HUGO GERNSBACK, *Editor*

RADIO CRAFT

In this issue—

Bridged-T Circuits

Electronic Transients

Magnetron Tubes

FEB
1946
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IN THE NEXT ISSUE

Sensitive Signal Tracer
Simple Capacity Bridge
Tuner-P.A. Amplifier
V. H. F. Transceiver
Limiting Circuits

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Contents February, 1946 Volume XVII, No. 5

ON THE COVER

The cover picture this month is from a photograph of three parabolic antennas atop the New York Telephone Building. One of each pair is a transmitting, the other is a receiving antenna. Engineers are shown making circuit adjustments.

Chromatone Cover by Alex Schomburg

hallicrafters *new Model* S-40

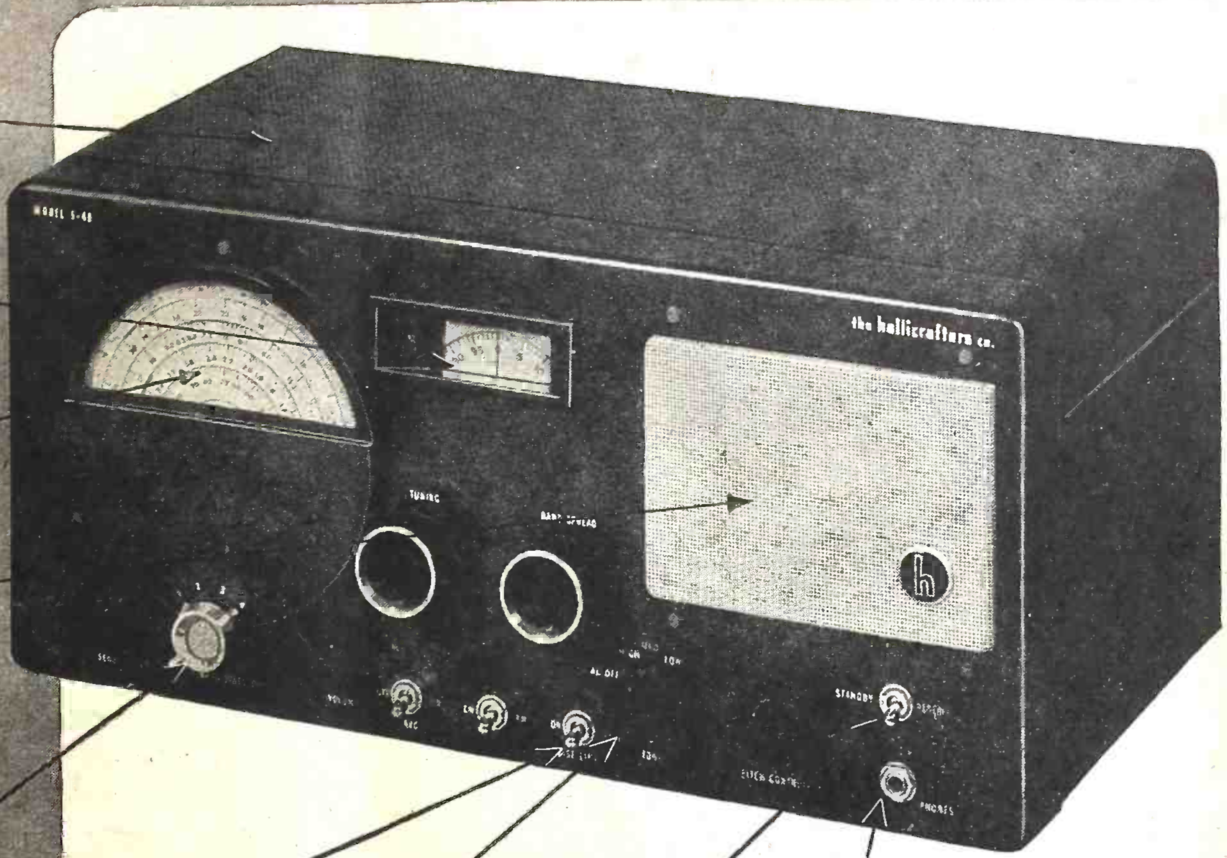
New beauty and perfect ventilation in the perforated steel top

Separate electrical bandspread with inertia flywheel tuning.

Tuning range from 540 kc to 42 Mc continuous in four bands

Self-contained, shock mounted, permanent magnet dynamic speaker

All controls logically grouped for easiest operation. Normal position for broadcast reception marked in red, making possible general use by whole family.



Automatic noise limiter

3-position tone control

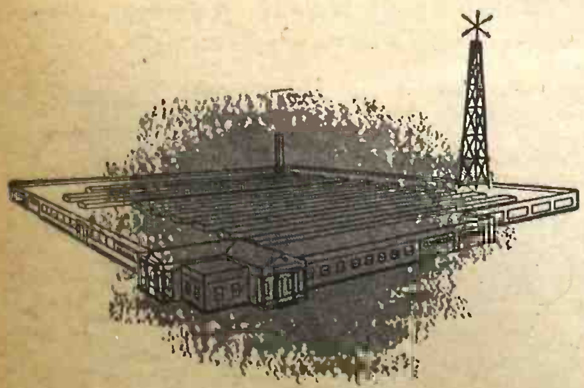
Standby receive switch

Phone jack

(APPROXIMATELY)

New design, new utility in a great new communications receiver . . . $79.50

Here is Hallicrafters new Model S-40. With this great communications receiver, handsomely designed, expertly engineered, Hallicrafters points the way to exciting new developments in amateur radio. Read those specifications . . . it's tailor-made for hams. Look at the sheer beauty of the S-40 . . . nothing like it to be seen in the communications field. Listen to the amazing performance . . . excels anything in its price class. See your local distributor about when you can get an S-40.



