RCA 77-A, with output of .317 volt across 250 ohms for an input of 10 dynes per sq. cm. and on open circuit the output is —89 db with reference to a 12.5 mw. level and sound pressure of 1 bar.

Velotron Microphone

This mike uses a ribbon moving in an electrostatic field, with response controlled by variation of the polarizing voltage. The circuit looks something like that of a condenser mike system, except the moving element is a ribbon.

Crystal Microphones

Basic construction is shown in Fig. 6. The voltage output is in phase with the sound pressure. The output voltage is proportional to the movement of the crystal produced by sound and the force required to produce a movement is proportional to the area on which the sound acts and to the pressure. A typical mike is the Brush AR 26 which has a range of 30 to 10,000 cycles, flat within plus or minus 3 db. Output is —66 db for a level of 1 volt/bar. A laboratory mike made by this company has a range of 30 to 20,000 cycles, flat within 1 db, and output level of —86 db for 1 volt/bar. Crystal mikes must not be used in temperatures above 130° F. as they permanently lose piezo-electric properties if this temperature is exceeded. The lower limit is —40° F.

Practical Mike Circuits

The set-up shown in Fig. 7A can be used for small transmitters of the portable type. The mike is a single button carbon and will give 3 to 6 volts peak across the grid resistor. Usually it is best to connect a single dry cell and to avoid fussing with battery adjustments, especially where untrained operators must use the equipment. In Fig. 7B the circuit for a crystal mike is shown. This type is relatively simple to hook up and the quality is good. However, crystal mikes won't stand any great amount of abuse and where shock is anticipated this mike should not be used generally speaking. The output will be about 1 millivolt from grid to cathode, assuming a reasonably short mike cable. In Fig. 7C, the double button carbon transmitter is shown.

A milliammeter may be used in breaking the circuit at points marked

(*Continued on page* 72)

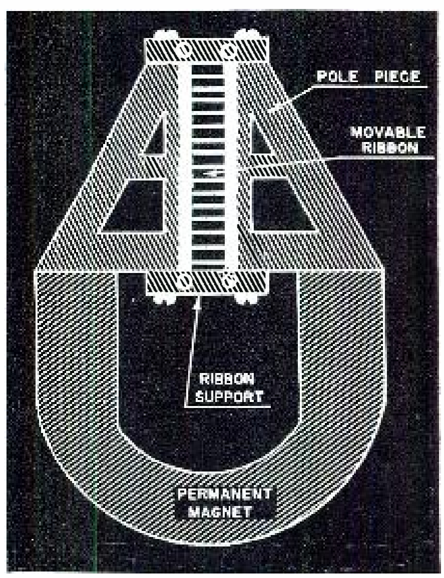


Fig. 5. The ribbon mike is still popular.

Spot Radio News

IN DEFENSE AND INDUSTRY

Presenting latest information on the Radio situation.

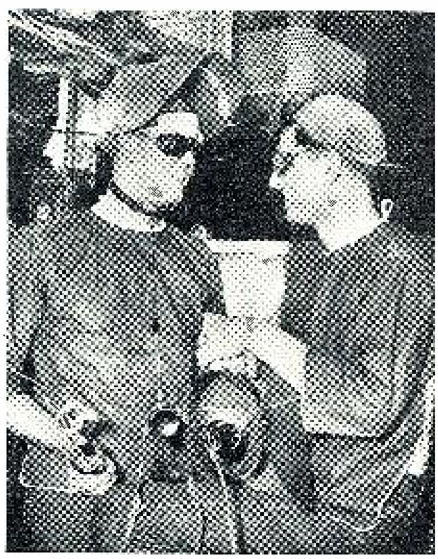
by LEWIS WINNER
RADIO NEWS WASHINGTON CORRESPONDENT

RADIO IN CHINA HAS NOT, as yet, unfortunately reached into the homes of many of the millions in China. Because of the vast distances, geological problems, and the innate peculiarities of the people in China, it has been difficult to establish this contact, supply all of the transmitting points required and provide, too, the millions of receivers that are necessary. This lack of receivers has been greatly emphasized since the beginning of the Sino-Japanese war and now, particularly, with the waging current global war. Such were the comments of T. Y. Low, Deputy Chief, Film Section, Military Affairs Commission, Government of the Republic of China, during an interview at the recent Society of Motion Picture Engineers Convention held in New York City, where Mr. Low was a featured talker. In view of this condition, Mr. Low explained it was necessary to use motion pictures. Mobile trucks, carrying such motion picture equipment, travelled in one instance to inner Mongolia and during a period of twelve months entertained over a million and a half persons. These persons travelled up to 200 miles to attend these showings. And as many as four thousand were in attendance at any one time. Many of the films were American with a dubbed-in translation. The translation, of course, was a visible one which appeared on the film as the persons spoke. This visual-sound method of entertainment and instruction was found to have tremendous sway. It is believed, therefore, that such a presentation which is naturally international in scope, presents an important possibility for the future of television in China. There is no doubt that such equipment is more expensive than the radios, of which there are so few now, but since one television receiver can entertain many and since it has such dynamic appeal, its application promises are high. The possibilities that television offers, particularly when used in mobile units, are thus beyond the human scope of imagination.

THE PRESENT EMERGENCY HAS PROMPTED MANY UNUSUAL INNOVATIONS. One of these recently discussed, concerns the adoption of an inter-communication system in motion picture theaters. It is quite evident that means of communicating between the booth and other sections of the theater are very essential in ordinary times and thus particularly so during possible emergencies. Although present plans are not very complete, it appears, though, that both the ultra-high frequency reflecting system as well as the telephone system may be used. The radio system, of course, has the advantage in that it is completely mobile, or portable, and thus does not restrict the receiving or transmitting points. Some demonstrations held with these "walkie-talkies" have been very successful. Of course, there is the problem of FCC licensing. In view, however, of the importance of the project, it is very probable that such permission will be granted when the systems are finally adopted.

THEY WON'T BE MAKING SHORT-WAVE sets in Germany any more, or rather, short-wave sets for Germany will not be available any more. Domestic sets for use by listeners in Germany, which are now being made either in Holland or in France, will hereafter be capable of receiving only the Deutschlandsender and other local transmitters. By curtailing this manufacture, they hope to stem the tide of the tremendous short-wave program of the Allies. It is, fortunately, a bit late for this move, since millions have short-wave sets and millions more will be made in shops and cellars by the dexterous people of the occupied countries, so that *they* can hear the *truth.*

Special Intercom unit for welders.



IN A RELEASE RECENTLY SENT OUT BY THE FCC, covering the discontinuance of ham license grants, the FCC said that "the call letters of outstanding amateur station licenses will be reserved for assignment to the present stations licensee upon proper application when licensing of amateur stations is resumed, *insofar as it is possible and practicable to do so.*" It did appear, therefore, as if call letters might be shuffled a bit. However, the FCC did not mean that they will disrupt this identification custom, but rather that they may have to use certain call letters and frequencies during emergencies that will call for possible changes. This is a remote move and it does appear as if the call letters, of which so many hams are proud, will be back again with their original owners when it is all over.

F-M SEEMS TO BE GOING ALONG on its own merry way to the delight of thousands. Recently compiled statistics show that F-M enthusiasts have an average of as much as 10½ hours of service. Of course, there are areas in which 24-hour service prevails and there are still others in which the 6-hour minimum required by the FCC is in force. The latter is in the minority. Although at the start F-M programs were mostly duplicates of those presented on A-M channels, today over 73% is non-duplicated. As a matter of fact, there are eight stations whose programs are entirely conceived and prepared for F-M transmission. Reports show that there is very little likelihood of any of the F-M stations curtailing their operating schedules. Of course, it may be necessary for some of them to reduce their schedules because of their inability to secure replacement parts or tubes. We hope, of course, that this will be in the very distant future.

It is interesting to note that Westinghouse already has four F-M stations, the latest one of which is W49FW at Fort Wayne, Indiana.

RADIO WILL BE BRITAIN'S NUMBER 1 national entertainer this winter, say the editorials of London's papers. It is important, they say, that dealers and radio service men who remain at the home front, see to it to the best of their ability, that every radio set in use is maintained in working order so that the great work of the broadcasting service of England can continue. It's "Keep 'Em Playing" in England as in America.

THEY'RE ASKING FOR MORE AND MORE WOMEN for service in radio in the military and civilian. There are jobs in nine branches of the war service. For instance, the Civil Aeronautics Administration offers a six-month course at $1,440 a year. Upon completion of the course, there is an advance to $1,620 and further advancements further on. The position is entitled "Trainee Junior Aircraft Communicator."

For the Army air forces, women student instructors are necessary. Novices will get $1,620 a year and experienced instructors will get $2,000 a year. There are four schools in operation. Their locations are . . . Scott Field, Illinois; Sioux Falls, South Dakota; Madison, Wisconsin, and another in Chicago. At the Signal Corps General Development Laboratory in Fort Monmouth, N. J., women from 16 to 50 are being paged for a six-month course which pays $120 a month with an increase to $135 upon completion of training. Lieutenant John T. Freeman, who is the assistant personnel officer, has the job of looking for and training women.

At the Bureau of Ships, Navy Department, in Washington, Lieutenant L. B. Wheeler is asking for applications for women in the radio section. Salaries offered are $1,400 to $1,800 for new comers. College graduates earn from $2,000 to $3,200 a year. Other naval departments requiring women include the Naval Ordnance Laboratory and the Naval Research Laboratory. At Naval Ordnance, Ralph Cautley is in charge and at Naval Research, Fred A. Pierce is the man to see.

The famous research unit at the Radiation Laboratories Massachusetts of the Institute of Technology is also on the look-out for women. In this division, appoints are by contract and the salaries start at $1,500 a year.

The Army Signal Corps has already begun training members of the WAAC's to replace enlisted men as radio operators and radio mechanics in Army Air Force headquarter companies. The training is being conducted at the Midland School, Kansas City, Missouri. Those learning radio operation will receive a 13-week course. The radio mechanics course will last 8 weeks. For these courses, candidates receive code aptitude tests and trade aptitude tests. Many women formerly employed in radio plants are members of this new trainee group. Others in this new class include those who have attended special night classes at radio school and at the American Women's Voluntary Services' night school, whose efforts by the way cannot be too highly commended.

Probably one of the foremost women instructors in radio is Mrs. Dorothy Hall, wife of the well-known Lieutenant Commander Horace Hall, USN, retired. Mrs. Hall, who like many, began with radio as a hobby, is now an assistant to Professor H. N. Partridge, director of Broadcasting and Radio Instruction at New York University. She is teaching code and radio theory. Her students, oddly enough, do not include women, but rather cadet students of the Army Air Corps and many others. Mrs. Hall, it will be recalled, established short-wave communication with isolated Pitcairn Island in the South Pacific in 1938, which resulted in the shipping of food and medical supplies to the stranded members of Pitcairn Island.

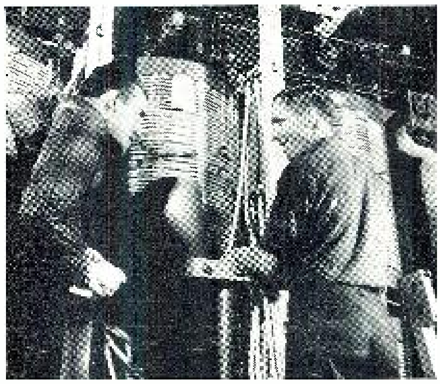
THE PUBLIC ADDRESS ENGINEERS OF ENGLAND who have their own engineering society in London, have recently adopted standard renting condition for public address devices. In these forms they have established recommended charges and solution to problems covering both merchandising and technical activities. The society has done much to mold the effectiveness of the public address engineers in England, having also solved many technical problems.

In organizing this society, not only were the foregoing problems a factor, but also the development of component standardization. The maintenance of quality public address work was also decreed as an essential. At the recent annual meeting, the reports indicated that membership has shown an increase. This was predicated, according to the officials of the society on the fact that public address work is going to be a very important factor in the post-war era and that as such, it is necessary that a solidified organization be available to act effectively.

THERE IS GOOD NEWS FOR THE SERVICE MAN from Washington. Replacement parts for receivers should be able to flow with greater consistency because of relaxations set forth in a new interpretation of order L-183. Of course, as we have said before, all of these programs are predicated on the availability of material. The new controlled materials plan should serve though to provide the necessary materials required to produce the various replacement parts needed.

Probably the greatest problem today is that of tubes. Although it has been estimated that a tremendous supply of tubes is available, surveys show that the supply isn't so tremendous. The estimated supply at the present time is approximately twenty million. When it is realized that there are over forty-eight million receivers in use and that over forty-three million replacement tubes will be required, it can be readily seen that there is quite a problem on hand. And it must be remembered, too, that tube manufacturers are producing more tubes now than the highest production schedule ever called for in peace time. As a result, raw materials have been virtually gobbled up in enormous quantities. The WPB realizes this and is making every effort to provide for the manufacture of tubes on some consistent basis so that a flow of tubes will prevail. Washington realizes that it has a very difficult project on hand involving a variety of complexities. But it also realizes that without tubes radio becomes quite a sick child. Thus, there is every belief that a solution to this awkward problem will be provided quickly.

Inspecting large Power Transformer.



THERE WILL BE A CIVILIAN "M" DAY next July 1st. On that date, Donald M. Nelson expects that the peak of maximum war production will be reached and that as a result, we shall know the worst that can happen to business and also, how far rationing will have to be extended. We should also know at that time which goods will be considered non-essential and thus which goods may or may not be continued to be made. The new controlled materials plan, which it is hoped, will provide the effective solution to the production program, will begin operating in the second quarter of 1943. At the beginning, it will be concerned only with three basic critical materials, steel (both carbon and alloy), copper and aluminum. As other materials become sufficiently critical to require control they will also go under the controlled materials plan. During the third quarter, all such materials will probably be brought into the plan.

Two classifications of allotments will be maintained under this new program. They will be identified as "A" and "B," with the class "A" products receiving their allotments with an allotment number directly from the claimants' agencies. In other words, manufacturers working on such items as tanks, aircraft, etc. generally are contracted for, by or through a claimants' agency. In the class "B" section, we have products such as radio, generators, electrical appliances and general parts frequently incorporated in other products and civilian items. These will receive their allotments from their WPB industry branches, which in turn will receive allotments through the Office of Civilian Supplies. Each claimants' agency will be able to allot for each month up to 105% of its monthly allotment. This over-allotment is intended to stimulate increased production from producers of controlled materials. Claimants' agencies will also be authorized to make allotments for future quarters on the basis of declining percentages of allotments established for the current quarter. Briefly, the plan will provide for the distribution of materials and control of that distribution so that the materials needed most to win the war will be available.

THE POPULARITY OF ELECTRONICS has gained such favor that already many associations identified with radio and electrical work have either changed their names to feature electronics or at least included the title. The most recent of the associations to consider adoption of electronics is the NEMA. They plan to change the section called Radio Appliance and Electrical Division to Electronics Division. Over at RMA they are also seriously considering the substitution of the word "electronics" for "radio." Of course, it must be remembered that electronics is an all-encompassing word and concerns the vacuum tube and its electronic properties in a wide variety of applications of which radio is one. To date, radio has probably held the greatest prominence in its association with the vacuum tube, since to a great measure, its most effective use was begun here. Of course, this is notwithstanding the use of the X-ray and other similar type tubes. It was, though, through the effective control of the electron in these radio tubes and their affiliated brethren that electronics became so important a factor. Today, of course, there are many special tubes that are used for electronic work, that have no full identification with radio. However, the inner activity of the tube resembles in most instances that of the radio tube. And thus, it is simple to see why the word "electronics" seems to have such an attractive call to many. In view, however, of the fact that radio still is a vital science in itself, involving many factors of which it is possible to call the vacuum tube but one of them, the word "radio" should be retained as an effective means of identification.

TUBES FROM OUR COUNTRY will soon see service in the receivers of England. A comparatively large number of American tubes have been exported under the Lease-Lend Act. Thus far, thirty distributors have been appointed to parcel out these tubes. A very strict control of distribution and price is being maintained. The same price ceiling program that has been adopted here is in use in England. All shops must display the ceiling price just as we do over here.

Exactly what tubes are involved in this lend-lease budget are not known but according to authorities the group is compiled of tubes that are necessary for the most popular American sets that have been sold over there. The use of these tubes in the English sets is also possible for in many instances the physical dimensions are similar. The tubes will only be sold as replacements and for repairs. A suitable certification that the tubes required are for such use, must be submitted at all times.

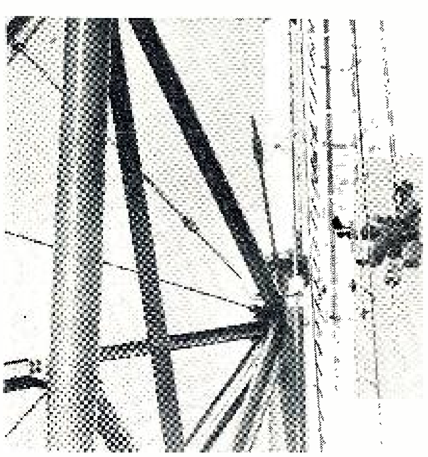
THE COMMUNICATION DIVISIONS OF OUR MILITARY FORCES and those of Britain will hereafter be more closely coordinated than ever before. Following a series of conferences between Air Commodore O. G. W. G. Lywood, Director of Signals, British Air Ministry, Major General Dawson Olmstead, Chief Signal Officer and Colonel Alfred W. Marriner, Director of Communications for the Army Air Force, epic arrangements were made to insure close cooperation of the radio and other communications divisions of these units.

While such a cooperative plan has been in operation, in effect, the plans now formulated establish more firmly this procedure. A delegation of British communications experts toured radio manufacturing plants, research and development laboratories and communications training schools to become thoroughly familiar with our latest methods and plans. Such reciprocal tours are being planned for the future so that full knowledge of British and American activities are known to each communications division.

LIGHTING HAS WON AN IMPORTANT PLACE in recording studio design today. In the recently opened recording studios at WOR in New York, the control rooms have specially designed holophane lighting that provide a new ultimate in studio lighting. Vision panels are so sloped that glare is at a minimum. This glare has been a problem since it so often interfered with the vision of production men and talent. Another feature of these new studios is the unusual dubbing room. Special equipment for dubbing has been installed in a uniquely designed and acoustically treated room, which while being adjacent to the recording equipment, is physically and acoustically isolated. Dubbing equipment consists of four dual-speed, constant velocity turntables with reproductions achieved through the use of four high-fidelity lateral-vertical reproducers. In dubbing, we have the same kind of work with sound and records, as we have in the motion picture industry with film. In the sound studio two or more previously recorded programs can be pieced together or rerecorded or live announcements can be coupled with previously recorded material. Or, it is possible to rearrange material that may have been previously recorded but out of sequence.