INSIDE STUFF: Beneath the sleek exterior of the S-40 is a beautifully engineered chassis. One stage of tuned radio frequency amplification, the S-40 uses a type 6SA7 tube as converter mixer for best signal to noise ratio. RF coils are of the permeability adjusted "micro-set" type identical with those used in the most expensive Hallicrafters receivers. The high frequency oscillator is temperature compensated for maximum stability.

From every angle the S-40 is an ideal receiver for all high frequency applications.

hallicrafters RADIO

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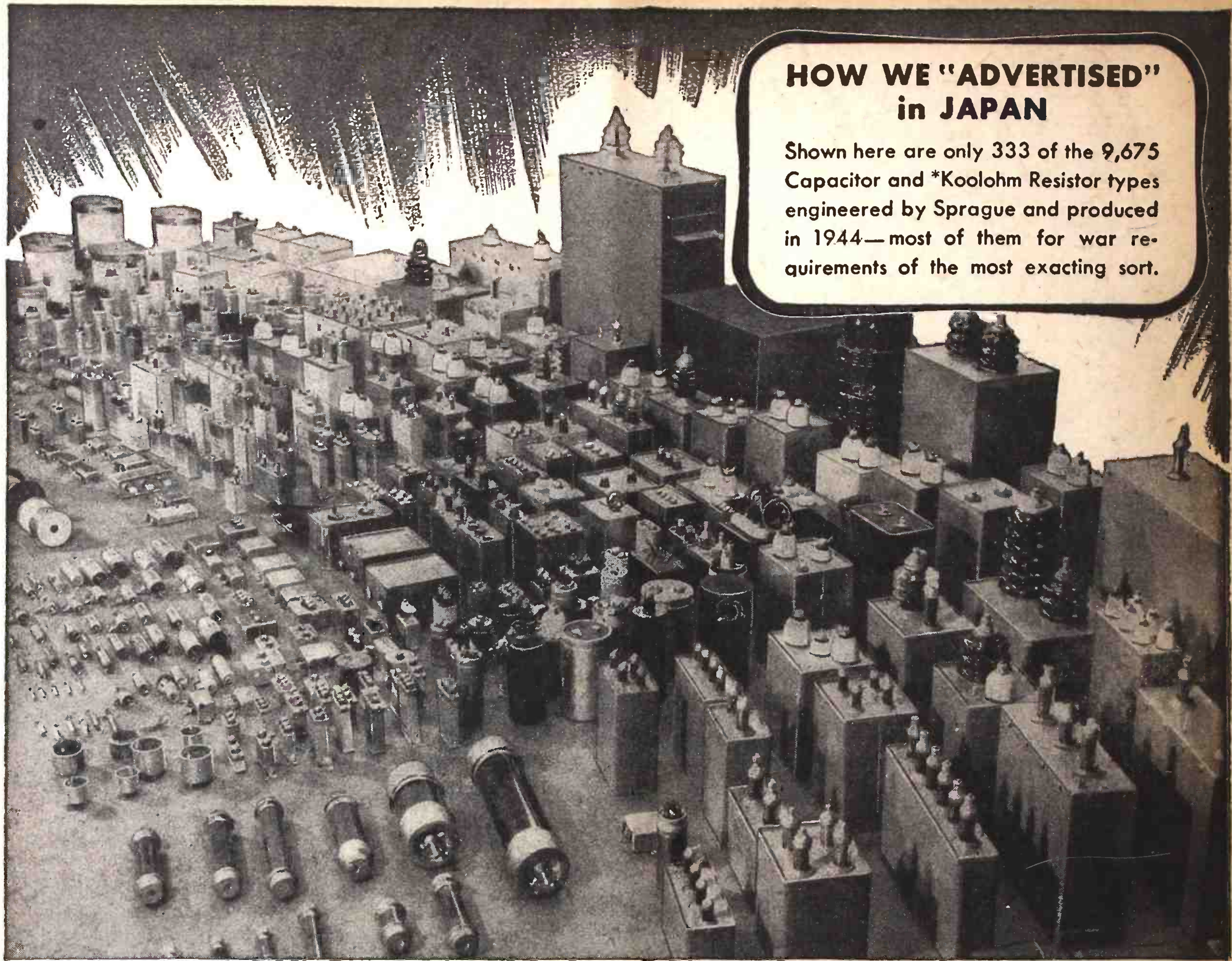
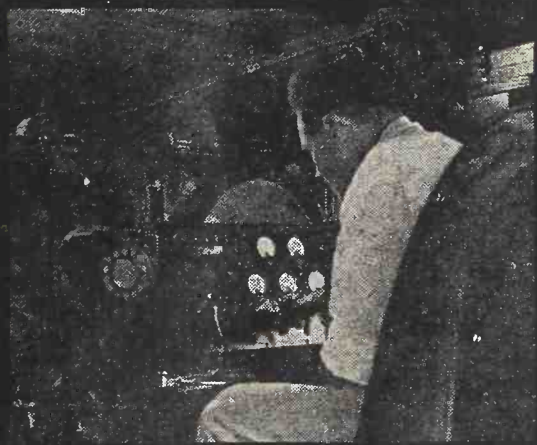

HOW WE "ADVERTISED" in JAPAN
Shown here are only 333 of the 9,675 Capacitor and *Koolohm Resistor types engineered by Sprague and produced in 1944—most of them for war requirements of the most exacting sort.

New Fields

Electronics is already a most important factor in industry. Many manufacturing processes depend on electronic controls—employ electronic processes. In medicine and agriculture, too, electronics is being used extensively. Are you ready to cash in on this development in a field that is so close to radio?

New Equipment

Every day you learn of new types of radios and improved television—new electronic devices. Fac-simile, F.M., Radar, Sonor—all present new problems of manufacture, operation and maintenance that demand training and experience. Consider your advantages if you have the necessary preparation to tackle this work.



New Hook-Ups

The relatively simple wiring of the radio receiver of a few years ago is as out-of-date today as one of the first automobiles. The new Radio and Television sets, and Electronic devices demand a thorough knowledge of new principles. National brings its students the results of *continuous research* and improved methods.

NEW OPPORTUNITIES

Think what all this great progress in Radio, Electronic power and control and Television means to YOU PERSONALLY—you who are already in Radio or have a natural inclination toward it. The greatest opportunity of a lifetime is right within your grasp.

Compare the job you now have or expect to get when you are out of service or your present war job with the great future presented you by the broad field of Electronics.

Literally tens-of-thousands of technicians are needed in Radio and Television stations and communications companies all over the country—to operate, maintain and repair equipment. The man who knows modern methods and equipment is welcome almost at his own price.

Latest figures show that Radio represents a 5-billion dollar industry and, in the opinion of experts, it is a secure, well-established, basic type of business offering steady employment. Television, according to authorities, offers half a million openings right at the start.

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Here is an interesting forecast of the future of Radio and the opportunities present for you in this, and allied fields right now. It is profusely illustrated and describes the jobs waiting for trained men everywhere. Send the coupon below for your copy.

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From O. K. Ivey, Washington, D. C., comes this endorsement: "I believe National offers the best course to be had . . . Keep up the good work."

Robert Adamsen, Kearney, Nebraska, National graduate, has two radio jobs—makes double pay as a radio instructor and as engineer at Station KGFW. He writes: "I am proud of My National training and appreciate the co-operative spirit."

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Want to be your own boss, with a fine-paying radio shop of your own? We show you how to set one up and operate it successfully. Hundreds of Coyne graduates are doing it. You can, too. Send now for details.

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My new giant Radio Opportunity Book has dozens of shop pictures, facts about Radio and Television jobs, my plans to help you. Rush coupon today. No obligation; no salesman will call. You alone will decide. But don't delay. Act NOW.

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By HUGO GERNSBACK

TELEVISION RECORDING

Video recording paralleling that of sound is urgently needed

WHEN radio broadcasting was young (in the early Twenties), it became necessary for the radio industry to record radio programs for many different purposes. It did not take long to solve the problem because the phonograph had pointed the way. Inasmuch as all recording was on relatively low frequencies, the solution was comparatively simple. Soon programs could be recorded on disks, on films, and magnetically. Today, these methods are standardized and most of the engineering problems have been solved.

In television there exists a parallel need for recording video programs, but so far the problem has not been solved satisfactorily. That there is a distinct necessity for video recording is apparent to all interested.

To begin with, television broadcasters—for many reasons—wish to keep an actual log of some of their important broadcasts so they can be recorded for historical, as well as commercial, purposes. In the near future, television sponsors will also wish a permanent record of their television broadcasts. Commercial television (advertising) broadcasts, where the same program is to be put on the air in different cities, by different stations,—will also require recorded video for that purpose.

At the present time the only way in which this can be accomplished is by means of a photographic film whereby a picture record is made of the broadcast. This film can then be preserved for any length of time and can be "played back" at a later date. This is cumbersome because film must be developed, then dried, etc. The film can either be exposed photographically, by filming the action in the studio direct, by attaching a motion picture camera to the television camera, or the motion picture camera is trained on a cathode-ray tube so that the actual television sequence is photographed.

These two methods are roundabout ways as they are purely optical in nature and are not true, direct, video recordings. What is wanted is a radio-electronic record rather than optical-film recording. The trouble with video recording is that the frequencies now used in television run above three million cycles a second, which is much too high to allow satisfactory recording (for instance), on a wax record. The ordinary phonographic method no longer works at these high frequencies for the simple reason that so far no means is known whereby a phonograph needle could vibrate at such high speeds.

There are, however, other methods whereby it will be possible to solve the problem, which now becomes one of engineering. One of the obvious methods is, a disk-film similar to a phonograph record. A sensitive circular film could conceivably be exposed whereby a light beam could be modulated electrically and a record made on the film in this manner. To "play back" such a film-record would merely mean to reverse the process by having a light beam follow the recorded spiral by shining through it. Then a very sensitive photo-electric, or similar cell, would record the light variations which then would be fed into an amplifier, thence into a television receiver. In this manner the complete record could be "played back" exactly as is a phonograph record in the audio band now. For a short program such a system would be satisfactory no doubt, but for programs running an hour or more it would necessitate too many film disks. This is also a cumbersome method, because the film-disk must be developed, dried, etc. For these reasons something better is required.

The first alternative that comes to mind is a magnetic recorder. The trouble with this is that so far it has not been possible to make a recording anywhere near three million cycles a second. There is a "lag" in magnetic recording and it also takes a certain amount of time for a magnetic "impregnation" to be impressed on iron wire.