Other features of these new studios include variable acoustical partitions, temperature controlled recording cabinets and suitable audition and reference recording rooms.

Transmitter Antenna maintenance.



IF THE LIGHTS GO OUT AT WOR for one reason or another, commentators and announcers will still be able to see their scripts, thanks to an invisible paint that has been developed by Westinghouse. Standard typewriter ribbons may be dipped in this paint to provide characters that become luminous because of their exposure to an ultraviolet lamp. The microphone also receives this paint which becomes a glowing greenish light in darkness. Let's hope we never have to use this "black light" procedure.

SUGGESTION AWARDS ARE BEING WON by many men and women in radio plants. Former art student John Vos, who is now a radio test man at an Eastern plant, recently won $400 for suggesting an improvement. His suggestion, according to the Army and Navy officials, will save thousands of man hours and conserve large quantities of scarce materials. For making seventeen suggestions, Laura Garrison has received $350 in awards. One of her most recent ideas concerned aircraft transmitter design.

During the past ten months, the workers of one large manufacturer producing radio equipment for the Government, received over $115,000 for suggestions of over twelve thousand ideas.

THE SEND-A-RECORD to any man in the service program, is really booming these days. Not only are the department stores going at it in a real big way as we pointed out last month, but many manufacturers are sponsoring such programs, too. In New York, for instance, at what has been called "War Bond Square" a national blade maker is making records to be sent to those in service. And they're doing quite a business, but it's free.

Thus far, over 70,000 such records have been made. This particular program also extends over the various Army camps with mobile equipment cruising the camps. The records used, of course, are the six-inch paper disc style. The Government has looked upon this program with favor even though space facilities for mailing are at a premium. They believe that this campaign is a good morale builder and is thus worth the transportation sacrifice.

(*Continued on page* 67)

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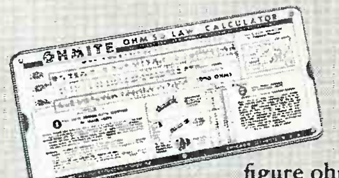

Handy Ohmite Ohm's Law Calculator

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Radio Frequencies

(*Continued from page* 9)

range between oscillation and non-regeneration.

The sole tuning control is the variable condenser, C, the dial of which may be graduated directly in kilocycles or megacycles. The input, grid, and tickler coils (L1, L2, and L3 respectively) are made changeable to afford wide spectrum coverage with the single tuning condenser. These coils are wound upon a single form for each frequency range, all three thus being changed simultaneously. The coils may be shifted mechanically either by plugging or switching.

Although the monitor may be operated from an a.c. power supply, best isolation will generally be obtained if the instrument is powered by self-contained batteries, as shown in Figure 4. The instrument case may then be employed as an all-inclusive shield to one point of which all circuit returns may be made.

The unknown-frequency signal is fed into the monitor either through a line connected to the input terminals, or by means of a small pick-up antenna fastened to the "high" input terminal. If the latter signal input is employed, the "low" input terminal will be grounded to the instrument case, as shown by the dashed line in the diagram.

The monitor, or heterodyne detector, lends itself readily to calibration. The procedure is simply to pick up a series of known standard frequencies, logging the points at which they appear on the dial. Exact-frequency sources, such as crystal oscillators or a closely-calibrated signal generator, should be employed for this purpose.

Accuracy of calibration is greatly aided by an efficient zero-beat indicator which will show when the standard signal is tuned-in "exactly on the nose." Satisfactory indicators are the magic-eye tube and the a.c. output voltmeter with fast movement. Headphones, while affording sufficiently accurate calibrations for certain requirements, generally do not permit the operator to distinguish exact zero beat. Accuracy of indication will be influenced both during calibration and operation by the type of input device. If an antenna is employed, it should not exceed a few inches in length—and the same antenna must be employed for operation and calibration as well. This is because, the regenerative detector may be detuned somewhat by the input device.

Selectivity of the instrument, during calibration and subsequent operation, is improved by loose coupling between L1, L2, and L3 and by employing the minimum amount of regeneration necessary for satisfactory operation.

The monitor may be used in one of two fashions: (1) as a direct indicator of the signal frequency, or (2) as a means of comparing an unknown with a standard frequency.

The accuracy afforded by the first method of operation will be governed by stability of the detector, regularity of checking the instrument against standard frequencies, precision with which the dial may be read and reset, and efficiency of the zero-beat indicator. When the second method of operation is used, monitor dial readings are of no consequence, deviation of the unknown from a standard-frequency fundamental or harmonic being determined by measuring the beat note between the two with still another instrument.

The accuracy of measurement, which at top operating efficiency may become a few thousandths of one percent, depends therefore entirely upon the accuracy with which the beat note may be measured. With a high-grade audio oscillator or a.f. standard as the beat note identifier and a cathode ray oscilloscope as the indicator, high orders of accuracy are obtainable.

Frequency Meter-Monitor

Another rapid method of measuring radio frequencies consists of "locating the signal frequency" with a highly stable variable-frequency r.f. oscillator. Zero beat between the oscillator and the unknown signal is indicated

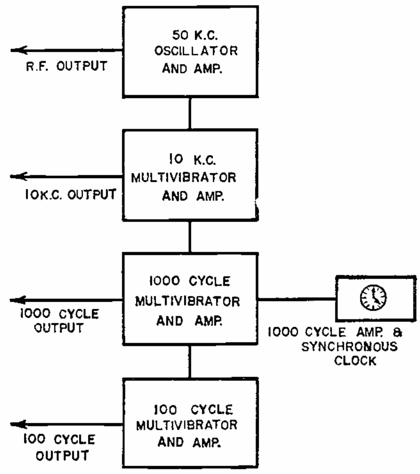

Fig. 10. Block diagram of freq. standard.

by a suitable detector-amplifier-indicator line-up, and at zero beat the signal frequency is read directly on the oscillator dial.

A functional block diagram of equipment for this system is shown in Figure 6-A. This apparatus, combining the monitor principle previously described with a self-contained reference standard (oscillator) has been used widely in amateur and experimental stations. It has been termed *frequency meter-monitor* or *heterodyne frequency meter*. Employing the heterodyne principle, it is capable of highly accurate frequency indications.

Some simplification of the basic circuit arrangement is possible. For example: it is not necessary that the monitor portion of the circuit be tunable, since this stage functions merely as a mixer. The final working circuit

(Figure 6-B) therefore contains an *aperiodic* detector as the monitor stage. Likewise, it is not necessary that the oscillator portion of the circuit be tunable throughout to fundamental frequencies in the working range of the instrument. The oscillator tuned circuit may be designed to cover some appropriate low-frequency band, whereupon harmonics of all settings in that band will be available for higher-frequency measurements. The oscillator might, as an example, cover 500 to 1000 kc. on fundamentals. On second harmonics, 1000-2000 kc. would be covered; on third harmonics, 1500-3000 kc.; etc. An additional advantage of the single-band tuning arrangement is the necessity for only one coil which may be mounted rigidly in the circuit, offsetting the numerous vagaries of plug-in or switched coils.

Frequency Standards

In modern practice, highly accurate standard frequencies for calibrating or measuring purposes are generated in the laboratory or at the communications monitoring center by *frequency standards*. These equipments operate upon fixed frequencies so chosen that their harmonic points mark the entire radio frequency spectrum. Because of the fixed-frequency scheme, a highly-stabilized crystal oscillator may be employed as the basis of a frequency standard. The lower the frequency of this oscillator, the closer together will be the standard-frequency harmonics afforded.

Emissions from a frequency standard may be employed directly in the calibration of receivers, monitors, heterodyne frequency meters, and similar devices which make use of received signals directly. They may likewise be employed in the identification of radio frequencies by the comparison method, and in the calibration of wavemeters, r.f. oscillators, and similar instruments which require the intermediary of a monitor or receiver circuit.

The *frequency standard* derives its name from the fact that other frequencies may be referred to the emissions of this instrument as the final authority. The fundamental frequency of the *standard* assembly is accurately maintained and does not deviate from its rated value by more than a few cycles per megacycle at any instant between periodic checks of the equipment.

The frequency standard itself is in turn referred to some accepted source for adjustment. This source is either (1) a strictly maintained radio station carrier, (2) the national primary frequency standard maintained by the Bureau of Standards, or (3) standard time. The accurate emissions of the national primary standard are made available indirectly through standard frequency transmissions from the Bureau's radio station WWV, while standard time signals are supplied to the entire country through broadcasts from the *U. S. Naval Observatory*. Both of these services are now available on a daily basis.

Depending upon whether the frequency standard is referred for adjustment directly to (1) standard time, or (2) to some other radio emission such as WWV transmissions or radio station carriers, it is referred to as (1) a *primary standard* or (2) a *secondary standard*. This is the reverse order of their simplicity.

Secondary Standards

A stable low-frequency oscillator (Figure 9-A, B) makes the simplest possible secondary frequency standard. The fundamental frequency of this oscillator, and its harmonics afford a number of calibration points which extend far into the spectrum before they grow too weak to be useful. The unit is "standardized," like other more elaborate secondary standards, by correcting its oscillator frequency according to some known standard frequency.

The number of spot frequencies provided by any standard increases as the fundamental frequency of the unit is lowered, since harmonics are closer together for the lower frequencies. The frequency of the simple oscillator or of the oscillator unit of a complex standard as well will therefore be made as low as possible.

Since it is desirable to employ crystal control in the oscillator stage, the practical lower-frequency limit for crystal plates will govern the lowest value of frequency which may be chosen. For convenience and economy, as well as for general usefulness, 100 kc. is employed as the basic frequency in a large number of secondary standards. However, 50-kc. oscillators are to be found in the highly-refined and more expensive laboratory frequency standards. In the first case, spot frequencies are provided at 100-kc. intervals; in the latter case, at 50-kc. intervals.

The quartz plate employed for oscillator stabilization is maintained at constant temperature by a suitable oven unless the plate is specially ground to have zero temperature coefficient. Oscillator tube voltages are automatically regulated by one of the well-known methods.

Utility of the frequency standard is increased still further by addition of one or more multivibrator stages to provide intermediate spot frequencies between the oscillator harmonics. The multivibrators are special resistance-capacitance oscillators which are synchronized with the oscillator and function as frequency dividers—dividing the oscillator by their own fundamentals.

Multivibrator theory and operation has been covered in several previous articles on these pages and will not be repeated here. Suffice to say that these stages may be synchronized at frequencies which are either harmonics or sub-harmonics of the oscillator frequency and that they will then sup-

ply stable harmonics of their own frequencies or direct output, as shown in the block diagrams, at their own fundamentals.

Figure 9-C shows how 100-kc. and 10-kc. points are obtained from a 50-kc. oscillator by means of multivabrators. 9-D shows the popular 100-kc. oscillator-10-kc. multivibrator combination which is the basis of most amateur frequency standards. 9-E illustrates the use of a 1000-kc. oscillator with 100-kc. and 10-kc. multivibrators. A secondary standard of this type is shown in Figures 3 and 5. The particular utility of this layout for a secondary frequency standard is afforded by the 1000-kc. oscillator frequency, harmonics of which are useful at very high radio frequencies.

The use of multivibrators with any of the frequency standards shown in Figure 9 is not restricted to the frequencies of operation shown. They may be used at still higher or lower frequencies and in tandem. Stabilized frequencies as low as a single cycle per second may be obtained. Likewise, additions may be made to any of the circuits. A very useful stage, not shown in the block diagrams, is a harmonic amplifier employed to intensify some band of harmonics from the frequency standard. The harmonic amplifier tuning control is easily visible in Figure 3.

Means are provided for correcting the secondary standard according to some standard emission. For example, a small tuning condenser is frequently connected in series or in parallel with the crystal to permit the frequency of the latter to be shifted slightly to bring the oscillator in step with the standard frequency. In other units, variable air-gap holders house the crystals and adjustment of the gap gives the same result.

Primary Standard

From the foregoing discussion, it is seen that all frequency standards are high-precision signal generators. The secondary standard must have its frequency corrected periodically against some recognized standard frequency. The primary standard, on the other hand is corrected by reference to standard time, which is the basis of frequency.

A primary frequency standard is shown in the photograph of Figure 7, and in block diagram in Figure 10. While the diagram does not show *all* of the refinements contained in this instrument, the salient features distinguishing it from the secondary standard are readily visible.

A portion of the output voltage developed by the 1-kc. multivibrator is amplified and used to propel a 1000-cycle synchronous electric clock. This clock will keep correct time, therefore, as long as the oscillator frequency remains 50 kc. Deviations in oscillator frequency will show up as time drifts when the clock is checked against standard time. The principle involved is that 50,000 vibrations of the oscillator crystal are necessary to drive the clock 1 second ahead. A positive frequency drift will cause the clock to be driven farther than one second, while a negative drift will retard its progress. By checking regularly against *Naval Observatory* time signals, once during each 24 hours, the total oscillator drift in cycles for the 24-hour period may be ascertained. The oscillator frequency may then be corrected either positively or negatively, as required, this operation being repeated until the frequency drift becomes zero or of negligible value.

The primary standard is the most refined of all frequency-generating equipment. By maintaining the temperature of the oscillator crystal very minutely (usually plus or minus one-hundredth degree Centigrade about operating temperature) and by regulating the operating voltages carefully, the highest order of frequency stability is secured.

Methods of Using Frequency Standards

Various pieces of frequency-generating or frequency-determining equipment may be calibrated directly from the secondary standard, as pointed out previously. The secondary standard is calibrated directly from some primary standard which may be an instrument, *per se*, or a standard-frequency radio signal.

Associated with most permanently-situated frequency standards is a measuring rack containing (1) a low-frequency oscillator, (2) heterodyne frequency meter, (3) variable-frequency audio oscillator, (4) harmonic selector, and (5) beat indicator. According to one method of using this equipment, the frequency of a received signal may be measured with an accuracy of approximately 20 parts per million. The heterodyne frequency meter is set to zero beat with the received signal. The reading of the frequency meter dial is noted. Frequency meter readings are then obtained for the nearest spot frequencies (from the frequency standard) above and below the received signal, and these dial readings noted. By interpolation on the frequency meter dial, the signal frequency may then be determined.

Another method which permits an accuracy of 1 part per million consists of the following operations: A beat note is obtained between the unknown signal and a known harmonic of the 10-kc. multivibrator. The beat frequency is measured by means of the audio (interpolation) oscillator, adding or subtracting this beat frequency from (or to) the multivibrator harmonic, depending upon whether the signal is seen to appear above or below the stand-frequency harmonic.

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Emergency Receivers

(*Continued from page* 29)

common with this type of detector and it is accordingly not as readily subject to vibration as the light-contact crystals. However, there is widespread belief among experts in the field that the slight superiority obtained with the carborundum crystal is not worth the battery requirement.

Notes on Crystal Operation

Radio detector crystals are extremely susceptible to soiling. Consequently, it is imperative that greater than ordinary care be taken to keep them clean at all times. Not only must they be protected from dust and dirt, but likewise from oils that may be transferred from the hands. The mineral surface should never be touched by the fingers, all handling being done with tweezers or by grasping the metal mounting in which the mineral is set.

Galena and similar light-contact type crystals are readily subject to vibration and may be thrown out of adjustment by this cause. When important receptions are to be made without interruption, the crystal set of this type should be mounted on sponge rubber or suspended by cords or elastic bands.

Heavy static discharges will impair, or completely destroy the spot sensitivity, as will also high-voltage signals from closely-coupled local sources such as oscillators or transmitters.

The length and height of the antenna required by a crystal set will depend upon the sensitivity of the crystal, the Q of the tuned circuit, and upon the nearness and power of the stations to be regularly received. In some localities, particularly where local transmitting stations are situated within five or ten miles of the receiving point, crystal receivers may be operated with bed-springs or insulated window screens as antennae, or with short lengths of wire strung vertically to the ceiling.

Contact Detectors

A light, imperfect contact between two metallic surfaces possesses limited ability to rectify r.f. currents. For example: a fine-wire cat-whisker, whose point rests lightly upon a metal terminal, will form such a detector. The cat-whisker of a crystal detector resting upon the metal crystal cup instead of the mineral has been known to deliver perfect signals as long as the lightness of contact was "critical."

Considerable delicacy of adjustment is necessary to obtain maximum sensitivity which, at best, is somewhat inferior to crystal in most cases. The writer finds that some improvement in sensitivity is obtained by employing dissimilar metals for the contact, copper and platinum having given the best results in his tests.

A very interesting experiment was made on a contact tested detector which consisted of a length of pencil "lead" resting lightly on the edges of two double-edge safety razor blades which were "cut into" a wooden base for support. This rectifier proved surprisingly sensitive, however it exhibited considerable microphonic action as well, reproducing nearby speech and noises as well!

Contact detectors may be employed in place of the crystals in any of the circuits shown in Figures 1 to 6.

Contact detectors are highly important for use in emergencies when no other rectifying devices are obtainable. However, the extreme delicacy of their adjustment causes them to be easily disturbed by vibration, hence other types are preferable, except where an emergency leaves no other alternative.

Oxide Rectifiers

Miniature copper oxide or copper sulphide instrument rectifiers may likewise be employed in place of the crystal detectors in any of the circuits shown in Figures 1 to 6. The common meter rectifier is a full-wave bridge-type unit and consequently the circuit of Figure 4 will be the most readily applicable.

Relatively large parallel surfaces are employed in these rectifiers, and correspondingly large capacitances result. The effect of the rectifier capacitance, in parallel with the receiver tuned circuit, is to raise the minimum tuning capacitance, thereby restricting the high-frequency limit of the receiver. At the same time, this capacitance by-passes a portion of the r.f., reducing the signal strength. These are the noteworthy disadvanges of the oxide rectifier as a radio detector.

An advantage, however, is the absence of adjustment requirement. No sensitive spots need be located, nor contact pressures adjusted. Meter rectifiers are designed to withstand a much larger current level than will be encountered in the simple receiver circuits. Consequently, this type of detector will not be as easily impaired by strong signals and heavy static discharges as will crystals.

Home-Made Diode Tube

An interesting and inexpensive diode tube for use in place of the crystal, oxide, or contact detectors in the simple receivers may be made from a double-filament automobile headlight bulb, as shown in Figure 7. The receiver circuit for this improvised tube is shown in Figure 8.

The best bulb for the purpose is the G.E. Mazda 1158 (See Figure 7). This is a 6-8 volt type with one 3- and one 21-candlepower filament. The two "outside" filament leads are connected to solder-spot terminals on the insulated base, while the common point between the two is connected through a heavy wire post to the metal shell of the bayonet base.

The 21-candlepower filament is a

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single thin strip connected from its stiff, heavy vertical support rod to the common filament support rod. Its solder-spot base contact is just under the word TOP on the metal shell. This filament must be burned-out by application of high voltage. Its heavy support rod, situated only about one-eighth inch from the good filament, will remain to act as the diode plate.

The undisturbed 3-candlepower filament is spirally-wound and arranged in an inverted-V shape, and will act as the diode filament. This filament is not specially-treated with a high-emission compound like the thorium coating of radio tube filaments; however, it will emit electrons in sufficient number to give satisfactory results even with the small "plate" area.

There will naturally be some variation in results obtained with different tubes manufactured according to the directions just given. But the double beam bulbs are cheap, and it will profit the experimenter to purchase several of them, make the necessary improvisions, and select for use the one giving the loudest signals. The others may be stored as spares for emergency use.

The filament draws a rather large amount of current for normal operation; however, this drawback should not be of monumental concern if the diode receiver is to be operated during rather short, emergency periods.

In connection with diodes, it is of interest that power-supply type rectifier tubes are useable as diode detector tubes in any of the simple receivers. In an emergency when other tubes are not immediately available and radio reception must be established quickly, these tubes may be drafted for service. The only power requirement is a source of filament or heater voltage. The 117-volt heater type (e.g., 117Z6-GT) will perhaps be most useful in this application when line power is available, since the heater may be operated directly from the house line without a transformer or dropping resistor. And at the same time, circuit returns are made directly to a cathode element which is separated electrically from the dangerous, high-voltage heater.

C. W. Reception with Simple Receivers

Each of the emergency receivers described thus far utilizes the principle of simple rectification (linear or semi-linear detection). None of these circuits is capable of regeneration or oscillation, which means that they are suitable only for reception of modulated signals—radiotelephone or tone telegraphy. If it is desired to receive continuous wave telegraph or other unmodulated signals, it will be necessary to include in the circuit some form of continuously-running, high-speed interrupter.

Figure 9 shows one such chopper device. This is a motor-driven commutator which interrupts the r.f. circuit in the return lead, making the c. w. signal audible in the headphones. The tone of the signal will vary directly with the frequency of interruption, which depends in turn upon the motor speed. This is under the operator's control if a speed-control rheostat is included.

The chopper device is inserted in the return lead, since if it were in the "high" side of the circuit it would introduce a high value of capacitance to ground.

Another satisfactory chopper device might be a make-and-break contactor actuated by a motor-driven cam or eccentric. The low-inertia springs and contacts might easily be made from two contact-bearing spring blades from a discarded phone jack.

The buzzer-type of circuit interrupter, while convenient, unfortunately is not satisfactory for use in these circuits, since the sparking contacts (however slight the sparking may be) generate a widely-interfering damped r.f. wave which will blanket out antenna signals and at the same time will force a signal of its own into the antenna.

Suggested for motor-driven circuit interrupters are the miniature dry-cell-type motors supplied with toy builder sets such as Erector. The speed of these little machines is readily controlled by a series rheostat to permit control of the signal tone.

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Electronic Pump
(*Continued from page* 23)

tively charged shield which, with the assistance of a magnetic field, focuses the electrons coming from the filament upon the opening mentioned above. This filament is a ring around the axis of this hole in the diaphragm, affording a cone-like path for the electrons focused upon the tiny passage. This wave of electrons tends to diverge after passing through this aperture, as indicated by the broken lines in the diagram.

When, however, an axial magnetic field is applied by passing current through the coil (which aids the job of focusing, and restricts the spread of the wave of electrons) each electron is prodded to pursue a spiral-shaped path, after passing through the plate diaphragm. This helical path of each electron tends to pass through the axis of the system at frequency intervals, and the entire length of this trail may be much greater than that obtained without a magnetic field.

These paths of minute matter seem to converge at the same points —where each path passes through the axis of the tube. Although only one diaphragm is shown in the diagram, it is feasible to place additional diaphragms, with holes through their centers, at each electron focusing point. This plurality of diaphragms increases the action of this electronic pump.

Here is how this electronic pump operates: A reasonable degree of vacuum is obtained by use of the rough pump. Then the filament of the electron tubes of the high-vacuum pumping system is heated to a sufficient temperature to force electron emission. The direct-current potential is applied to the plate elements and the magnetic field is boosted to a value in which the electron paths are suitably lengthened and focused to afford the greatest pumping efficiency. When the pump is primed, the first stage of the pumping may be cut short by connecting some or all of the elements of the chamber to be evacuated to a source of high-positive direct current. Manifestly, the chamber or container to be exhausted of air or gas must be heated during the evacuation in the customary manner. A pump of the electronic type just described is said to possess advantages not found in the vapor jet-condensation pump, which requires low-temperature traps to bar vapors from the container or chamber being evacuated.

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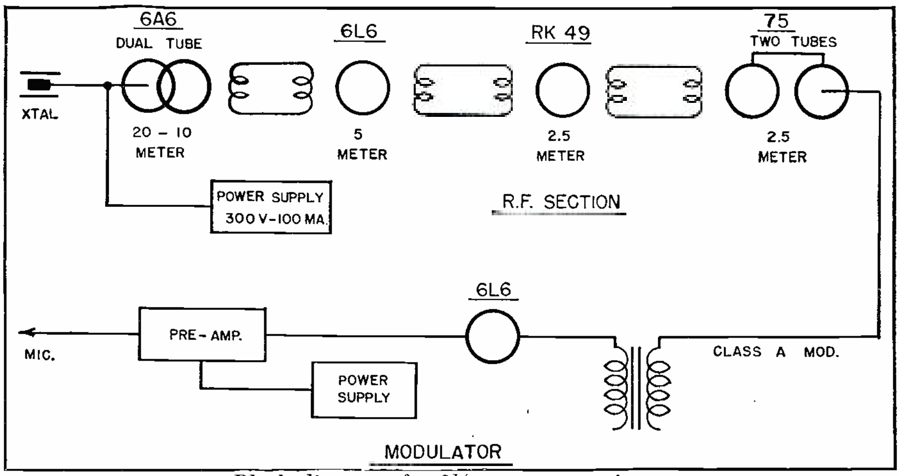
Emergency Radio Receivers
on Page 28.

WERS Report
(*Continued from page* 13)

equipment, of course, still remains with the owner, but must also be regarded as being the property of the city.

In a majority of the instances, the equipment used is of the composite type. The transmitter, for instance, of one control center was built up out of old parts of odds-ends lying around some shacks. Notwithstanding, its performance has been remarkable. A block diagram of this typical transmitter is shown on this page.

There are two types of 2½ meter receivers used as shown in Fig. B. One is for city control reception, and the other is for the auxiliary station to take orders. Both of these receivers are ideal examples of ingenuity. The very tiny receiver shown on top of the metal cabinet at the right of the transmitter uses a 6J5, 6C5, and 6F6 with inductive tuning and a mica padder. The speaker is of the 3½" magnetic type. The other 2½-meter job is a super that was formerly a 5-meter unit. In its 5-meter design, a 6D6, 6C6 and 6D6 were used in the first section. To accommodate high-frequency reception, the circuit was re-designed for acorn tubes. And, of course, the coils were rewound to permit tuning to 2½ meters.



Block diagram of a 2½ meter transmitter.

Since mobility is a very important factor, it is not only necessary to have a transmitter and receiver for the car, but one for carrying about, such as a walkie-talkie. One type that is used in New York is shown in Fig. A. It was constructed of old parts, even as to the housing itself, which is wood that was found lying around the shop. In the car, we have one instance where a commercial unit was employed. This was necessary because of the many problems attendant to car design. Fortunately, many of these commercial units were available. In the installation that will be made later on composite units will be used, too, because all the tricks required to make these sets work will have been successfully included in new designs. In the present installation to achieve maximum radiation and reception, an unusual antenna was designed. This is illustrated in Fig. A. A diagrammatic sketch of the coaxial cable, connecting to the antenna is shown on Page 55. It consists of a five-foot piece of 1" round hollow bakelite in which is installed a concentric copper cable (⅜" copper tube with No. 16 wire on beads). The output is fed into a half-wave doublet.

In Maryland the WERS problem is quite a different one because of its state-wide application. In order to provide maximum efficiency the system was designed to cover fifteen-mile areas. Not only has radio been used successfully here, but wired radio too. At the present time, for instance, an area of approximately 100 square miles which takes in the semi-rural area surrounding metropolitan Washington, has been effectively covered in this way. In this instance, the installations are in fire houses. The use of power lines for directing radio waves has been a pet project of many and doomed to failure by many, too, because of its many difficult problems.

In other localities, of course, the use of typical ultra-high-frequency equipment is essential and like the New York City amateurs and engineers, our Maryland friends have made tremendous strides, too. They have, for instance, established standardized panels for the fixed transmitters. At this writing, these transmitters are enclosed in a cabinet with a handle attached for carrying and with an antenna mounted thereon. The panels have a minimum of controls. For instance, there is just an on-off switch, a tuning dial for receiving, a send-receive switch and a regeneration control. The volume control is mounted inside and adjusted upon installation.

So as to provide additional equipment, salvage drives have been made. A drive through the schools netted 400 old radios. Through the efforts of the

Vocational War Training program these sets are being disassembled and the parts are being segregated by the students. Laboratory facilities have been donated, so that the WERS group can direct the design of receivers, their construction at the school and at home. In this latter respect the students are given a complete kit containing all parts with a diagram and asked to devote as much time as possible toward the construction of this equipment. In this way, it is possible to obtain a variety of necessary receiving and transmitting units quickly and with a minimum of priority problems to think about.

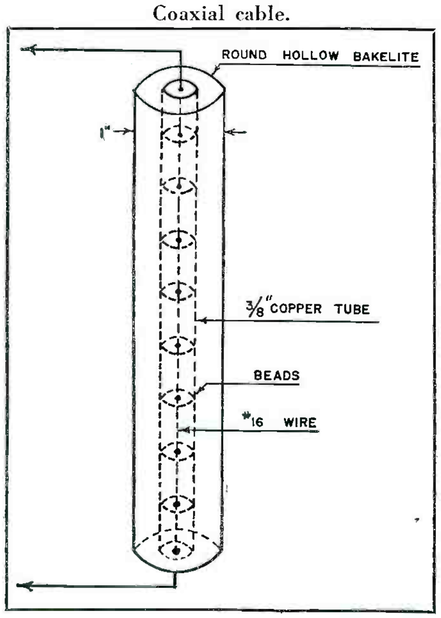
As in New York City, except for the control stations, the other equipment is located on the homes of amateurs and other selected operators during the process of design and test. Of course, much of this equipment will be eventually moved to such points as hospitals, military targets in addition to main civilian defense headquarters.

In the units, the oscillator tubes used range from single 6D6's and HY-75's to 7A4, 76, 56, etc., in linear tank arrangements. In the main, the linear tank circuits are used due to the easy manner in which they oscillate and their simplicity of building.

Since Cumberland is situated in the heart of the mountains in Maryland with the city itself built in around the hills, complete coverage over this area has really been a tough problem. However, most of these hard-to-contact spots have really been made easy-to-contact spots by using relay stations on hill peaks or in the tops of buildings. This may sound simple but when one realizes that there are five mountain ranges between Cumberland and the eastern shore of Maryland, we can see what tremendous engineering project is involved.

In the Baltimore County network, a variety of problems were also met and solved. In one instance, an attempt was made to feed the antenna with spaced feeders. Under normal circumstances, this would work quite

Coaxial cable.



well with coaxial cable. But that isn't available today and with spaced feeders emanating before they reach the radiator, it was necessary to place the transmitter on the roof and control it from downstairs. Again, trouble grew in the audio frequency lines to the roof. To solve the problem, the complete modulator was installed in the building and the oscillator alone was left on the roof.

Transceivers produced some trouble too. In one instance, while the carrier came through very well, modulation troubles persisted. Adding another stage in the modulator circuit cured that trouble. It seems as if the trouble originally came from the power supply, for the power packs used were originally from receiving sets that had a load limit of 90 mils. For receiving purposes, this voltage jumped to 400 and thus had a tendency to block the tubes, dropping when the load was put on for transmitting. To solve this problem of instability, a resistance was placed across the power supply, tapped at necessary intervals for receiving voltage and completely thrown out of circuit when transmitting.

Another antenna problem met concerned the use of a J antenna. It appears that in some instances a set installed in a room with a matched antenna attached has but slightly less efficiency than one attached to an outside antenna by a feeder. In addition, the inside equipment has the additional advantage of being unaffected by weather changes.

Although this new emergency effort has been one in which the amateur was to have played an all-encompassing role, the war has voided this complete possibility. While it is true that in practically all instances the amateurs have been the guiding unit, commercial operators and newly-taught operators have filled many an important post, avoiding in many instances complete disaster to the communications system. In this respect, the amateurs and professionals, teachers and engineers, are worthy of the utmost commendation for their untiring efforts in training such new personnel. Incidentally, in New York City, women are being trained for these posts in the AWVS and very successfully, too.

Incidentally, all radio carriers are subject to silencing orders from proper military officers. The Commander of each Defense Command has been given the right to silence any and all radio stations within the limits of his Command area at his discretion. It is anticipated that the War Emergency Radio Service and certain other emergency services, such as the police service, will be allowed to continue operation during air raids, providing such services abide by prescribed regulations issued by the Defense Command.

The WERS has in the short time of its existence, more than justified its creation. It has served to provide the necessary emergency networks and awaken a new interest in the outstanding work of the amateur and radio enthusiasts. And out of this tremendous civilian effort will come an unprecedented series of developments of which we, on the home front, will be mighty proud.

The author wishes to acknowledge with grateful thanks the kind assistance and cooperation of the following who furnished invaluable data for this report: *Harry Whiting, John Weber and Max Goldberg of New York City; Thos. F. McNulty, Director WERS, Maryland; L. R. Jenkins, Radio Aide Cumberland, Maryland; and Frank Lyn, and Joe Hunter of Maryland.*

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We have been advised that a few reprints of the article "Conquer the Code with Rhythm" are available from RELAY—Room 618, Sixty-six Broad Street, N. Y. C. This article appeared originally in a past issue of RADIO NEWS.

Practical Radio
(Continued from page 31)

ferent functions. In radio-frequency amplifier pentodes, the suppressor permits obtaining a high voltage amplification at moderate values of plate voltage. This is a distinct advantage, especially in equipment that must be powered by dry batteries. In power output pentodes, the suppressor makes possible a large power output with high gain, due to the fact that the plate swing can be made very large.

Beam Power Tubes

Another method of returning the secondary-emission electrons to the plate, without the use of a suppressor grid, is to return them by the repulsion of negative space charge between the screen and the plate. The effect of such a space charge is accentuated if the plate potential is lower than the screen potential. By proper design, the space charge may be made so dense as to form a virtual cathode (i.e., a plane of zero average electrostatic field and zero electron velocity) near the plate at low plate voltages.

In the beam power tube, of which the 6L6 type is an example, the necessary electron density is achieved by confining the electrons to beams by means of two beam-forming plates (only one is shown at (*b*) of Fig. 10, for sake of clarity), which are at cathode potential. The proper homogeneity of space and the electron velocity is attained by proper elliptical design of the contours of the cathode, grids and plate, as illustrated at (*b*) of Fig. 10. A flattened cathode is used as it gives a more uniform and larger effective emitting area than a round cathode would.

The screen and control grid wires have equal pitch. They are so assembled and aligned that the screen grid wires are immediately behind those of the control grid and the initial repulsion given the electrons by the negative control-grid wires prevents the electrons from striking the positive screen grid wires, as (*b*) of Fig. 10 illustrates. Consequently, since very few of the electrons moving toward the plate can therefore strike the screen grid directly, the screen current is small (except at low plate potentials) and little secondary emission can occur from the screen. In addition, the zero potential gradient (virtual cathode or space charge if desired) prevents secondary emission from the plate.

These factors result in a tube which, because of its low screen current has low screen dissipation and consequently larger power rating without danger of electron emission from the screen because of low screen temperature. Furthermore, because of other factors which we will study later, this type of tube is able to handle large amounts of power with low distortion even when operated at comparatively low plate voltage. It is superior to the pentode tube in this important respect.

This type of tube has been very popular with amateur operators. The economy of the 6L6, for example, is well known.

Multi-Purpose Types

During recent years there have been many types of multi-purpose tubes manufactured. While some of these are simply two tubes combined in one envelope, some of the special types merit an explanation. One of these is the converter tube, used as a combination oscillator-first detector in superheterodynes. There are several different types of this tube manufactured, but substantially all consist of an oscillator section, usually a triode, and a mixer section, in which the local signal from the oscillator section, and the received signal are mixed.

Coupling between the two sections of these tubes is usually accomplished through the electron stream. A tube of this type is shown schematically in Fig. 11. The type shown is known as a *pentagrid* converter due to its five grids. Grids number 1 & 2 act as the grid and plate respectively of a conventional triode and are used in conjunction with the cathode in the oscillator circuit. The oscillation in this section of the tube supplies an electron stream to the rest of the tube that varies at the oscillator frequency. This stream is in turn controlled by the incoming r.f. signal impressed on grid number 4. The variations in plate current are due to the combination of the oscillator and signal frequencies. Grids number 3 & 5 which are connected together inside the tube are to accelerate the electron stream and to shield the signal grid number 4 from the other electrodes.

Another type of converter tube enjoying great popularity at the present time is shown in Fig. 12. In this type grid number 1 is the oscillator grid, while grid number 2 is connected within the tube to the screen (grid number 4). This combination shields the signal grid (number 3) and also acts as the plate of the oscillator section. Suppressor action is furnished by grid number 5. In the design of this sort of tube the space charge around the cathode is unaffected by electrons from the signal grid. The result of this form of design is that the r.f. voltage on the signal grid has little effect on the cathode current. In circuits using automatic volume control there is therefore little change in oscillator transconductance due to changes in bias.

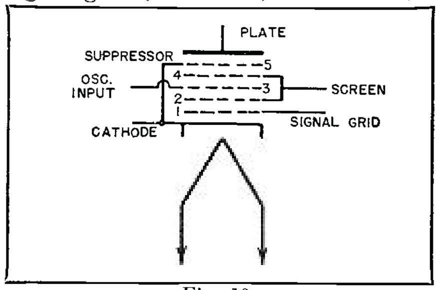


Fig. 13.

Another form of converter used occasionally is the type shown in Fig. 13. This tube differs in that it has two independent control grids, number 1 & 3. The incoming r.f. signal is applied to grid number 1 while that from a separate oscillator is applied to grid number 3. Due to the sharp cutoff characteristic of grid number 3 a small amount of oscillator voltage produces a comparatively large change in plate current. Grids number 2 & 4 are connected together inside the tube and accelerate the electron stream and shield grid number 3 from the other elements. Grid number 5 which is connected inside the tube to the cathode functions in the same manner as the suppressor in a pentode.