It is believed, however, that in time this difficulty may be overcome, and it would seem that there is a possibility that magnetic recordings—even at a frequency of three million cycles—should not be thought impossible. Much experimental work remains to be done in this field, but in time this problem will also be solved.

That it is possible to do recording at very high speeds is best shown by the fact that it has been done in another way for several billion years. By this we mean that the animal eye has, and is doing it successfully. It is known that we see by electro-chemical means. There would, for instance, be no persistence of vision if it were not for the visual purple on the retina of the eye. This too constitutes a type of recording, similar to optical-film recording, except that the time-consuming developing and drying is done away with.

We now come to the second *(Continued on page 368)*

Radio Thirty-Five Years Ago

In Gernsback Publications

FROM the February, 1911, issue of MODERN ELECTRICS:

Non-Heating Spark Gap, by *D. E. McKisson.*

An Eighty-Foot Wireless Mast, by *R. C. Bodie.*

A Hot Wire Meter, by *P. W. Wormser.*

A Rotary Tuner, by *E. J. Sortore.*

New Marconi Circuit.

An Efficient Aerial Lead-In, by *Howard Tucker.*

To Receive Long and Short Waves, by *H. H. Anderson.*

A Novel Practicing Set.

A Simple Detector Stand, by *J. N. Davis.*

New Electrolytic Detector.

Compact Tuning Device, by *J. E. Crockford.*

Electrolytic Detector, by *A. P. Gompf.*

HUGO GERNSBACK

Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of Modern Electrics on file for interested readers.

RADIO-ELECTRONICS

Items Interesting

PRESIDENT of the Institute of Radio Engineers for the year 1946 is Dr. Frederick B. Llewellyn of Summit, New Jersey. He succeeds Dr. William L. Everitt. Dr. Llewellyn, a consulting engineer on the staff of Bell Telephone Laboratories, is an international authority on the design of vacuum tubes used for communication and electronic control purposes. His theoretical study of the subject resulted in his invention of the ultra-high-frequency oscillator tube which is fundamental to the development carried on during the war in radar and other communication devices. He is also known for his work on stabilized oscillating circuits used in radio and telephony. A graduate of Stevens Institute of Technology, his early work was in connection with the transatlantic telephone, and he was also one of the engineers who installed radio telephones aboard the steamship Leviathan, the first installation to be used in public service between ship and shore. In 1936 he received the Morris Liebman Memorial prize for his analysis of reactions within the vacuum tube.

FM OUTLETS are being grabbed up by existing radio groups, standard broadcasters and newspapers, *Advertising Age* declared last month. Newspapers and standard broadcast stations were responsible for more than eighty per cent of the applications for FM stations pending before the Federal Communications Commission.

Digging resolutely into its backlog of applications, FCC has demonstrated in its actions so far that no anti-newspaper theories are guiding the allotment of FM grants. Of 65 licenses awarded on one recent weekend, fully a third went to newspapers.

Impartiality of the procedure is illustrated by the fact that 107 of the 129 new licenses processed during the past month are going to applicants who are already operating standard stations, says *Advertising Age*. Of the 22 newcomers, 14 are newspapers.

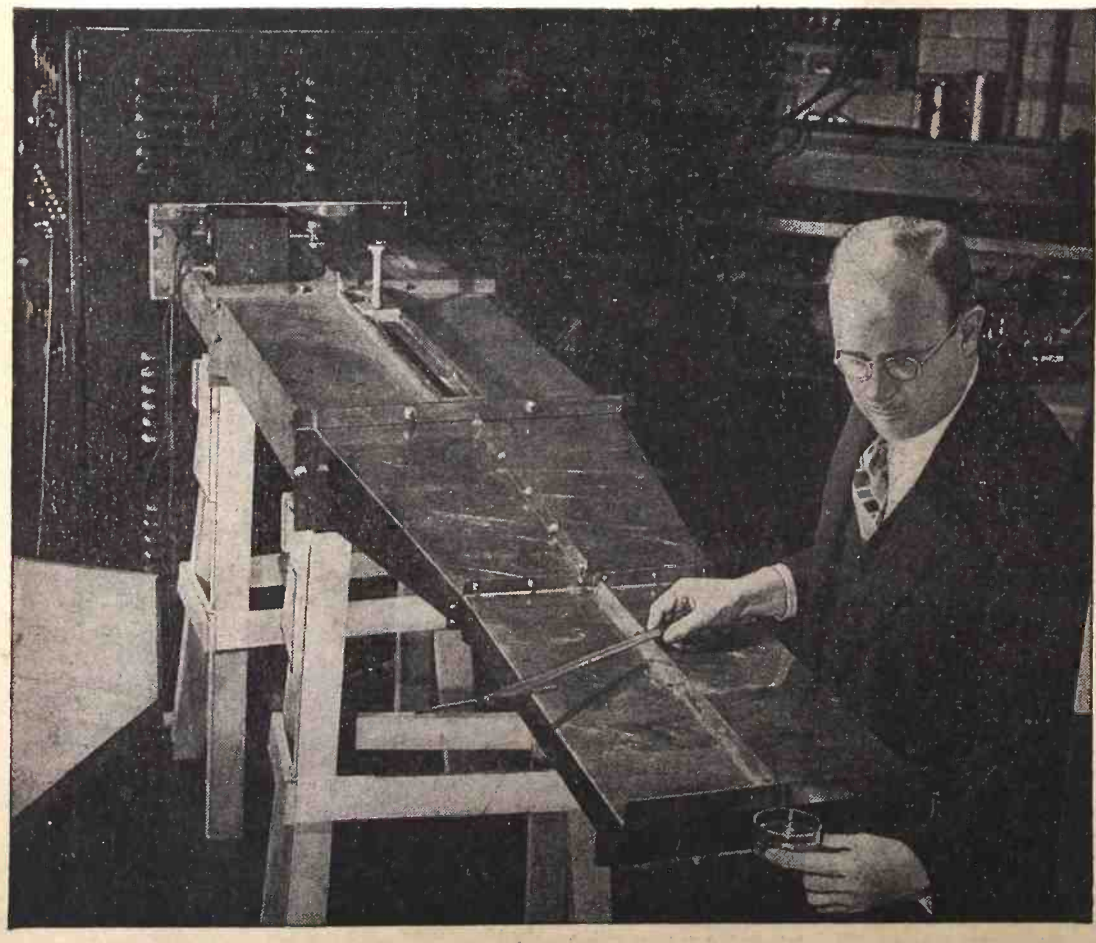
PHASITRON a new FM modulator tube, will make possible savings up to 10% in the cost of low-power postwar FM transmitters, General Electric officials reported last month.