In addition to the converter types described above probably the most common type of multi-electrode tube is the diode combined with a triode, tetrode or pentode. In these tubes the usual practice is to mount either one or two diode sections around the lower end of the filament or cathode, and use the diode sections for detection and automatic volume control. The other section of the tube is then used as an amplifier for the signal after it has been rectified by the diode

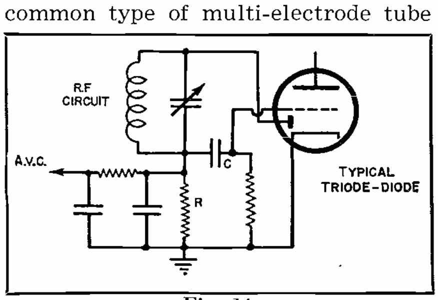


Fig. 14.

section. A typical example of the connection of such a tube is shown in Fig. 14. In a circuit of this type the rectified voltage developed across the resistor R by the rectifying action of the diode is coupled to the grid of the triode through the condenser C and in turn amplified by the triode section. In addition the rectified voltage is filtered through an RC filter and used to apply varying bias to the r.f. and i.f. stages in order to provide substantially constant output with different levels of signal input.

A type commonly used in midget receivers is the rectifier-pentode or beam power tube. This is simply a combination of two tubes in one envelope. One section functions as a half wave rectifier, while the other is usually an output type of beam tube or pentode. Separate heaters and cathodes are used on each section. By use of such construction, economy in space requirements, important in midget receivers, is obtained.

In addition to the types that have been described many tubes have been developed for special purposes, such as high amplification, low interelectrode capacitance, large outputs with low distortion, variable mu or gain, etc.

In the next installment we will take up the various applications of tubes as they are actually used, together with explanations of the various classes of amplifiers.

(To be continued)

Acknowledgement

The author of "The Electric Eye in Electronics," which appeared in the Dec. 1942 issue wishes to acknowledge with thanks the use of the following diagrams:

Fig. 1, 2, 3, 6
Courtesy of F. H. Shepard Jr.

Fig. 4
Courtesy of Weston Electric Co.

Fig. 5
Courtesy R. C. A.

Fig. 7, 8
Allied Control Co., Inc.

Vitrohm Strip Resistors

Vitrohm Strip Resistors are especially suited to applications in aviation, radio, and installations where space limitations and high unit space watt ratings are important requirements.

These resistors employ a strong, flat refractory core for the resistance wire winding. Terminals are mechanically banded and spot welded in position on the core; the core and winding are then sealed in a fused on Vitrohm enamel.

Each unit is fitted with a self-sustained mounting bracket and spacer. These spacers and end brackets are riveted to metal strips that extend through the core providing additional heat radiating facilities.

Several sizes of Vitrohm Strip Resistors are available, ranging from 1½ to 6 inches in length with ratings of 30 to 75 watts.

Bulletin 23, available on request gives dimensions, ratings, ohmic values, and other information. *Ward Leonard Elec. Co.,* Mt. Vernon, N. Y.

Electronic Beam Control
(*Continued from page* 19)

the potential on the capacity unit is built up. Obviously, with a high impedance load circuit, such as the negatively-biased grid circuit of an electron tube, no current output is obtainable in the absence of an input signal.

The outfit schematically described in Figure 1 is appropriate for use as an integrating circuit. The amount of electric energy necessary to charge the capacity unit to the point of being unstable is independent of the form of the charging wave and of the time element required to complete the charge. That is to say, for a specified value of capacitance and the fixed circuit parameters of tube 5, this amount of radiant energy is the same for each complete wave cycle. Take any one set of circuit parameters for tube 3, the time necessary to complete the charge on the capacity element depends entirely on the time integral of radiant energy in the signal.

Therefore, according to the designer of this circuit, the frequency of occurrence of the return voltage pulses, across the output terminals, may be utilized to indicate the time integral of energy in a signal, and usually this will be exactly proportional thereto. Mr. Page, the inventor of this electron-beam apparatus, contends that this circuit is particularly applicable to the task of indicating the time integral of energy appearing in a signal above a predetermined voltage level—for instance, the indication of the amount of power in a signal or modulation peaks in excess of a selected level. This application simply requires that the electron tube be biased beyond cut-off by the value necessary to prevent conduction in the tube, for all signal voltages below the desired level of indication.

Still another use of this electron-beam control equipment is, when associated with certain other circuits, to obtain a multiple-line axis in a cathode-ray-tube oscillograph, about to be described. Examine the circuit in Figure 2 (in which the elements are designated by the same reference characters as in Figure 1) and you will note that the potential built up across the capacity unit is applied between the grid and plate elements of a phase-inverter tube.

The current through the latter gives impetus to a positive potential at a certain point (indicated by the numerals 27), which is impressed on a deflector plate. At the same time, the negative potential at point (30), due to drop through a resistance unit, is applied to another deflector plate. As the potential across the capacity element, however, is built up, a progressively greater negative potential is impressed on the grid element of the phase-inverter tube. Current through the latter is diminished thereby, cutting down the positive potential applied to the plate (28) and decreasing the negative potential impressed upon plate (32).

This procedure causes the electron beam in the cathode-ray tube to be shifted in steps corresponding with those of the potential charge across the capacity element. Two other capacity units are provided to insure a balanced output from the phase-inverter tube.

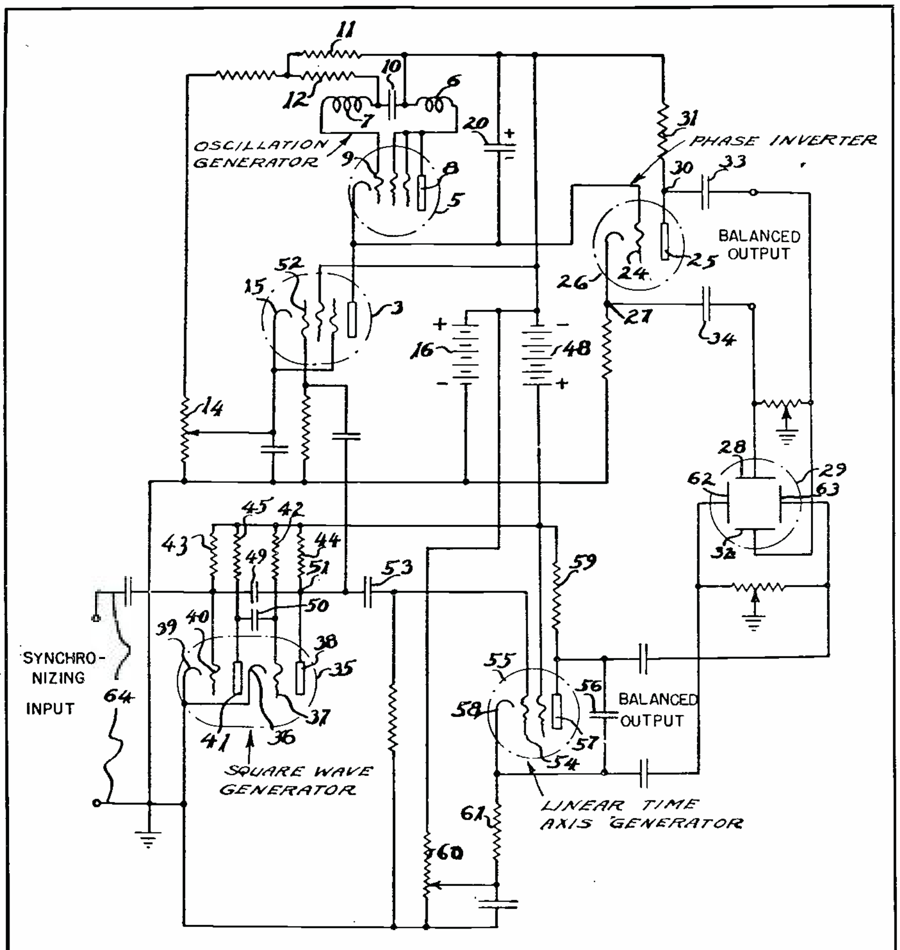
The impulses for rendering tube 3 conductive are derived from a square-wave generator, of the multi-vibrator type. It involves the use of two triode units indicated in Figure 2 as a twin triode tube, having the usual filament, grid and plate elements in one unit, and a filament, grid, and a plate in the other triode unit. (It is, of course, feasible to arrange the triode unit in separate tubes.) The two grids and the two plates are connected, respectively, by four resistance units to a common lead, connected by another lead to the positive side of a source of energy. The plate (38) is associated with a capacity unit to grid (40), and likewise plate (41) is connected to grid (37) through capacity (50).

As outlined by the inventor in the text of his patent papers, the impressing of a positive potential to the grids (37 & 40), as well as to the plates (38 & 41) markedly increases the frequency range of the multi-vibrator type of generator and also has a stabilizing influence on the operating frequency.

As is well known to radio engineers, current passes through the triode units alternately in a square-wave generator. As the current passes from the plate to the cathode, the positive potential on the plate is decreased, but when the current from the plate to the cathode is halted abruptly

(*Continued on page* 62)

Figure 2.



Numbers 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 20, same as Figure No. 1.
24. *Grid.*
25. *Anode.*
26. *Phase inverter tube.*
27. *Positive potential point.*
28 & 32. *Deflector plate.*
29. *Cathode-ray tube.*
30. *Negative potential point.*
31. *Resistor.*
33 & 34. *Capacitances.*
35. *Triode tube.*
36. *Cathode.*
37. *Grid.*
38. *Anode.*
39. *Cathode.*
40. *Grid.*
41. *Anode.*
42. *Resistors.*
43. *Resistors.*
44. *Resistors.*
45. *Resistors.*
48. *Positive side of a source of potential.*
50. *Capacitance.*
51. *Positive potential point.*
52. *Grid.*
53. *Capacitance.*
54. *Grid.*
55. *Tube.*
56. *Capacitance.*
57. *Anode.*
58. *Cathode.*
59. *Resistor to positive terminal.*
60. *Resistor to negative terminal.*
61. *Resistor to negative terminal.*
62 & 63. *Deflecting plates.*
64. *Input lead.*

Mfrs. Literature

(*Continued from page* 35)

available to supply power to large d.c. systems in steel mills: the synchronous converter, the motor-generator set driven by either a synchronous or an induction motor, and the ignitron mercury-arc rectifier.

Accompanying diagrams show cross sections of the rectifier, comparative efficiencies of the three types of power-conversion units, effect of phase control on output-voltage and output-current wave shapes, and a floor plan illustrating a typical 1500-kw., 250-volt ignitron mercury-arc rectifier installation.

For additional information write to the *General Electric Co., Schenectady, N. Y.*

Color Code Resistor Card

Sylvania announces a Color Code Resistor card for radio technicians issued at this time as a help in the Wartime radio servicing job. It is free to all *Sylvania* radio servicemen.

In handy pocket size form, the *Sylvania* Color Code Resistor Card should prove to be a most valuable aid in circuit revision work. It clearly shows the A, B, C, and D color denotations of a resistor, explains the resistor color code and gives examples. On the reverse side of the card is Ohm's Law, one of the basic radio circuit formulas. Its definition and explanation is a helpful reference for every radio man.

The *Sylvania* Color Code Resistor card has already been welcomed by those who have seen it. Servicemen are running into an increasing number of circuit revisions, and technical helps such as this one give service-men a lift in the very tough job of keeping America's Radio working with a limited amount of materials.

They are available through *Sylvania* jobbers or can be secured by writing directly to *Sylvania News,* Emporium, Pa.

Radio Formulas and Data Book

Allied Radio Corporation, Chicago, announces the publication of a new condensed handbook especially designed to meet the demand of servicemen, students and engineers for a convenient and practical compilation of radio data and information in handy form. This booklet has been edited by Nelson M. Cooke, Chief Radio electrician, U.S.N. This new vest-pocket sized manual of most frequently required essential mathematical formulas, tables, data and standards commonly used in radio and electronics, eliminates the constant reference and tiring hunt through bulky textbooks for needed formulas.

The serviceman, student, designer and engineer has placed at his fingertips for instant reference formulas covering Ohm's Law, Resistance and Capacitance, Inductive Reactance, Impedance, etc.; also d.c. Meter Formulas, Trigonometric Functions, Natural Sines, Cosines, Tangents, and Radian Tables, etc., as well as numerous conversion tables which are constantly required. Consisting of forty pages of practical radio data, the "Radio Formulas and Data Book" measures only 3¼" x 5". —30—

Electronic Beam Control

(*Continued from page* 60)

there is a sudden spurt in the positive potential at a certain point in the circuit. This increase in energy is applied to the grid (52) of tube 3, causing the latter to pass an appreciable amount of energy, but this tube reverts again to a non-conducting condition when the passage of current from plate (38) to cathode (36) begins anew.

The square waves generated in this multi-vibrator generator are also applied through the capacity unit (53 in Figure 2) to grid (54) of an electron tube (55) in a linear-time axis circuit, devised by Mr. Page and the patent rights assigned to the United States Government. Another capacity unit (56) is connected between the plate (57) of the tube (55) and cathode (58) thereof. It is also connected through a terminal of power source (48) and through resistance units (60 & 61) to the negative terminal of the same energy supply source. The resistance between the capacity element (56) and the respective terminals of the power source is equal and of such value that the capacitance does not take more than from 2 to 20 per cent of the potential of the power source during the time between pulses applied to the grid (54) from the square-wave generation. Therefore, the increase in potential across the capacity unit (56) is practically linear. When a positive pulse is impressed upon the grid (54), however, the electron tube assumes a conducting attitude and the capacity element is instantaneously discharged through the tube.

The potential built up across the capacity unit (56) is applied to two deflecting plates of a cathode-ray tube. And, it is manifest that, this building up of the potential across the above capacity element (and the resultant shifting of the cathode-ray beam across the screen) corresponds to the time duration of one of the potential voltage steps across the capacity unit (20). Thus, we are informed, for each new vertical position of the electron beam, the latter is swept horizontally once across the screen. Thus, there is established a multiple-line-time axis that represents a period equal to one cycle of charging of the capacity unit (20). The operation of this square-wave generator may be synchronized with any other radio phenomenon by a voltage corresponding to such phenomenon applied across the input lead wires.

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Book Review

(*Continued from page* 36)

power supplies, vibrators and vibrator power supplies, phone-radio service data, automatic tuning—operation and adjustment, frequency modulation, television—suggestions for the post-war boom, capacitors—how to overcome war shortages, practical radio noise suppression, vacuum tube voltmeters, useful servicing information, and receiving tube characteristics—of all American tube types.

A limited number of copies are available from authorized *Mallory* distributors.

"BEST BROADCASTS OF 1940-1941," selected and edited by Max Wiley. Published by *Whittlesey House,* London, *McGraw-Hill Book Co.,* New York. 344 pages. Price, $3.00.

This interesting book brings together a year's group of the outstanding scripts in all fields of radio broadcasting. Wartime programs naturally receive more attention than in any preceding volumes, and the opening scripts are important talks by President Roosevelt and Prime Minister Churchill. Included are outstanding programs of Fred Allen, Fibber McGee and Molly, The Quiz Kids, Rudy Vallee and Jack Benny. Also included are news commentators, serials and for the first time, "Invitation to Learning."

"RADIO AMATEURS HANDBOOK," 20th Edition. Published by the *Amateur Radio Relay League,* West Hartford, Conn. 600 pages. Price $1.00 in continental U. S. A., $1.50 postpaid elsewhere.

This new edition of the "Ham's bible" is exceptionally well fitted for its wartime role. Much new material on defense communications rounds out its field of usefulness. The handbook is now a recognized training text, uniquely valuable in teaching radio for civilian and military purposes, in practical down to earth fashion. This new edition retains the features that makes previous editions so successful, plus new material designed to make it even more valuable in its wartime role. Simple yet thorough treatment of fundamentals stripped to essentials, nonmathematical is continued. The theory and design sections cover every subject encountered in practical radio communication, sectionalized by topics, abundantly cross referenced and fully indexed. Bulking large in the new material is a comprehensive 50-page chapter on War Emergency Radio Service.

"RADIO IN STATE AND TERRITORIAL EDUCATIONAL DEPARTMENTS," by Carroll Atkinson, P.H.D. Published by *Meador Publishing Co.*, Boston, Mass. 133 pp. plus index. Price, $1.50.

This is another in the series of books published by *Meador* from the McLucas Memorial Library and the Nelson Memorial Library. It is a non-technical discussion of this all important subject, and is of particular interest to those engaged in radio educational departments, colleges, and other institutions of learning. It gives a complete breakdown as to the activities of many important departments of education. Main features are (1) broadcasting as an instructional tool and (2) broadcasting as a public relations tool.

"LEARNING THE RADIO TELEGRAPH CODE," published by the *American Radio Relay League,* West Hartford, Conn.

Designed to fill the need for a guide to the student of radiotelegraph code —a fast growing need now that many thousands of persons are interesting themselves in dot-dash communication as valuable training in the war effort —the publication of a special booklet entitled "Learning the Radiotelegraph Code" was announced recently by the *American Radio Relay League,* national association of amateur radio operators.

The text presents a unique method of learning based on the aural system of approach. The radiotelegraph code is considered in the light of another language having its peculiar pronunciation and syllables. Even though an individual cannot secure the constant supervision of an experienced radio code operator he may feel confident to go ahead and study by himself, under this new method. Fundamental sounds are learned first—then letter sounds are learned integrally instead of as separate dots and dashes; in fact, those terms are taboo and "dit" and "dah" have replaced them. The booklet includes much material on learning to send well, high speed operation, copying to typewriter, general operating data and code practice equipment, as well as a full set of lessons in learning to send and receive which are ideal for class instruction.

The League expects that extensive use will be made of the text in the numerous community evening radio training classes sponsored by its affiliated clubs throughout the country. It has already been approved by various official government agencies for such use.

Price, 25c per copy, postpaid.

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Preset Receiver
(*Continued from page* 34)

for musical reproduction, is remotely mounted in a large baffle and naturally dominates all conversation in the room. When the OM wants the news or the baseball game, the 6" speaker mounted on the output chassis is switched on, permitting more confidential listening. The output transformer which came with this speaker was designed for push-pull 42's, but the slight mismatch is not annoying.

All power supply and output parts are mounted on a chassis of ¼" plywood about 15" x 17". Not shown on the diagram are line filters and bypasses on the 110 volt line. Each constructor will have his own ideas about the best arrangement. At present we are using a line filter and feel that it's pretty hard to beat.

So much for the construction of the receiver, carefully built, it will provide real reception of musical programs from local stations and with a good pick-up will reproduce recordings in a most satisfactory manner. After we had the set in operation, we began to wonder just how well the tuner was operating and what laboratory tests of the selectivity and fidelity would show. To check these points we built the apparatus shown in Figs. 5 and 6.

The r.f. output meter is simply a slide-back VTVM connected to the cathode of the infinite impedance detector. It measures directly the d.c. voltage produced by r.f. on the detector grid, without loading the tuned circuits in any way. The leads to the meter can be plugged into a socket at the right rear of the tuner chassis and carry all necessary voltages to the 6E5. To determine the effect of any signal the antenna is first disconnected from the tuner, the 10,000 ohm variable resistor is set to zero resistance and the tuning eye adjusted to any chosen shadow by varying the 50,000 ohm resistor. The antenna is now con-

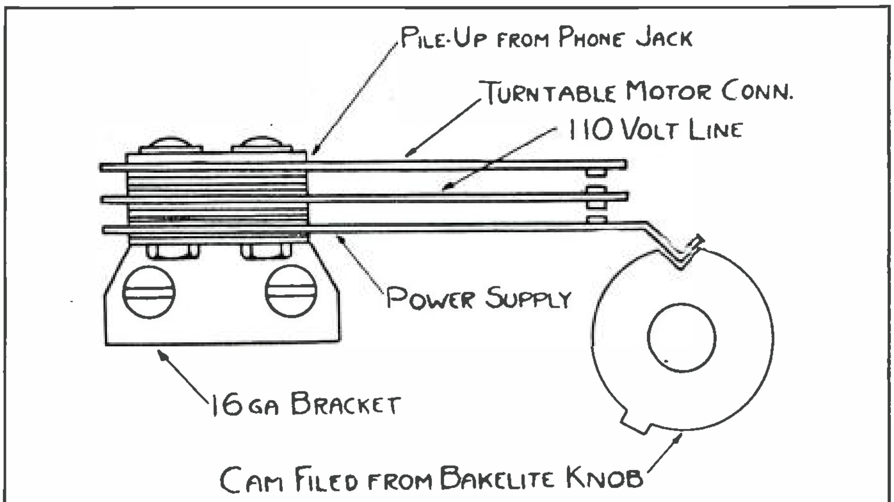
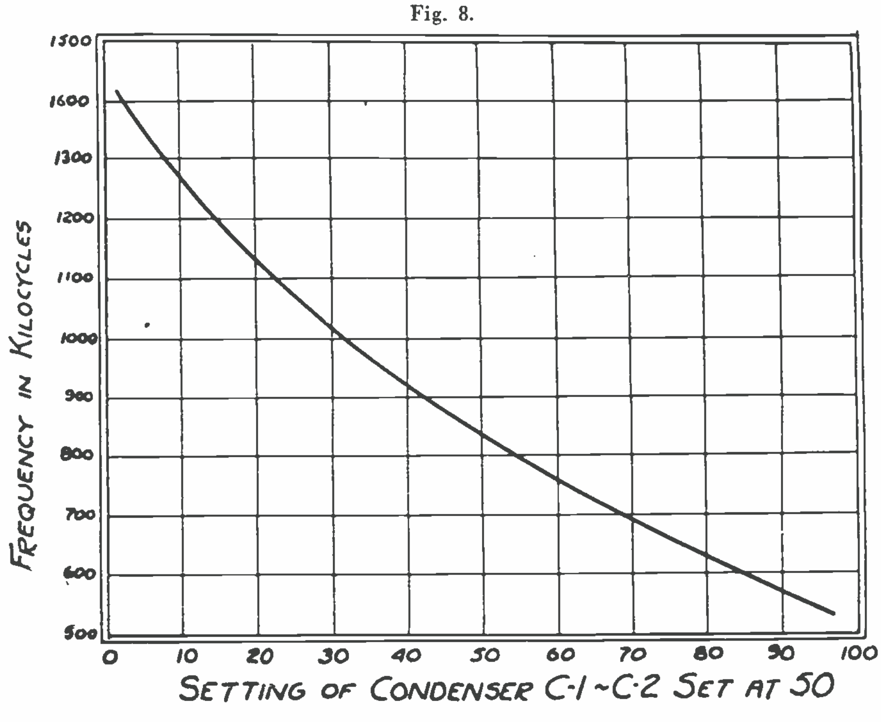


Fig. 7.

Fig. 8.



nected, changing the closure of the tuning eye. Adjustment of the 10,000 ohm resistor to return the eye to its original condition will cause a voltage equal to the change in voltage of the 6C8G cathode to be indicated on the meter. No calibration is required and accuracy is limited only by the meter used and precision in resetting the tuning eye.

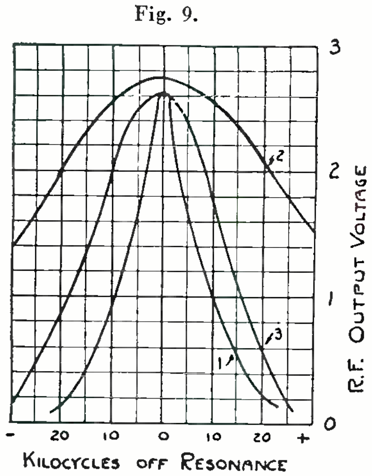
Having this meter in working order we constructed a simple oscillator with two tuning condensers. The 365 $\mu\mu$fd. condenser is of the usual broadcast set type, with offset plates to approximate straight line frequency characteristics. The smaller condenser was made by stripping most of the plates from a 100 $\mu\mu$fd. semi-circular plate variable. It is important that this smaller condenser approximate a straight line capacity characteristic through the middle portion of its range.

To study the frequency response of the receiver several steps are necessary. First prepare a calibration curve along the lines of that shown in Fig. 8. This curve shows the frequency corresponding to different dial settings of the large condenser, the smaller condenser being kept at half scale and is prepared by observing zero beat between the oscillator output and the signals picked up from local broadcast stations. Having this curve we can find the number of dial divisions which correspond to 10 or 20 or 50 kc. deviation from any given central frequency. We now can tune the oscillator to zero beat with any station, with C2 at half scale, then detune by moving the C1 through a number of divisions corresponding to, say, 20 kc. Retuning by adjustment of C2 will give the number of divisions on the C2 dial corresponding to 20 kc., from which we can compute the number of divisions for 1 kc. This calibration of C2 will be different for different settings of C1 and must be determined for each case.

After this calibration is completed and the number of C2 dial divisions for 1 kc. is known for all the station frequencies to be studied, we can proceed to align the preset receiver as closely as possible to any desired station. Then tune the oscillator to zero beat with C2 at half scale. Next, remove the antenna and substitute the oscillator output lead. If this lead is kept short and if a series condenser is used in the antenna lead little detuning will result from this substitution. The oscillator output may need to be attenuated to approximately the same level as the signal; if so, insert series resistance in the connecting lead. This change will probably necessitate retuning, starting from the first step. When all is balanced and tuned and the oscillator is feeding unmodulated r.f. at the station frequency into the receiver, note the voltage developed. Now move C2 enough to shift the frequency 1 kc. and again note the voltage. By taking enough such points, curves such as those shown in Fig. 9 can be plotted.

By carefully retuning the padders on the receiver a result on the order of Curve No. 1 can be obtained. Where adjacent channel interference is not a problem, two of the stages can be slightly detuned to give a result like curve No. 3. It will be noted that these curves are for a central frequency of 710 kc. At the low frequency end of the band selectivity is more than ample and some such spreading out is desirable. At the higher frequencies, however, the response pattern broadens out as shown by Curve No. 2, so that interference results from strong stations within 50 kc. of each other. While this method of getting response curves is laborious compared with the use of a wobbu-

Fig. 9.



Curve 1 ~ Maximum Selectivity at 710 kc
Curve 2 ~ Maximum Selectivity at 1390 kc
Curve 3 ~ Tuned for Broader Response at 710 kc. Cathode Resistor Changed to Balance Voltage.

lated oscillator and cathode ray oscillograph, it does make use of equipment generally available and is sufficiently accurate to give a good idea of what's going on in the r.f. circuits. We have proven to our own satisfaction that the human ear is a poor judge of amplitude distortion, some of the eccentric, double humped curves we have observed from fine sounding stations have seemed almost unbelievable. Use of the meter also helps to visualize the logarithmic relationship between power and apparent volume.

There are many further continuations of the ideas of this preset receiver which will occur to every constructor. The required motion of the main control knob is a natural for remote control using a ratchet relay, preferably energized by a carrier wave acting on a 0A4G. Fixed condensers and variable inductances would be more stable than the arrangement used but the cost was in our case, prohibitive. One of many types of tone control could be added. Our experience is that such controls are nearly always poorly adjusted and are better left off. Whether our plans are followed closely or are merely used as a starting point, we feel sure that anyone will find plenty of interest and satisfaction in the construction of a preset broadcast receiver.

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The Multi-Servimeter

(*Continued from page 26*)

of tone controls can be tested by applying the signal just ahead of the control and noting the action as the control is changed.

In testing push-pull stages, the test prod must be placed on both grids and plates of the stage. There should be no difference in the volume on either of the grids and the same applies to the plates.

Checking Microphones and Pickups

High impedence microphones and pickups may be tested by plugging them into the Test Jack and rotating the Test Selector to the a.f. Low position. Low impedence mikes and pickups may be tested if a suitable coupling transformer is used and the Test Selector is set for a.f. With the microphone or phono pickup plugged in, the Multi-servimeter can be used as a 3-watt public address system.

Testing Power Supply Filter Efficiency

To check the power supply for hum, place the test prod in the a.f. Hi position and apply the prod to one side of the rectifier filament. The next step is to follow the current to the output through the various stages of the filter net-work and note the effectiveness of the filter. There should be a noticeable decrease in hum as each condenser and choke is passed.

Aligning Superhetrodyne Receivers

After ascertaining the i.f. setting of the receiver to be aligned, from the manufacturers specifications, the r.f. oscillator is adjusted to the frequency of the i.f. transformers and sine wave modulation applied. The test lead from the r.f. pin jack is loosely coupled to the 1st Det grid of the receiver and the chassis bonded to the GND jack of the Multi-servimeter. It is important that the section of the receiver tuning condenser that tunes the oscillator be shorted out before the aligning process is begun.

A weakly modulated signal is applied to the receiver and the test prod is connected to the AVC line of the receiver. The Test Selector is in the VTVM position. The 6U5 is used in this case, as a resonance indicator, tuning for minimum shadow. Beginning with the secondary trimmer of the i.f. output transformer, tune for minimum shadow angle. The r.f. Gain may be used to regulate "eye-sensitivity." After the secondary trimmer has been resonated the primary of the same transformer is adjusted in the same manner. After resonating both windings of the transformer, the process is repeated to compensate for any inter-action between the windings. The next i.f. stage is aligned in the same manner. It can be seen that the primary winding of the first i.f. transformer will be the last one to receive the tuning. The r.f. is then removed from the grid and coupled to the Ant. post.

The next step in the operation is to remove the shorting wire from the oscillator tuning condenser of the receiver and the r.f. oscillator and the receiver tuned to some frequency near the high frequency end of the broadcast, or short wave, band. This frequency will probably be about 1450 kc. on the broadcast band. We are now ready to adjust the oscillator, radio frequency and mixer tuning. The oscillator parallel trimmer screw is adjusted for minimum shadow angle on the 6U5. The first detector and r.f. trimmers are also adjusted for maximum output.

The next step is to tune the r.f. oscillator and the receiver to some identical frequency near the low frequency end of the band, about 550 kc. The receiver oscillator series padders are adjusted for resonance as indicated by the Magic-Eye. This operation should be carried out while "rocking" the receiver tuning dial and tuning for maximum output. At maximum output, there may be a slight error in the dial setting but the error is very small and is more than compensated for by the high over-all efficiency. The r.f. and mixer stages are now aligned for maximum output. If the receiver has short wave bands, they are tuned in exactly the same manner as the broadcast band; i.e., the receiver and the r.f. oscillator are tuned to the high frequency end of the band and the parallel trimmers adjusted, then the low frequency end of the band is tuned and the series padders adjusted. The r.f. and mixer tuning condensers may have slotted end plates on them, if this is the case, the ends are bent for correct tracking of the coils.

After building this set, it may be found that the capacity of the test prod may change the tuning of some of the r.f., i.f. or AVC circuits. If this is the case, a one megohm resistor will have to be inserted in the test prod at the tip. This will cure any tendency to detune the circuits being tested.

The output of the r.f. oscillator may have to be fed, to the receiver being aligned, through a dummy antenna. An excellent "dummy antenna" consists of a .0002 mica condenser that is in series with a 20 microhenry r.f. choke. This choke is paralleled by a 400-ohm non-inductive resistor in series with a .0004 mica condenser. The r.f. oscillator is coupled to the end of the net-work that has the .0002 condenser. The other end of the net-work is connected to the receiver antenna post.

All of the parts and proper values are included on the diagram. The entire instrument was made from a salvaged receiver. The receiver used was a superhet. The knobs and the switches were bought for less than $1.50 at a radio supply house. The metal panel is from an ALL-Star Jr. receiver and a metal cabinet has been ordered to house the entire instrument.

The dial that is used was salvaged from the same receiver. The scale was scraped off with a razor blade and a new scale drawn on with black India ink.

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Spot News

(Continued from page 42)

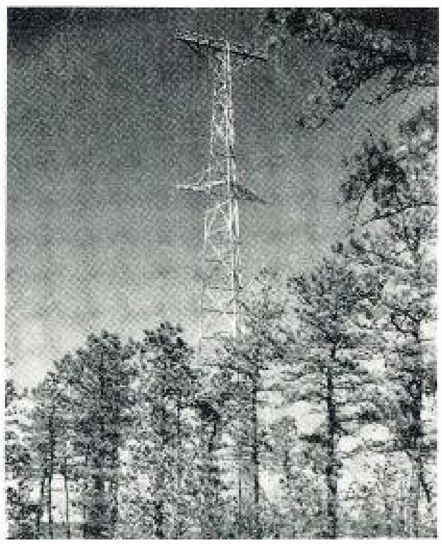
BEFORE A RECORD-BREAKING ATTENDANCE at the one-day Rochester Fall Meeting of radio engineers, officials of the Government and industry presented analyses of vital radio problems of the day. Among the important problems discussed, was that concerning material, by J. J. Farrell, designing engineer for General Electric. Mr. Farrell pointed out that while man power, standardization and simplification are ordinarily classified as vital factors, their importance becomes minor in contrast to the material problem. For, without a suitable source of material, all the programs abovementioned are without weight. With an effective program of alternate and substitution material allocation, we can proceed with the other plans.

Mr. Farrell exhibited various alternates for critical materials that have helped to solve the problem up to date. He stressed the point, however, that unless this alternate manufacture could be continued or improved upon, the allied projects of simplification, standardization and manpower could not be completely controlled. Among the exhibits shown by Mr. Farrell were various steel skeleton-type chassis and specially designed cabinets that accounted for the saving of over two million pounds of aluminum, the material previously used.

Another interesting alternate shown by Mr. Farrell was a wire-wound resistor which supplanted a vitreous-enamelled resistor. This alternate unit used nichrome wire welded to phosphor bronze wires which served as taps and supports and weighed almost one-half as much as the vitreous components.

Among the other outstanding talks of the meeting was the banquet speech of James Lawrence Fly, Chairman of the Federal Communications Commission and Board of War Communications. He pointed out the necessity for post-war thinking now, suggesting the formation of committees to study the possibilities of television and frequency modulation. He pointed out that the distance limitation that is now imposed upon television must be broken down. Expansion in the upper regions of the frequency spectrum must be planned now, he said. It is virtually certain that it will be possible to take immediate possession of that portion of the frequency spectrum between the present upper top of approximately 150 megacycles to at least 3,000 megacycles, he explained. International broadcasting must also be considered, said Mr. Fly, and in this respect his remarks paralleled those of Mr. Low, the Chinese authority about whom we spoke elsewhere. For Mr. Fly said that new methods and techniques may be found in the broadcasting of sound and pictures to people in foreign lands that will give visual and living emphasis common to people everywhere.

In conclusion, Mr. Fly pointed out that radio is destined to achieve its greatest prominence after the war and



A typical 6 megacycle beam antenna.

we must, at all costs, not only think about it, but plan for this suitable acceptance.

FROM THE AIR FORCES INSTITUTE of Scott Field, Illinois, comes the first of a new periodical bulletin called "Air Scoop." Although it only contains four pages, it is as meaty as many sixteen-page affairs that have come across this desk. Facts on communications equipment are presented in a very interesting manner supported by diagrams and cartoons. In an editorial by Captain James Lattig who is a director of the institute, a lucid explanation of what instruction means today is presented. Here is a little paper that will certainly make every student of the institute proud.

GERMAN RADIO EQUIPMENT IN MILITARY USE TODAY does not include anything unusual in electrical design but is quite unique in its mechanical structure. So reports Lieutenant Gifford Hull of the Royal Corps of Signals, in a report published in Electronic Engineering in London. Lieutenant Hull points out that one of the most striking features of this equipment is the extensive use of aluminum alloy die castings. Sub-assemblies with the r.f., i.f. and a.f. circuits, are individual units with male and female strips for interconnection.

The trimming condensers are in most instances silvered ceramic even for the audio-frequencies. Mica compression condensers are not used at all. The tuning condensers also use aluminum alloy die castings. The rotor plates which are die cast and machined are mounted on a ceramic spindle. The same procedure applies to the stator plates. The coils have a very interesting method of construction, for they use a deposit of silver in a spiral groove to form a winding. The winding is quite wide but microscopically thin. It appears as if the deposit was put on by electrolysis rather than by spraying.

Iron dust cores have been used extensively in their receivers, with very little effort to standardize design of coils that may be used for the same purpose but in different models.

The transmitters use straight line frequency type variometers for tuning the oscillator and amplifier circuits. An interesting device found in the German field transmitter as well as in an Italian transmitter was a sealed crystal indicator. This device consisted of a tiny crystal bar that was held in the prongs of a pair of tweezers mounted in a glass envelope similar to that of a tube. In this envelope was a gas which glowed pink when the crystal was fed with a.c. voltage at its resident frequency. Since the German transmitter found was self-excited and the crystal was connected across a time circuit of the power amplifier, the crystal glowed when the tuning control was set to the proper crystal frequency. When the set was off calibration, the crystal glowed at a different dial reading, denoting that the transmitter required retrimming. In other words, the crystal was used as a check on the transmitter calibration and not to control frequency.

On the whole, it seems as if the Ger-

Copper tubing for oil and fuel lines.

mans have gone to great pains to accomplish what can be done in a variety of more simple and direct methods and with a corresponding increase in efficiency.

A WASTE MATERIAL NOW SERVES AS A BASIS for a new plastic. Known as "lignin" and coming from sulphite used in the manufacture of pulp, it is now serving as a substitute of phenol fibre for insulating purposes. This new plastic comes in paper sheets and when conditioned to a proper moisture content and heated and subjected to high pressure, a tough fibre board, paralleling pound-for-pound the strength of steel is obtained. In addition, this new plastic fibre has good electrical properties, is less corrosive than phenol fibre and can be easily punched.