The tube is so constructed that the electron stream is in the shape of a disc, directed against an inner cyclindrical plate which has two rows of staggered holes cut in it, one just below and one just above the plane of the disc. The excitation voltage from the crystal-controlled oscillator of the transmitter is transformed into three phases and applied to a 36-wire grid in such a way that the edges of the disc of electrons are alternately bent up and down, giving it a scalloped effect, with the edge of the disc tracing out a line on the inner anode like that of the conventional representation of a sine wave. On each deviation from the horizontal, electrons escape to the outer plate through the two rows of holes in the inner one. The rotating three-phase field causes the irregular edge of the disc to appear to rotate—all these effects resulting in a sinusoidally-varying output current.

The G-E Phasitron, frequency modulation tube.

Audio voltage from the speech amplifier is applied to a coil around the Phasitron's glass envelope. Increase and decrease of the magnetic field surrounding the coil speeds up or slows down the rotating disc of electrons, dependent on the modulation voltage, thus causing a sound-controlled phase modulation of the Phasitron's output current.

From an engineer's standpoint, the purpose of the new modulator tube is to make possible the introduction of comparatively wide phase excursions at audio rates in a crystal-controlled radio frequency carrier voltage.



Dr. J. A. Hutcheson demonstrates the new "blow-torch" at the Westinghouse laboratories.

AN ELECTRONIC "blow-torch" may revolutionize industrial high-frequency heating methods, stated Gwilym A. Price, executive vice-president of Westinghouse, at a demonstration last month. The electronic blowtorch, a dielectric heating unit which hurls ultra-short radar waves at an object to be polymerized, cured or bonded, was displayed by Dr. J. A. Hutcheson, associate director of the Westinghouse Research laboratories.

The device projects electronic waves on the material to be heated, wherever it may be, whereas previous dielectric heaters require that the object be placed in an electrical field created between two stationary metal plates or electrodes.

The advantage of this unit is that it is possible to bring heat direct to the object or joint to be heated. It can be used in restricted areas and effectively on irregularly-shaped pieces of material. Formerly, when a non-symmetrical piece

MONTHLY REVIEW

to the Technician

was placed between the electrodes, the areas nearest the electrodes were in danger of being scorched or burned before the entire piece was uniformly heated throughout.

Odd-shaped plywood forms and T-joints formed by struts or spars can be easily cured or bonded with this new super-high-frequency unit, which is still in the research stage and not available commercially.

OVER-OPTIMISM about the new Citizens Radio service was deprecated last month by Daniel E. Noble, general manager of the Communications and Electronics division of Galvin Manufacturing Corporation. Speaking over Radio WGNB, Mr. Noble pointed out that there is not room for an unlimited number of radio telephone conversations on the air, and that other services which have received much wider frequency bands are likely to be pinched at times.

"The FCC did set up a Citizens Radio Band of ten megacycles" stated Mr. Noble, "but not more than 100 party lines can be established in the band. One of the reasons for establishing the band at 460 megacycles was that this is not a very satisfactory region for radio telephone mobile and portable communications at the present time and there was no great commercial demand for such frequencies."

TELEVISION images of heretofore unachievable detail, brilliance and contrast were demonstrated to press representatives last month at the RCA Laboratories, Princeton, N. J. The new black-and-white images were made possible by receivers containing new and greatly improved Kinescopes, or picture tubes. These television pictures were bright enough to be seen in a fully lighted room.

The tubes used in the new receivers were far more efficient than any publicly demonstrated previously. In the new tubes the fluorescent screen on which the image appears in black-and-white is backed up with a very thin coating of aluminum which permits the use of higher voltages than formerly. The aluminum film acts as a mirror preventing loss of light inside the tube thereby greatly improving picture brilliance and contrast.

Stereoscopic pictures in color were also shown. The perspective of the pictures was emphasized when girl models held out flowers as if offering them to the audience. A cane pointed toward the audience protruded with amazing realism. Special polarized filters in the camera and receiver, and polaroid glasses worn by the spectators produced the three-dimensional effect.

Although the pictures reproduced by the mechanical color system show promise, RCA engineers pointed out that color television is still distinctly in the laboratory stage of development, with obvious shortcomings. There is much technical development, they said, that needs to be completed before a practical color television system will be ready for the home service to the public. They estimated that this will require about five years.