LAST MONTH WE INDICATED THE GROWING importance of aircraft cargo traffic. According to the OWI, this traffic is increasing daily. Recently, 32 tons of bristles, 70 tons of silk, 47 tons of tin and 70 tons of tungsten were moved from China to India over a period of eight weeks. And later on, 98 tons of tungsten were flown out in ten days. When the Western Hemisphere wanted rubber seeds from Liberia, 20 tons were sent over here on a cargo plane. These are but a few of the many uses to which this new form of transportation is being put. It is readily evident, therefore, that its importance will grow and that the need for flight communications offices required on these huge planes will increase accordingly.

ALTHOUGH IT WAS HOPED THAT RADIO SERVICE SHOPS in London would be classified as essential, the recent decision of the Ministry of Labor has vetoed that classification. However, individual cases will be considered for deferment. Dealers will have to supply information as to the average number of repairs, both major and minor, carried out during each month in a year; the area served; conditions relative to the adequacy of the repair facilities in that district, and the number of persons in the departments, skilled and semi-skilled. If the men employed in this work are essential and cannot be replaced by older men or women, deferment negotiations can be begun.

There will be no withdrawal of women assistants who are over thirty-one. Those between twenty and thirty-one will not be withdrawn from service unless a substitute has been supplied. It must be remembered that in England women between the ages mentioned and unmarried are subject to the National Service Act, and are included in this manpower report.

THAT THE CREATIVE TALENT OF OUR INVENTORS IS STILL IN HIGH GEAR is quite evident from the many interesting patents which are being granted weekly. Many of our old friends are still developing new systems. For instance, Walter van B. Roberts of "Roberts-Regenerative-Circuit" fame has developed a new type of oscillator for a cathode ray oscilloscope.

Unusual construction is still a design feature of radio set inventors. For instance, Daniel J. Crowley has been granted a patent for a radio receiving set with a bell-shaped casing. The radio is within the bell-shaped casing and contains the various components consisting of a variable condenser, volume control and control discs, etc. These control discs are supported one above the other and control the rotation of the volume control and condenser.

Shielded spark plugs for radio use have also come into the inventing realm. The latest patent on such a device has been granted to Tullio Tognola.

To obtain a relatively uniform frequency response over a predetermined group of frequencies and attenuation over a restricted group of frequencies, David E. Sparks has invented a new antenna system for which he has been recently granted a patent.

Aircraft communication devices have also been featured as newly granted patents. One such patent recently granted to Horace T. Budenbom covers a navigational system for aircraft. It employs a short range high-frequency wave reflection altimeter, this altimeter transmitting f.m. waves and combining received reflected waves from the earth's surface beneath the craft with instantly transmitted waves to obtain beat notes, the frequency of which indicates altitude.

Television seems to be a pet topic of many patentees. During one week six patents were granted on various television systems.

Paul V. Galvin has accepted a temporary ninety-day appointment as a technical advisor to Major General Coulton who is in charge of production for the Signal Corps . . Philco's Chairman of the Board Larry E. Gubb has been elected President of Cornell University Alumnae Association . . . J. E. "Dinty" Doyle former radio editor for the Hearst papers has been appointed director of WABC publicity . . . It's Lieutenant Commander Carl Miles now. Lieutenant Commander Miles was formerly Chief Engineer of the Hallicrafters, Inc. and is now in charge of Aircraft radio and electrical inspection for the Navy . . . Another Hallicrafter personality in the service in Marvin Roye, late of the Roye Sales Agency. He is now a lieutenant in the Signal Corps . . . H. J. Mandernach is the new Sales Manager of the Replacement Tube Section of General Electric at Bridgeport, Conn. . . . Two more radio companies have been added to the list of "E" winners this month. They are Clarostat of Brooklyn, N. Y. and Sylvania in Emporium, Pa. Philco in Chicago has won an "E" too. This is the fourth award to Philco . . . Now in charge of all sales promotion activities of the Transmitter and Electronic Tube Division of G. E. at Schenectady is John G. Porter . . . Charles Golenpaul, sales manager of Aerovox has been reelected for the chairmanship of the Eastern Division of the Sales Manager's Club for a third term . . . Emerson Markham is now the manager of the G.E. f.m. station W85A at Schenectady.

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For the Record

(*Continued from page 4*)

much more than 100 hours. Yes . . . he understood his basic circuits, but when a specific problem was presented on another circuit which was similar, he was completely lost as to what technique would be required for solving the problem. In other words . . . he had learned only the "specific" circuit in question. Others of like characteristic appeared to him as being made up of remote parts and tubes. He had learned that such-and-such a tube was a triode, but when presented with similar types, became confused and thought of each triode as a separate innovation.

We are not taking issue with those established institutions of learning, of which there are many, as they have found from long experience that to train radio men requires the following of a carefully worked out plan, and that many hours are required for the study of each particular phase. These schools are to be commended. We look forward to the day when the "overnight" institutions will follow suit and will not disillusion prospective radio students by kidding them when they ask whether or not it is possible to learn radio in four, six or eight weeks time by stating in the affirmative.

We look forward to the day when this will be accomplished.

Contest Winners

WE intended to announce the winners in our recent *National Competition for Radio Inventors* in this issue. Entries were received at the very last minute in such large quantities that we are literally swamped. It has been most gratifying to watch the arriving material and to note the complexity in design of some of the ideas presented. In fact, several of the entries have required six or eight hours of analyzing in order to determine their merit.

It is necessary that we spend considerably more time in the careful analysis of the entire group of entries in order to do every one of them justice. So many are outstanding, that it becomes a major operation in making final selection of the winners. We expect to be able to give you the good news in the February issue.

Thanks for your indulgence!

Tube Collectors Club?

EVER since we ran an appeal recently for antique tubes, we have received correspondence from several old timers who have spent many years in collecting radio tubes as a serious hobby. It seems now that only a handful of radio men possess what might be termed as an "elaborate" collection of historical tubes. We had the pleasure of making the personal acquaintance of one of these collectors on a recent trip to the east, and later found another upon our return to Chicago. We think it would be a splendid idea to form a Swap Club in RADIO NEWS to include a small group of serious collectors in order that we might aid them in securing "hard to get" types from other members.

There are few historical exhibits . . . yes, too few . . . throughout these United States where the new radio student may see for himself the growth of radio as he knows it today and which would not be possible were if not for the Flemings, deForests, etc.

We would like to hear from those who have in the past, and who are still, keenly interested in radio from a *historical* viewpoint, and if there is sufficient interest, we could lay plans to form a club for the purpose of members exchanging specimens and historic data among themselves.

How about it, fellows . . . do you like the idea?

Our own collection now totals over 300 types and you readers are still sending them in. Thanks, gang, for your help!

Recordists . . . Note!

WE have been preparing an entirely new series on the art of recording. New developments are taking place in spite of the war, and others will be made that indicate that a new series would be of value to our readers in the months to come.

We have been busily engaged in the preparation of entirely new material, and the first in this new series is scheduled for early publication.

The new series will be presented as a complete course on the subject and will include many new features. Watch for it!

Contents

GUY DEXTER, long associated with RADIO NEWS, has once more pulled something out of his hat. We refer to the story on "Emergency Radio Receivers" beginning on page 28 of this issue. You students and experimenters who are finding it difficult to get critical parts will indeed enjoy this highly informative article. It's a scoop!

Little practical information has been received of late concerning the activities of the WERS. Read for the first time an authentic story written by Lewis Winner beginning on page 10 of this issue. It will be most enlightening to you hams.

ARE you studying electronics? It's a "must" for our post war radio era.

73, OR.........................

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Microphones

(*Continued from page* 39)

X for checking button current, potentiometer P being adjusted for equal currents in each button circuit. The output is usually around ¼ or ½ volt between the grid-cathode of the tube. In Fig. 7D the ribbon mike circuit is shown. This circuit is usually employed in broadcast work but the ruggedness of the inductor mike, consisting of a moving conductor in a magnetic field, makes it particularly useful for portable applications. The output of these mikes, inductor and ribbon, is about the same, usually around 40 millivolts grid to cathode, if the cable is short and the transformers are good. In Fig. 7E, the condenser mike is shown. The output is usually very low and a pre-amplifier very close to the mike is required. Output is about 20 millivolts for a high grade mike.

In practical work, servicing a microphone is best done by the manufacturer or his specially trained field representative, although there is no reason why the average technician could not do the repair work having made a preliminary study of microphone construction. Minor repairs are usually made by servicemen operating p.a. outfits or by the maintenance department in a broadcasting system. Some stations have elaborate facilities while the smaller stations don't go in for repair but make a temporary replacement and send the mike to a service shop. The practical servicing of microphones is not covered fully in ordinary textbooks since there seems to have been little interest in this aspect except as concerns the specialist. But a number of books contain adequate descriptions of fundamental nature and appended are suggested references.

There are other important characteristics of a microphone's design and application, one of which is the microphone's directional pick-up qualifications. Each particular type of microphone has its own directional characteristic. An extreme case is the so-called sound cell, used extensively for noise measuring instruments, which is equally sensitive to sound waves from any horizontal direction. With the design and application of special housings, baffles, etc., any type of microphone may be made uni-directional; that is, sensitive at front only which would reduce to a minimum such problems as feedback, audience and background noise, reverberation, etc. Notably among this type of microphone is the Shure *Uniplex* crystal microphone and the Electro-Voice No. L-15 Velocity Microphone. Both of these are exceptionally well designed for directional pickup and are ideally suited for studio application.

Applied Acoustics, Olson & Massa, P. Blakiston Co., Philadelphia, Pa.
Electrical Engineers' Handbook, Pender & McIlwain, John Wiley, N. Y. C.
Amateur Handbook, ARRL, 38 La Salle Road, Hartford, Conn.
Service, 19 E. 47th St., New York, March, 1939; February, 1940.

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Fig. 6. Crystal microphone.

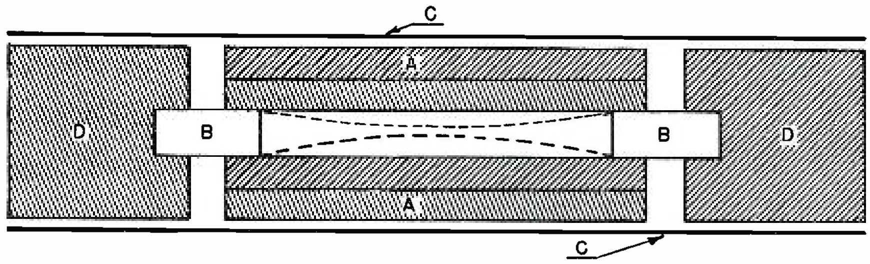
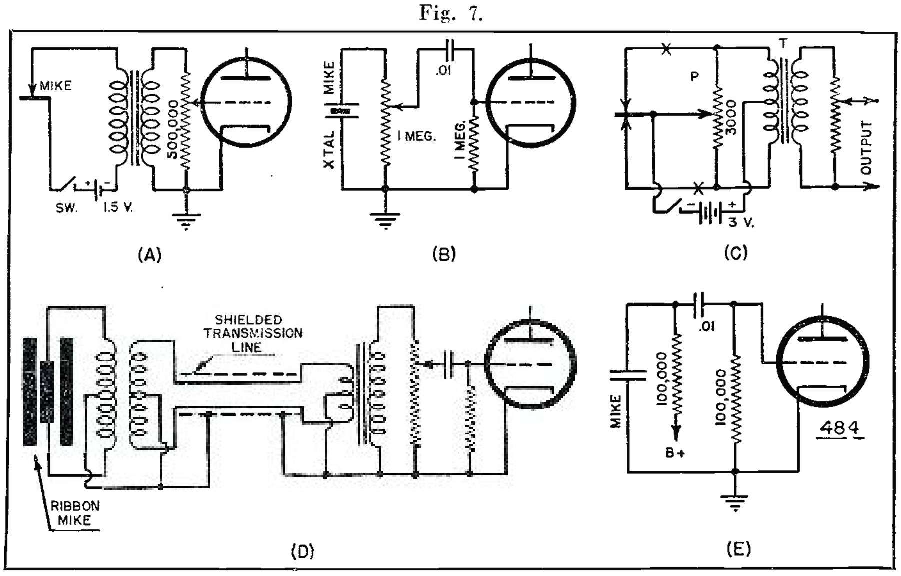


Fig. 7.



Progress in Electronics

(*Continued from page* 16)

meter. It also tells how its range can be extended; as described in this resume its upper limit is 100 volts.

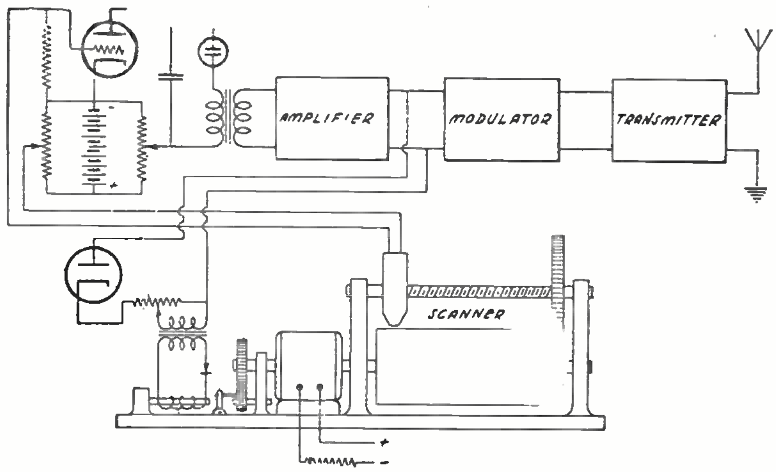
Patents on no less than five electronic measuring instruments, not to mention a tube control circuit, were granted in a single week to Colin I. Bradford, of Stratford, Conn., and assigned to the *Remington Arms Co.* While all are worthy of comment, only one can be considered here, due to the vast output of American ingenuity under the spur of wartime need. The one covered by Patent No. 2,301,194 is referred to as a "flight detecting device," and may be used to measure the speed of such objects as bullets.

Suppose a crystal microphone to be connected in the grid circuit of a vacuum tube, the output of which is amplified and fed to some such instrument as a recording galvanometer; this would register the instant at which the discharge of a firearm took place, or when the projectile passed the microphone. Then suppose the bullet or other projectile is directed through the axis of a coil which is coupled to the plate-cathode circuit of the first tube and the grid-cathode circuit of the amplifier. The passage of a metallic object through a coil in which current (a.c. or d.c.) is flowing will cause a change in such current; thus another impulse is registered. By having the microphone and coil at a measured distance apart, and by causing the strip upon which the two impulses are registered to move at a predetermined speed, the velocity of the projectile is easily measured.

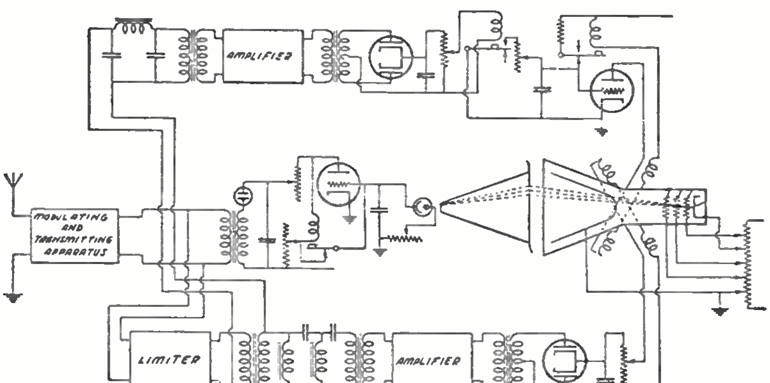
Not quite so directly connected with the war effort is a new facsimile system which has been assigned to RCA by John W. Cox, of Berkeley, Calif. This is but one of a number of picture transmission methods recently covered by patents; another, particularly designed for FM has been assigned to *Bell Telephone Laboratories.*

Mr. Cox's invention—he has just patented three; this is No. 2,301,374—is particularly interesting in that it does not employ synchronizing units, long considered an essential part of all facsimile equipment. It employs a scanner, an oscillator the frequency of which is varied to some extent by a photoelectric cell included in its circuit, and a cathode ray tube, much like those used in television. An optical system projects the cathode ray onto the PE cell, while a high-pass filter connected to the oscillator is so arranged as to pass a band the amplitude of which varies with the frequency, while the output of the filter energizes the horizontal-deflecting elements; the vertical deflecting coils or plates are controlled automatically when the frequency of the oscillator reaches a predetermined limit. Thus the unit becomes automatically self-synchronizing.

Nor can another of Mr. Cox's inventions be ignored, for it makes use of a variable-speed scan, automatically controlled by the density of the picture being transmitted. As described in patent No. 2,301,375, a tiny light beam is caused to scan a picture transparency arranged on a cylinder and rotating around an axis along which the scanning cell travels. But the rate of such travel is not uniform, for as the diagram shows, the cell is fed into a tube, the output of which is amplified and used not only to modulate the transmitted signal, but to control the speed of the rotating cylinder as well. Thus the movement of the cylinder is made intermittent, the periods at which it is at rest varying according to the density (or "darkness") of the portion of the picture being scanned at any instant. One great advantage of this system is that it can reduce the contrast in an excessively contrasty subject which, in ordinary facsimile systems, would "wash out" the highlights or "block" the shadows; another is that it can be made to add contrast in subjects which are too "flat" for good transmission under other methods.



No. 2,301,375.



No. 2,301,374.

Farnsworth Television and Radio Corp. has likewise acquired a new patent in the visual radio field. This, the invention of Madison Cawein, deals with automatic control of the overall black level of a television image. As disclosed in Patent 2,301,522, an intermediate IF amplifier builds up the video signal at an intermediate carrier frequency, while a separate tube amplifies the demodulated video signals. An output impedance is connected to the anode of the latter tube to develop a voltage drop in accordance with the demodulated signal, and a direct current path is provided from this impedance to the control element of the cathode ray viewing tube, while a condenser is used to by-pass the a.c. component. The result of these and other circuit details is to maintain a

Statement of the ownership, management, circulation, etc., required by the Acts of Congress of August 24, 1912, and March 3, 1933, of Radio News, published monthly at Chicago, Ill., for October 1, 1942. State of Illinois, County of Cook, ss. Before me, a notary public in and for the State and county aforesaid, personally appeared A. T. Pullen, who, having been duly sworn according to law, deposes and says that he is the business manager of the Radio News and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, W. B. Ziff, 540 N. Michigan Ave., Chicago, Ill.; Editor, B. G. Davis, 540 N. Michigan Ave., Chicago, Ill.; Managing Editor, O. Read, 540 N. Michigan Ave., Chicago, Ill.; Business Manager, A. T. Pullen, 540 N. Michigan Ave., Chicago, Ill. 2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Ziff-Davis Publishing Co., 540 N. Michigan, Chicago, Ill.; W. B. Ziff Co., 540 N. Michigan, Chicago, Ill.; B. G. Davis, 540 N. Michigan, Chicago, Ill.; W. B. Ziff, 540 N. Michigan, Chicago, Ill.; S. Davis, 540 N. Michigan, Chicago, Ill.; A. Ziff, 540 N. Michigan, Chicago, Ill. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holder as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. 5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is .... (This information is required from daily publications only.) A. T. Pullen, Business Manager. (Signature of business manager.)