On the other hand, demonstration of the black-and-white all-electronic television system clearly showed that it is now ready for the home.

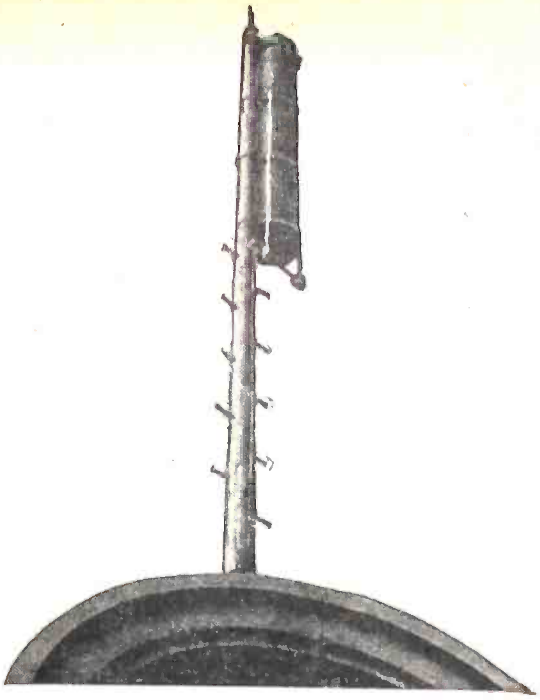
A PREVIEW of what the future may bring in the way of radio masts was given to inhabitants of New York City with the erection last month of a new kind of antenna for facsimile broadcasting. Guesses as to the function of the new apparatus ranged from atom-bomb developments to equipment for a trip to the moon.

The new antenna is built to carry both FM sound and the amplitude-modulated facsimile carrier, which is practically equivalent to that used in television. Designed by Captain W. G. H. Finch, USNR, well-known pioneer in facsimile, it is expected to concentrate the "beam" in a horizontal disc-like pattern which will result in stronger signals to receivers near the extreme range of the transmitter, which operates on line-of-vision frequencies.

According to Dr. Andrew Alford, who designed the antenna:

"The high frequency of the new FM band together with the horizontal polarization have made it possible to achieve something new in broadcasting: a single unit antenna which has gain over a half wave. This gain is obtained by using a bent metal sheet along which the wave length is longer than the wave length in space so that the radiation comes from a long vertical column. This results in a concentration of radiation toward the horizon—where it is desired—with less power being sent to the sky and into the area immediately adjacent to the station where the signal is always more than sufficient. WGHF's antenna radiates nearly equally in all directions of the compass. The input impedance of the antenna is relatively low so that the insulation is not subjected to high voltages. Only one seal insulator which is protected from the weather is used."

Close-up view of the new facsimile antenna.



The disc-beam facsimile antenna on its mast.

MAGNETIC RECORDINGS of an improved type are made by a German tape machine, specimens of which — sent home by the Army in Germany—were on display at the Department of Commerce last month. Feature of the instrument is that it uses a plastic tape with an almost microscopically thin film of magnetic material on its surface.

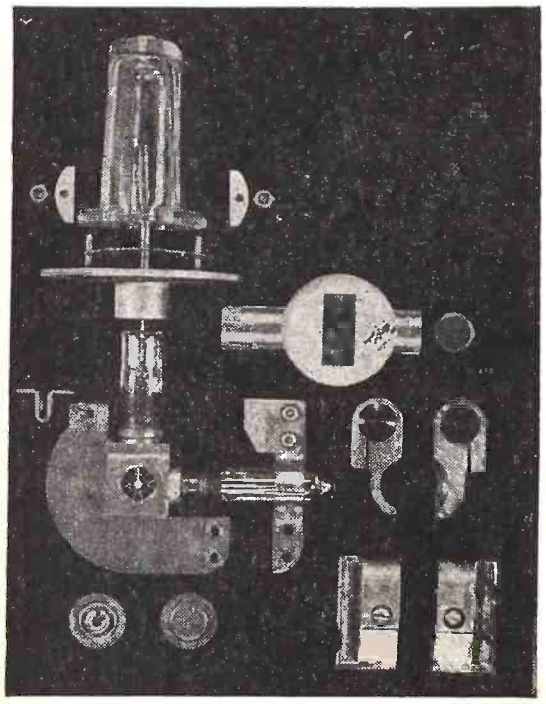
The equipment, which operates on alternating current, is designed primarily for connection to a radio receiver for recording, and to head-phones for playback. The signal from the receiver passes through an amplifier to the recording head, which magnetizes the coating on the tape. The exact composition of the tape is not known, but it appears to be a plastic composition coated with highly magnetic material.

The tape is very thin but fairly strong, and can be demagnetized and reused many times without signs of wear or deterioration. Each tape is about a half-mile in length on a single reel, and provides a recording time of about 45 minutes at average ribbon speed.

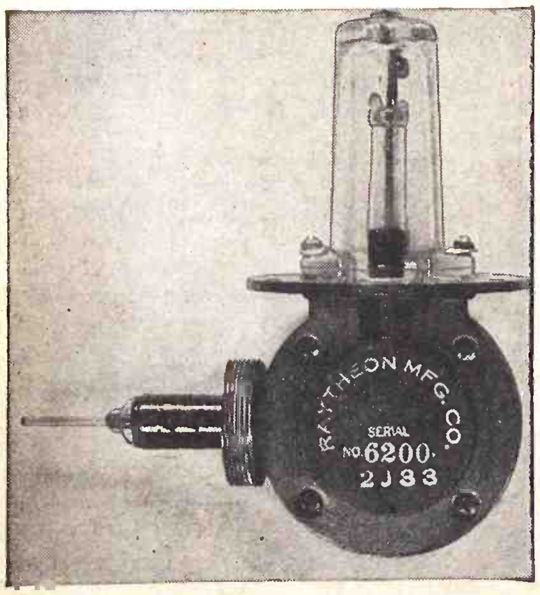
One of the interesting features of this machine is a pitch-restoring head. This device, used when the tape is played back at speeds other than the recording speed, permits restoration of the original speed.