Sworn to and subscribed before me this 25th day of September, 1942.

[Seal.] Lois Rea. (My commission expires January 28, 1946.)

relatively constant bias voltage between the control element and the cathode of the second amplifier. It is interesting to compare this method with the familiar d.c. restorer circuit, used as automatic over-all brilliance control in television receivers which are now in use.

As the previously mentioned circuit controls black level in television, so does the circuit covered by patent 2,301,607 control noise level in radio receivers. Invented by W. P. Bollinger and N. I. Korman, who have assigned it to RCA, it is a relatively simple form of "bucking bridge." There is a circuit which feeds in the signal, a demodulator to the output of which a limiter-rectifier is connected, and a voltage-doubler rectifier. A control potential is applied to the limiter-rectifier, comprising a voltage-doubler rectifier and demodulator connected in a back-to-back relation. Thus a noise surge is made to cancel itself out, to a large extent if not completely.

RCA, by the way, has long been a leading proponent of noise limitation. Some ten years ago, that company was featuring sets with Q.A.V.C. (quiet automatic volume control) which enabled the user to choose a point of sensitivity below which the set would be unaffected by incoming impulses, whether signals or "static." Although that old circuit did not cut the peaks of interference crashes, it did keep a great deal of "dirt" off the signals.

Getting back to the visual for a moment, the *General Electric Co.* has been assigned a German patent (U. S. No. 2,301,826) which covers something really startling: a *stereoscopic oscillograph!* By optical means, the user is enabled to view four cathode ray tube screens simultaneously and, apparently, superimposed. Consider one half of it at a time. Two such tubes are placed at right angles to each other, and a semi-silvered mirror is so placed in the observer's line of sight that one tube is viewed by reflection, while the other is seen through the semi-transparent mirror. One such set-up is provided for each eye, lenses like those used in stereoscopes being employed to bring the two pairs of images together. This invention virtually quadruples the utility of the oscillograph, for it enables the viewer to correlate the readings of four oscilloscope tubes into a single interpretable image. It is, one might say, the most interesting patent of the month.

This, by the way, is a month which, to this reviewer, seemed considerably behind its predecessor in regard to variety of inventions. True, some of those which were disclosed are of considerable importance, but the general scope was somewhat narrower than is usual.

Of course, inventions of great military significance are not published: they are carefully guarded secrets, and rightly so. The best brains in the radio world are turning out plenty of devices which will help speed the victory of the United Nations. Some of these will doubtless remain secret long after the war is won, while others will be put to use for the benefit of the American people.

The general trend of opinion is that television will be one of the utilities to become popular after this war, much as radio did after the First World War. Some believe that color television will be as common as, say, frequency modulation is now. These persons visualize black-and-white television receivers selling for as little as $25, and producing pictures far surpassing those now obtainable on sets costing well into the hundreds of dollars. While this reviewer would like to be equally optimistic, he can but quote a line from *Caponsacci:* "Possible—but difficult to believe!"

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Exp. Power Supply

(*Continued from page* 17)

switches. These switches can be numbered according to the order in which they follow, with small brass numbers which can be bought at any hardware store.

Marking the "B" power scale can wait until checked and tested with a voltmeter.

The small chassis for mounting the tube socket was constructed from a piece of number 16" gauge metal and was just large enough to seat the eight-prong octal socket. Drill two 8-32 holes on the back angle of the chassis, and bolt it to the back panel of masonite. All screw heads that might protrude from the surface were countersunk with a large drill.

Select a good eight-prong terminal strip, and mount it at the bottom of the front panel. These terminal markings were painted with colored enamel paint to match the different colored resistance wires. Be sure and designate the numbers of these terminals in round numbers with a sharp tool. Apply white enamel; then wipe off surplus from black surface.

Next, mount all of the switches to the front panel, soldering them into the circuit as they are mounted. It was found that by wiring the back panel separate from the case, a better soldering job resulted. Then connect the missing links to the eight-prong terminal strip.

Testing

After the circuit is wired, be sure to look over the circuit two or three times before testing for operation or application. Do not screw the back panel into place before the red glow of the rectifier tube appears after plugging into the power line. The rectifier heats up to normal and we now check for "B" voltages. In doing so, rotate the variable *Bradleyohm* to the right and check for polarity and voltage. First, place your voltmeter leads across terminals Nos. 7 and 8, checking for polarity. The red terminal lead from your voltmeter, being positive, must correspond to terminal No. 7.

By rotating the variable resistor R1 through its entire range, the output voltage at terminals Nos. 7 and 8 on the power supply may be varied from a minimum to a maximum value depending upon the necessary load current. At 120 ma., which is the maximum current permissible for this tube, the voltage may be varied between 76 and 0 volts; at 40 ma. drain the voltage can be varied from 132 volts to a minimum of 32 volts. It is apparent from these figures that one cannot calibrate and plot a single voltage calibration chart to meet all load conditions.

Several calibration curves may be made by plotting the voltage output against the rheostat position for various load currents, such as 20-40-60 ma., etc. However, in order to utilize these curves it would be necessary to know the current drain which the external load would need. This is not always known, and therefore it would be advisable to connect either externally or internally across terminals Nos. 7 and 8 a d.c. voltmeter, through which the actual output voltage may be read and varied by the variable resistor R1.

After the power supply has been tested, we now go to the heater supply, and if an a.c. voltmeter is not available, the different voltages can be tested by application of several radio tubes in series, selecting tubes with voltages of 6.3, 12, and 25 volts, etc.

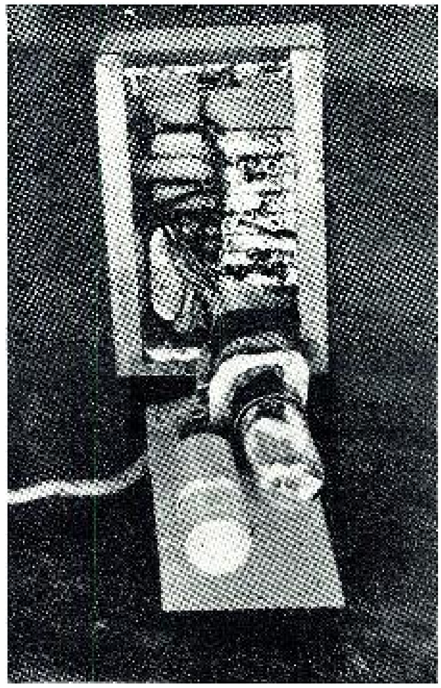
Looking at the filament voltage chart, we find that the necessary drop voltages for a 12-volt vacuum tube is approximately one hundred volts from the 117-volt line. Computing from the chart, hook the heater terminals to 4 and 6 with all of the switches in the "down" position. Be sure and check all switch positions twice before connecting the vacuum tube, as all radio tubes have only one life.

Proceed with the testing by hooking in series, two 12-volt vacuum tubes with a .3 ampere current rating. The chart states that the sum of 24 volts (the sum of the two tubes) subtracted from 117 volts equals a drop voltage of 93 volts across terminals Nos. 3 and 6 with all switches in a down position. Try adding various vacuum tubes in series until the drop voltage scale is thoroughly tested.

Note: In reference to the filament voltage chart, there are several switch positions omitted. Where these occur, the position of the switch is of no importance.

When the unit has been tested and proven to be wired correctly the small universal supply awaits application.

This little universal unit will furnish power supply to your present shortwave receiver, broadcast receiver, battery "B" supply, photo-cell hookups, etc. The little supply was first tested on a small shortwave battery receiver with a low "B" voltage supply of 45



Tube and condenser mount on back cover.

volts. The filament voltages were taken from an external "A" battery.

—30—

Sound Effects

(*Continued from page* 21)

full length on a table. Conversation between the dancer and an actress reached the air through a pair of mikes, one suspended over the table, the other placed near the floor.

One of the most realistic series of sounds ever aired went out from a theatre, long hall and washroom of the old Melrose broadcasting studio in Hollywood recently. The script called for action on the side of a mountain, within a deep cave and through a partly open stone door 25 feet in thickness.

For the outdoor episodes, the producer removed all the seats from the theatre and covered the walls and ceiling with sound absorbing drapes. He placed the actors at the rear of the stage, with three microphones 20 feet distant upstage. Jungle birds sang and breezes whistled from records as the cast walked out into the dead room, giving a true effect of an excited dialogue out in the open.

In order to achieve echoing cave effects, Scherdeman placed two ribbon microphones 60 feet apart in a nearby corridor. Flagstone and rocks were scattered along the floor. Characters spoke their lines while treading on the rock six feet from one mike. Distance and "acoustic lag" delayed their voices over the distant microphone. Coupled with sharp echoes from the hard surfaced walls, the split-second double talk produced the unusual effect.

When it came to talking through a

crack in the heavy, mythical rock door blocking the imaginary cavern, two of the cast simply stood 12 feet apart and spoke to each other behind a thin board backing placed six inches out from a wall. Their words were guided by the narrow channel to a mike placed midway between.

Scherdeman is preparing now for an innovation which he already has tried experimentally—splitting a program and delivering it by halves over two stations simultaneously. This will require two receivers in each home, placed at opposite ends of a room, or in adjoining rooms. The percussion and brass section of an orchestra will be heard through one, the strings through the other; or conversation will be divided, to sound more like small talk in the family circle. "When you hear actors talking back and forth across the living room," the producer predicts, "you will experience effects of far greater interest than those emerging from a single loud speaker."

Actors will not stand beside microphones on open stages. If the story calls for action on the porch and through the rooms and halls of a home, they will recline, sit, stand, walk, talk and cook within a skeleton house, complete from portable walls to a davenport and kitchen range.

For a recent broadcast, just such a house was set up in a Hollywood studio. Actors and actresses walked from a kitchen, surrounded by seven-foot plywood walls and containing furniture and appliances to be found in any kitchen, through a narrow hall, into the front room, and out through a snow-covered front porch. Seven mikes picked up the dialogue. To make the action and speeches seem more real, each character spoke from a "real life" position. One talked down toward the stove, while an overhead microphone caught her words on the bounce; another spoke up while reclining on a couch. Only the snow and porch were make believe. Bags of starch strewn over the floor of a tiny, enclosed room, crunched like the genuine article.

—30—

Aviation Radio

(*Continued from page* 37)

and transmit messages for the Captain or passengers. The radio operator will seldom use radiophone unless he is answering a distress call given by radiophone; the large part of the communications handled between aircraft and ground is by c.w.

The frequencies used by the radio operator are dependent upon the following: time of day or night; distance to be covered; frequencies assigned for contact with various stations; and general all around atmospheric conditions. In case he cannot contact on one of his regular schedules he will usually shift over to another frequency being guarded by the ground station and call. If no answer is heard, he will try another frequency until he has made contact. In the event that he has covered all assigned frequencies he will go back to his first frequency and call at regular intervals. These intervals vary from three to ten minutes, depending upon the regulations promulgated by the agency he is working for.

In view of the fact that the ground stations must know the aircraft's position at all times and if it is impossible to contact the aircraft, direction finding stations will usually listen for the aircraft transmissions and take bearings during the calling periods. On contact the radio operator will send position reports to the ground stations who will compare the d.f. bearings with those received. In this way the reliability of the base d.f. stations can always be established. If no contact is made with an aircraft for long periods, it is assumed that the equipment is inoperative; the aircraft has been forced down, or the operator is ill. The latter of course does happen, but not often. No reports from land stations or ships at sea concerning aircraft is indicative that something has happened to the craft. Of course, in wartime, it is obvious that "radio silence is golden."

The navigator will usually check his position reports with those of the radio operator and ground d.f. stations. The exact position of the aircraft at any given time is then easily known.

In domestic aircraft (airlines) where the co-pilot usually acts as radio operator, voice communication between ground and aircraft is utilized. Position reports, weather information, etc., is transmitted to and from the aircraft. Radio compass bearings, although not depended upon wholly for accurate navigation of the aircraft, afford the pilot with information which can readily be co-related with instrument bearings to give accurate check on position.

Perchance the equipment in a multi-motored aircraft carrying a radio operator becomes inoperative due to mal-adjustment or mal-functioning of one or more small parts, the radio operator in a few cases is able to render efficient repair. But in aircraft such as those employed by the airlines (domestic) if the radio equipment ceases to function, very little can be done about repairs and it is then necessary to depend upon auxiliary equipment. Upon landing at the next station (or if the weather is bad), at an emergency landing field, repairs are affected by trained personnel in a very short time.

During a flight, the radio operator must continually check on his equipment, take readings from various meters and plot them on an equipment log which is separate from the operating log.

The equipment log (depending upon the type of equipment) will usually contain space for indicating power to the final power amplifier stage or stages in the transmitter or transmitters; total final plate current and voltage; filament voltages; antenna current, etc. If readings during a flight are not what they should be, radio maintenance personnel will, upon the plane's arrival at a scheduled station, examine the log, obtain a generalized idea of the trouble encountered, and perform the necessary repair work. An equipment log includes dates and times for all transmissions.

In some types of equipment found in aircraft only two meters will be found, viz., final plate current indicator and antenna current meter (r.f. meter). If these are watched carefully during a flight a "running check" can be made on the equipment at all times. Low plate current could indicate low supply voltages, improper tuning, bad tubes, etc. No antenna current could indicate improper tuning, shorted antenna (to plane structure), defective antenna switching relay, etc.

An aircrafts operating log must always be conveniently located as it contains all essential data required by the FCC in addition to the information useful to the operator. All remarks are usually abbreviated and written in such a manner that enables any radio operator to understand them. When abbreviations are used in preparing FCC data, these must be explained somewhere on the log in order to obviate the possibility of a misunderstanding. In some of the larger aircraft two radio operators will operate the station in shifts or "tricks." The Junior operator who assists the Senior operator is often an apprentice or student and is often given the responsible duty of keeping the operating log "up to date." Most logs will contain two sections. One section will contain all the information required by the FCC and the other section will contain the information required by the operator's employer. This facilitates making entries and at the same time allows the relief operator to get a factual view of operating conditions, etc., upon coming on shift.

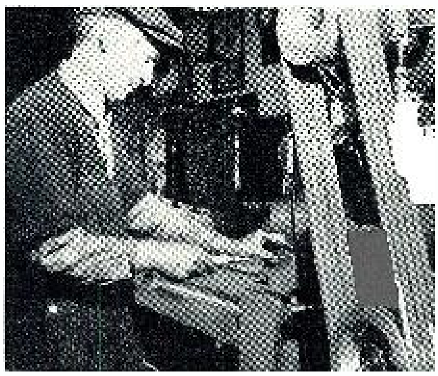
In order to expedite the transmission and reception of traffic, "Q" signals and abbreviated signals are employed by the experienced operator. No attempt is made to memorize all of those used, however, but the most commonly used are remembered after some repetition. A "Q" signal chart will usually be mounted on the operator's bench for quick reference.

Depending upon the form prescribed by the employing service, messages transmitted from an aircraft while in flight will contain in addition to the text: the time the message was originated (filing time in Greenwich Mean Time, 24-hour system); date; address of station or person to whom the message is going; signature of originator; name of the aircraft and/or call letters; and in some cases the craft's position. All traffic from aircraft to ground and vice-versa is handled as quickly as possible; brevity being the keynote to efficient operation.

The distress signals used by aircraft are: SOS for radiotelegraph and for radiotelephone, MAYDAY. The latter being a derivation from the French word m'aidez, meaning "help me." Distress messages concerning position, plight of the craft, etc., will follow the distress signals as soon as practicable.

The signal P-A-N, the urgent signal, is used when an aircraft station desires to make known that the craft is damaged and is forced to land; it being in need of no immediate assistance. It may be sent by either radiotelegraphy or radiotelephony. The urgent signal has immediate priority over all types of communication except distress signals, and must not be confused with the radiotelephone safety signal which is SECURITY. The safety signal is repeated three times after an initial call.

A form for transmitting the distress signal is as follows: SOS, SOS, SOS,



Skilled workers keep assembly lines moving.

de (from) "KZXCX KZXCX KZXCZ," K (go ahead). For radio telephone distress, MAYDAY is spoken slowly and plainly three times followed by the call letters of the station. Depending upon the situation, a position report may be given immediately after the distress call. Immediately after the call letters have been transmitted, "go ahead" and/or "answer" are transmitted verbally. if a position report is given, immediately after this report.

The reason for the hasty position report is that the aircraft station may become inoperative due to an impending crash or because of battery operation is only limited to short transmissions. In case a position report is heard in conjunction with the distress signals, other craft may proceed directly to the craft in distress with minimum delay.

Aircraft flying over maritime lanes are always equipped to receive and transmit on 600 meters (500 kcs.).

It has often been said that the well trained aircraft radio operator is somewhat of an amateur meteorologist. Aircraft flying over long distances such as those covered by *Pan American Airlines* cannot take chances with inclement weather. Weather forecasts, winds aloft, conditions at stations enroute, etc., must be known by the pilot and navigator if a flight is to reach its destination in a minimum amount of time. The radio operator must be capable of receiving weather information accurately, and this can only be accomplished if he is familiar with weather sequence transmission, and the forms used.

In order to simplify and expedite weather traffic, prepared forms containing "sequence blocks" are often used. These forms are approximately 4" x 4" and are lined so that it is a very simple task to fill in the data as it is received. Abbreviations (short forms) are used which makes weather traffic easy to copy and transmit.

A weather report for a station would look similar to this: GV LWR BKN 2 CLG 5 VIS 10M SE9 T70 D61 ALT (BAR) 2990. Deciphered: Green Valley, lower broken clouds at 2000 feet; ceiling 5000 feet (estimated); visibility 10 miles; wind direction and velocity, southeast 9 miles per hour; temperature 70 degrees; dewpoint 61 degrees; altimeter setting (barometer) 2990.

It is readily apparent that by using abbreviations that much time is saved.

In order to take advantage of winds at various altitudes the pilot must know their direction and velocity. If it is possible to "hook" a "tail-wind" at 9000 feet, the efficient pilot flying at 5000 will climb to that altitude after advising ground stations that he is making the change. With the tail-wind in the proper direction, an aircraft will of course travel faster. Various weather stations throughout the United States observe "winds aloft." That is, by utilizing a gas filled balloon which ascends upon release it is possible to calculate wind direction and velocity (if a theodolite and wind gauge are used), at various altitudes. Winds aloft are radioed to pilots upon request and if a radio operator is employed he receives the transmitted reports and gives them to the pilot and navigator for their information.