MAGNETRON TUBES

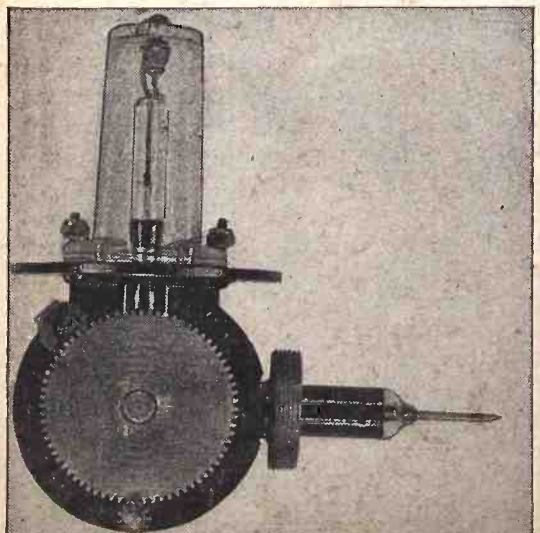
Supply at microwave frequencies the tremendous power required by radar and anti-radar devices



Cavities surrounding the central anode are easily seen in this 10-centimeter magnetron.



300-kw, 10-centimeter magnetron oscillator.



Tunable oscillator delivering 50-kw pulses.

OUR use of frequencies higher than any attainable by the enemy was one of the chief causes of the spectacular success of Allied radar equipment. Output of large quantities of power on wave lengths a few centimeters—even a few millimeters—long, was achieved of the *cavity magnetron*, one of the most important as well as most secret of our war weapons.

The magnetron itself is neither new or secret. Invented in 1920 by A. W. Hull of General Electric, it was described in technical magazines of that period as a possible means of producing ultra-short-wave oscillations. Existing tubes were efficient on all frequencies used at that time and for years thereafter, so the magnetron remained in comparative obscurity. Even when interest in waves a meter or two in length began to develop, velocity-modulated tubes or special types of standard triodes were generally used. Only the necessity of generating centimeter-length waves, needed for greater definition in radar apparatus, brought investigators back to the almost forgotten magnetron.

Basically, the magnetron is one of the simplest tubes in existence. It consists of a straight cathode surrounded by a cylindrical anode. The anode may be divided into segments, making an array of two or several plates around the cathode. The tube is operated in a strong magnetic field, with the access of magnetizing forces parallel to the cathode (N and S poles at end of tube).

When no magnetic field is applied, the magnetron acts like an ordinary diode. Electrons leaving the filament are drawn directly to the positively-charged plate. Upon application of a magnetic field, the electron is acted on by two forces—the electrostatic force attracting it to the plate and the magnetic force urging it in a direction at right angles to its path from cathode to anode. Therefore the electron moves in a curved path (Fig. 1), the curvature of which increases with the magnetic field strength, until a point is reached where the plate is missed altogether, and the electron—carried on by its own momentum—curves back toward the filament.

By properly adjusting plate voltage and magnetic field strength, an oscillation somewhat similar to the Barkhausen-Kurz type described in a recent number of *Radio-Craft* (Microwaves, August, 1945), may be produced. There are a number of other ways in which oscillation may be obtained in a magnetron.

One type of oscillation uses a split-anode magnetron. Electrostatic and magnetic forces are so adjusted that the tube acts as a negative resistance. The magnetic field force is increased to a point which prevents practically all electrons from reaching the anodes. If, however, one of the split sections is at a higher voltage than the other, the electrostatic field in the vicinity of the slot between sectors will be distorted as shown in Fig. 2. Any electron whose circular path causes it to move paral-

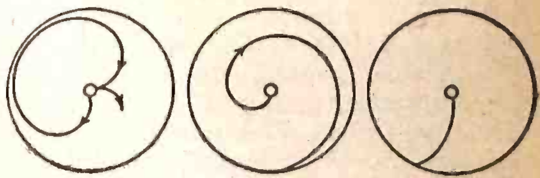


Fig. 1. The electron paths in a magnetron.