According to the *United States Weather Bureau* winds are rated according to velocity in miles per hour (mph). A light wind varies between 1 and 9 mph; a fresh wind between 10 and 19; a brisk wind between 20 and 29; high winds vary between 30 and 39; a gale between 40 and 59; and a hurricane, 60 mph up.

When a ground station transmits winds aloft information, transmissions are brief and concise. For example: the radio operator will send, "W/A Greerson . . . 2000,40; 4000,225; 9000, 240," etc. Deciphered the report would read: "Winds aloft at Greerson . . . at 2000, 4000, and 9000 feet; 40, 225, and 240 degrees respectively." In some instances the abbreviation for feet "ft" will be sent after each altitude; viz., 4000 ft. 40, etc.

General Information

Logs: Logs must be retained for a period of one year. If they contain information concerning a disaster which is being investigated by the FCC (who has notified the licensee) they must be retained until the licensee has been told to destroy them. Logs must be accessible for inspection by an authorized FCC representative at any reasonable hour. Erasures, obliterations, etc., are forbidden. Errors must be struck out, initialed by the operator and the date correction was made, indicated.

Licenses: Only citizens of the United States may be issued radio operator permits. Only a licensed operator possessing the proper class license can make adjustments to a radio transmitter. However, a licensed operator responsible for the maintenance of a transmitter may permit other persons to adjust a transmitter in his presence for the purpose of carrying out tests or making adjustments requiring specialized knowledge or skill, but he will not be relieved of the responsibility for the proper operation of the equipment. All licenses will be posted in a conspicuous place within the radio station for inspection by an authorized representative of the FCC at any time. In aircraft radio stations, aircraft radio operators need not post their licenses if they possess verification cards which testify to the existence of the original license. Information concerning radio operator's license examinations may be obtained by writing to the Federal Communications Commission, Washington, D. C., direct.

General Operation: The master (Captain) of an aircraft has supreme control and can forbid the transmission of any message from his ship. Obscene, indecent, or profane language transmissions are forbidden. Priority is given certain types of radio communications in the mobile service, this priority is: 1. Distress calls, distress messages and distress traffic; 2. Communications preceded by an urgent signal; 3. Communications preceded by a safety signal; 4. Communications relative to radio direction-finding bearings; 5. Government radiograms for which priority right has not been waived; 6. All other communications. An operator hearing a distress signal, urgent or safety signal should cease transmission if he realizes that his transmitter is on a frequency which would interfere with the transmission; should listen in and copy the transmission; and if it is apparent no one has answered the calling station (if an answer is required) should contact the station and render aid.

Ground radio station operation is like that of the aircraft radio station but differs in that more equipment with higher power capabilities is employed in addition to teletype equipment, interphone (inter-com) units, telephone, and visual communication aids such as the light gun, signal lights, etc. In some stations, radio direction finding equipment is employed to determine the position of aircraft at any given time.

Ground radio stations employed by the airlines employ experienced operators who are adept in the operation of teletype machines, and all communications equipment used in the ground station.

Each airline uses, more or less, standardized radio operating procedure. That is, operating signals, coded reports, etc., are the same throughout a network.

The ground radio operator when he reports for duty at an airlines station must be able to use the typewriter proficiently, know standard operating procedure, etc., and be willing to learn the routine employed by that particular airline. Other than possessing the proper class radio operator's license, it is essential that he know something about weather observation (standard weather reporting forms); flight operations; know his locality (area covered by his station); and realize that every pilot whom he serves is dependent upon him to furnish needed information quickly and accurately. It could be said that the ground station operator has more responsibility than the aircraft radio operator in that he is responsible for not only one aircraft but many. It is direly essential that he "stay on his toes" during his shift because the safety of aircraft in the air depends in a very large measure on radio communication.

The mistakes often made by both ground and aircraft radio operators are: failing to listen in before transmitting; adjusting their transmitters during a period of scheduled contacts, thus interfering with other stations attempting to move traffic; making transmissions too long, in that way denying others the use of the air; mumbling into the microphone instead of speaking clearly and enunciating each word carefully; sending needless procedure signals; using the air for "interstation rag chewing"; transmitting too fast for the other operator, necessitating many "repeats"; failing to use the correct amount of power for the distance involved; and making too many calls during a contact. These errors are inexcusable. The trained radio operator is one who avoids them, and always employs methods which are conducive to efficient operation.

(*To be continued*)

QRD? de Gy

(*Continued from page* 36)

George Honold, long time op at this station up 'n' quit because of it. Will check into this and let you know . . . so adios for the nonce.

BROTHER FRED HOWE of the CTU-Radio Officers' Union wins our cheers with his membership cards "Military Membership" and "Torpedo Club Membership," two cards that will do much towards winning the future loyalty of members when this war is won. The former notes that the "member is serving with the Military forces of the United States by virtue of which he is an HONOR MEMBER and in good standing in the Radio Officers' Union without payment of dues for the duration of the war." The "Torpedo Club Membership" card states that the "member has been torpedoed and by virtue of this is an honor member of the Radio Officers' Union in good standing and paid through. . . ." Although some ops may disagree with our enthusiasm we feel that every consideration should be given to those men who are doing their utmost to bring this war to a speedy end. Three cheers again, say we.

ALTHOUGH we read with pleasure of the saving of the lives of crew members of tankers and freighters we do not know of the many men who are floating around the expanse of watery wastes in the Atlantic and Pacific Oceans. This thought was brought to mind by an anonymous communication which we received about a year ago from Puerto Barrios, Guatemala, and we wonder whether the suggestion herein contained has been acted upon. Quote Marauding 20th century pirates already have sent a number of American merchantmen to the bottom of the sea; and now that our ships are to be armed and navigated through danger zones and into belligerent ports, others will inevitably suffer a similar fate.

Some persons may be surprised to learn that torpedoed seamen set adrift in lifeboats are not all granted an equal chance of ever reaching terra firma again. Here is the reason. When a Passenger Ship is sunk, the survivors take to the lifeboats, one or more of which is equipped with a battery-powered combination radio trans-ceiver to augment the possibility of being rescued; however, when a Freight Vessel is sunk, the surviving crew members take to their boats without the benefit of such communication aid. Why? Because the maritime laws of our country fail to require cargo ships to have any of their lifeboats provided with radiotelegraph apparatus. And, of course, marine safety appliances that are not compulsory are rarely if ever installed.

Not only during the present war but in the course of past conflicts and even during the intermittent doldrums of peace, we have read with horror of incredible suffering and death among strong men of the sea who unfortunately were stranded for torturous weeks in open boats. On countless occasions the lives of distressed seafarers could have been salvaged or suffering minimized had their forlorn little lifeboat been equipped with the wireless wherewithal of contacting the shore or hailing some nearby steamer which in all probability passed them by like a distant phantom after having failed to hear their feeble cries or to see their frantically flailing arms.

True to American tradition, our merchant seamen are ready and anxious to lend their skill in serving their country and, if necessary, to risk their lives in transporting food and war material to the champions of democracy. The least we can do for them in return is to enhance their safety as much as it is humanly and scientifically possible by providing them with some means of lifeboat communication. A simple and relatively inexpensive portable radio transceiver would do the trick. It is folly for us to view the future with false optimism after having witnessed the ordeal to which the intrepid *British Merchant Navy* has been subjected during the past two years. Precarious times and troubled waters lie ahead for American seamen and they deserve to be properly safeguarded by having all necessary equipment with which to cope with every eventuality unquote.

NOW that we are turning the point of defensive fighting into the great offensive which our Navy and Army are now waging, we have every confidence to believe that this shindig "ain't gonna drift on for years" as some crystal gazers have predicted. It's the good old American way of doing things. Getting under way seems like a lot of confusion and noise. But when the ball finally does get started rolling, the end isn't far away. So chins up and cheerio, with best 73 . . . ge. . . . GY.

—30—

What's New in Radio

(*Continued from page* 27)

extensively by the Signal Corps, in Army training schools and other important wartime applications.

The 3-inch-square meter used on RCP Model 423 has a movement of 395 microamperes or a sensitivity of 2,500 ohms per volt, while the instrument has a uniform a.c.-d.c. voltmeter sensitivity of 1,000 ohms per volt. Other features include the exceptionally high ohmmeter range of 10 megohms, each shunt and multiplier individually calibrated to a close tolerance, while all multipliers are individually matched in pairs so that the overall accuracy is within 1%. A suppressor type copper oxide rectifier is used for a.c. measurements and cabled or harness type construction is used.

Completely self-contained with necessary batteries and ready to operate, this versatile RCP instrument is available in a handsome walnut finish, both in bench and portable models. Compact size and operating convenience highlight the efficient and attractive design of this RCP multitester.

This instrument—and others are described in Bulletin No. 126, available upon application at the *Radio City Products Co., Inc.*, 127 W. 26th St., New York City.

—30—

LETTERS to the EDITOR
ON THE U. S. ARMY SIGNAL CORPS ISSUE

Letters have been received from hundreds of our Military and Civilian readers and from dozens of our advertisers. We wish it were possible to include all of the letters we have received, but space does not permit. Here are a few more:

". . . This issue is particularly well done and reflects great credit on both the Signal Corps and RADIO NEWS. Issues of this nature do much to further inter-service appreciation of the scope of work accomplished by the various units. The photographs were excellent throughout and give an excellent pictorial record of the wide-spread functions of the Signal Corps."

A. D. FRASER
Lieut. Comdr., U.S.N.

". . . It is an interesting thing to contemplate, but not long ago most publishers of trade and technical journals were wondering about how they could continue publishing. Almost every manufacturer figured "What's the sense of advertising," and that only gave the publishers plenty of reason to worry. Then, in the face of all this, you come out with this wonderful issue which is nothing short of historic, and I say that takes guts on the publisher's part, as well as the very manifest skill that you and the staff used in putting the book together.
"Warmest congratulations!"

W. J. HALLIGAN
The Hallicrafters Co.

". . . Not only do we think the issue is a splendid one, but many of the U. S. Army Signal Corps officers who have seen the book found it most enlightening and thorough, and have already referred to it for the valuable material it contains."

C. GOLENPAUL
Aerovox Corporation

"This is an outstanding publishing job and just the sort of thing we have learned to expect from Ziff-Davis. . . ."

N. W. SIEBER
Advertising Manager
Continental-Diamond Fibre Co.

". . . You are certainly to be congratulated for the splendid job which you have done in this issue. It is an amazingly complete job on the subject of the Signal Corps and I certainly intend to keep this issue among my permanent collection."

H. LEVY
Chief Engineer
Ohmite Manufacturing Company

Our sincere thanks to the hundreds of persons who have so kindly given their reactions to the November, 1942 issue.—Ed.

Only a few copies left!
Special U. S. Army Signal Corps Issue
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While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

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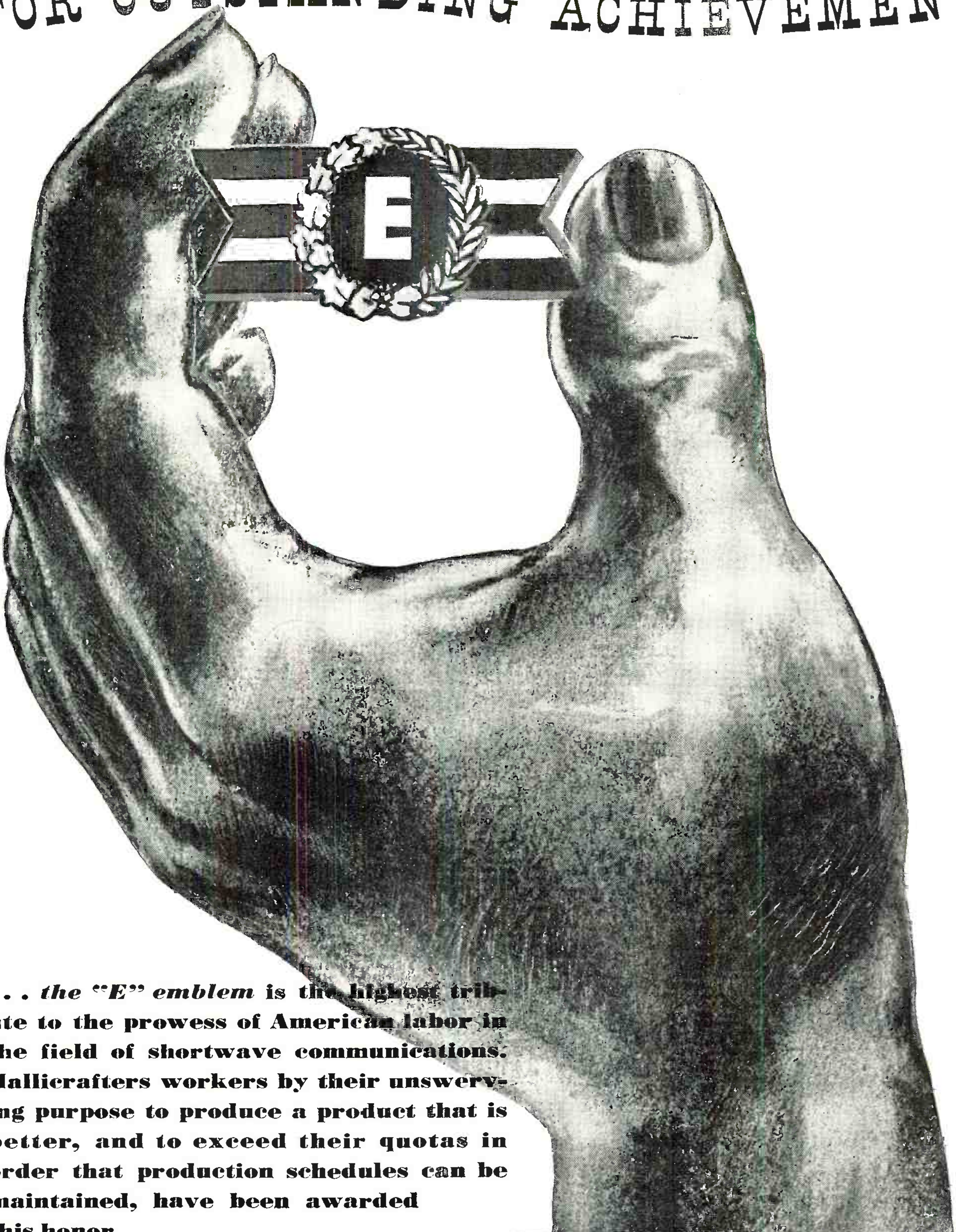

. . . *the "E" emblem* is the highest tribute to the prowess of American labor in the field of shortwave communications. Hallicrafters workers by their unswerving purpose to produce a product that is better, and to exceed their quotas in order that production schedules can be maintained, have been awarded this honor.

The accumulative electronic experience gained by Hallicrafters employes will be a dominant factor in future peace time production of advanced designs in shortwave communications receivers.

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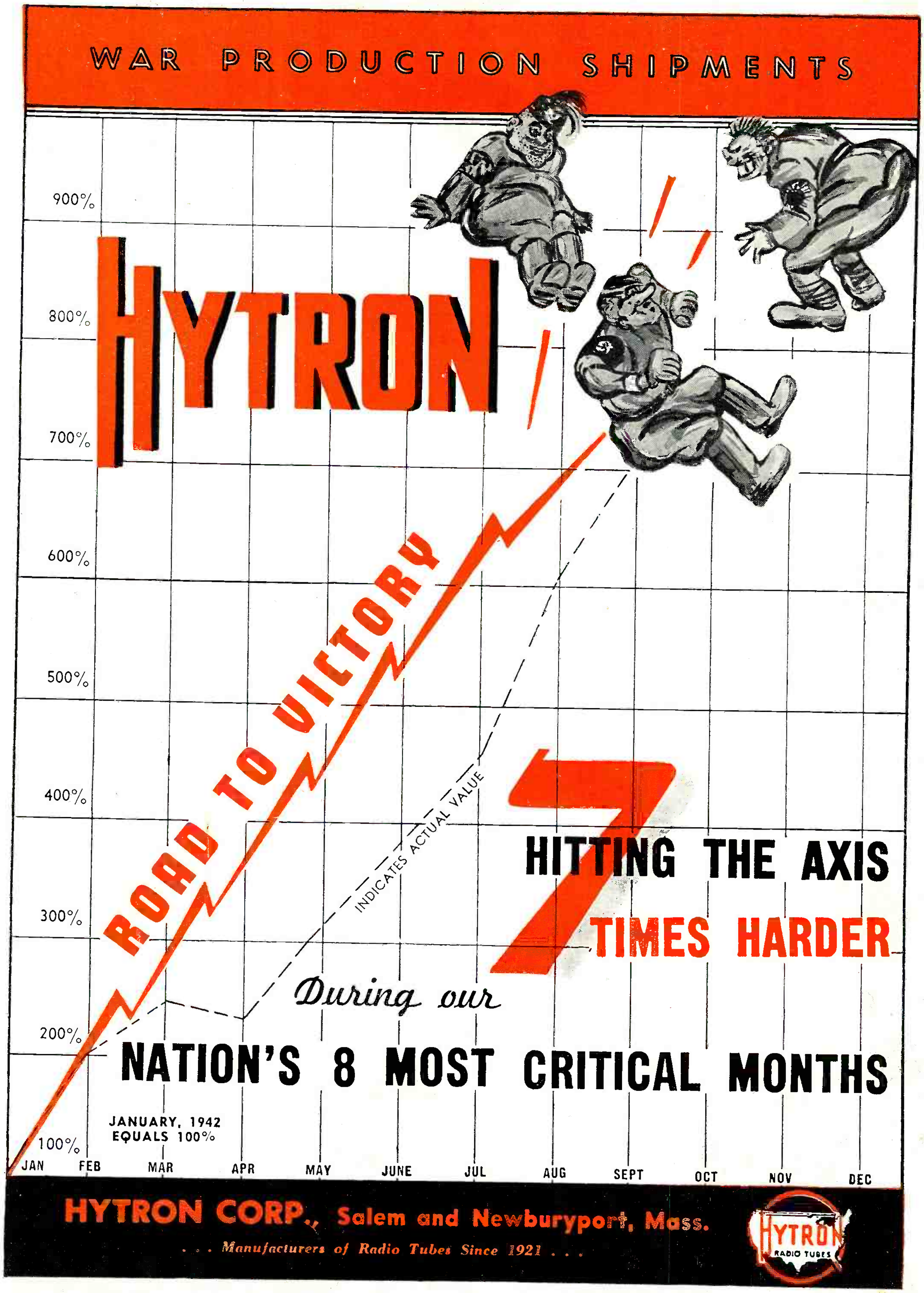
Keep Communications Open!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