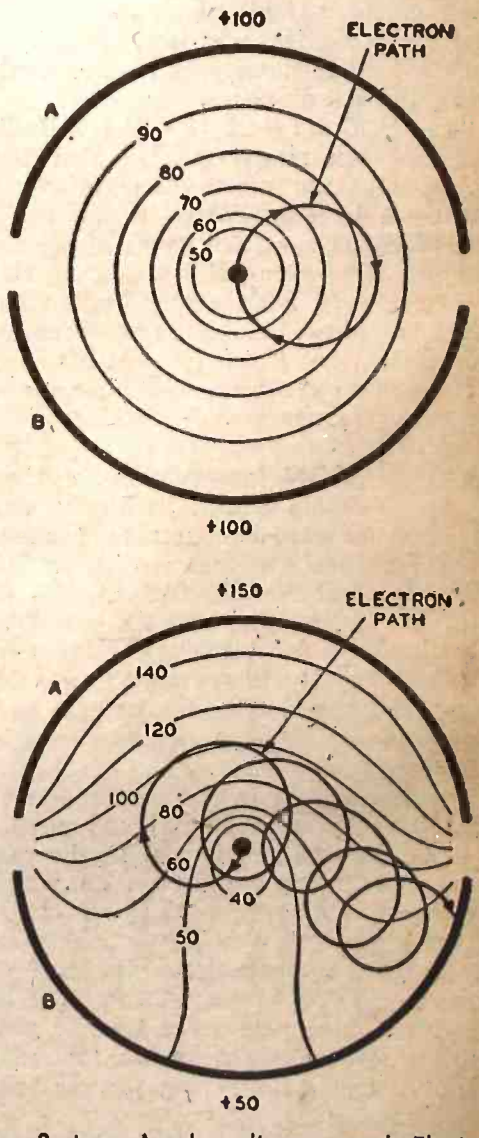


Fig. 2, top—Anode voltages equal. Electron never reaches either. Bottom—Voltages unequal. Electron reaches lower-voltage anode.

lel with the plate and in the direction of the one with lower voltage is retarded by the opposing field and no longer has momentum enough to carry it clear of the plates and back to the

(Continued on page 327)

ANTI-RADAR DEVICES

Anti-radar devices are jamming systems of various kinds which interfere with the radar echo. Since radars were the indispensable "eyes" of all armies, navies and air forces in World War II, the Allied jamming system, first sprung on the Germans in 1943, threw the Axis' defenses into utter confusion. It reduced the effectiveness of German anti-air-craft guns by 75 per cent. On D-Day, a carefully planned Allied anti-radar blitz thoroughly bewildered the Germans and feinted much of their strength out of position. By the late stages of the war, the Allied scientists' devices had made such a boomerang of Axis radar that the Germans and Japanese often gave up using radar lest it betray them. Photograph 1 shows a horn antenna used with the most powerful radar jammer ever made. It was known as "Tuba" and was used to jam German radars and prevent them from tracing RAF planes returning from raids on the Continent.

Photo 2 is the oscillator of a high-power jammer develpped by Harvard University's Radio Research Laboratory. Capable of sending out tremendous quantities of power over an extremely wide frequency range (200-2500 megacycles) it rendered useless all radar installations on which its ether-shaking waves were beamed.

Photo 3—called a tinsmith's nightmare—is actually an ingenious antenna for radar jammers, sending out a circularly polarized signal to jam enemy gun-control radars.

Photo 4 is another "Tuba" antenna, designed to give a beam very sharp in

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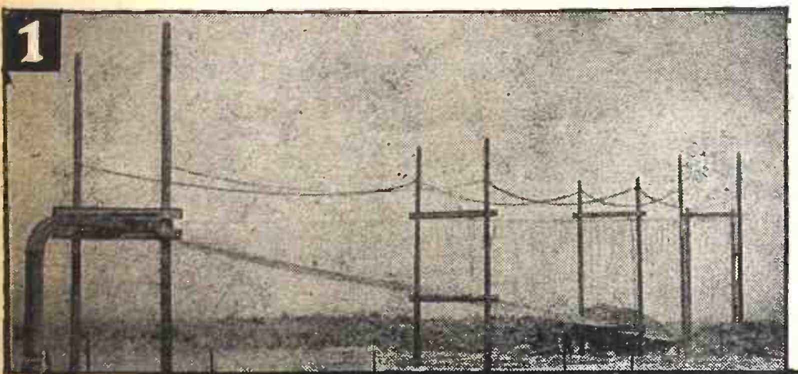
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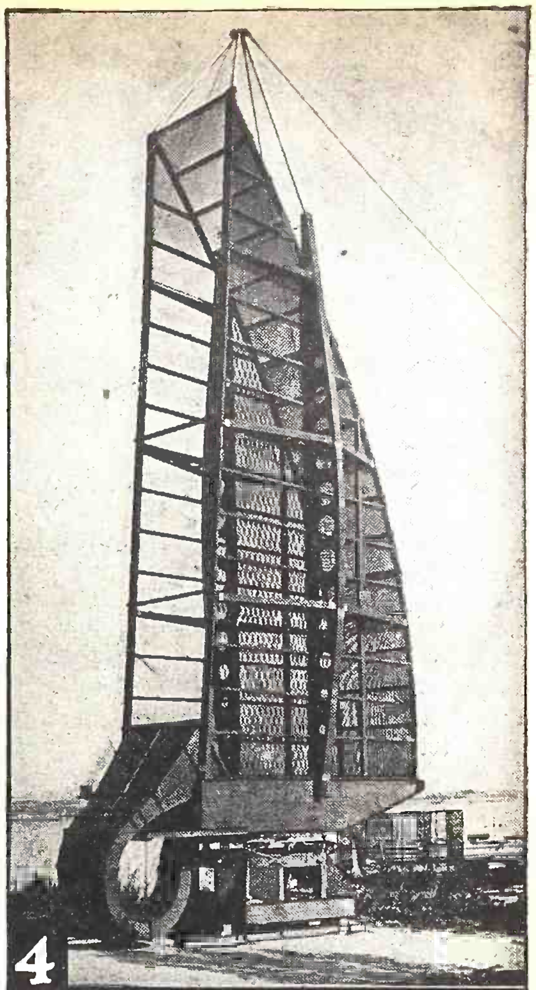
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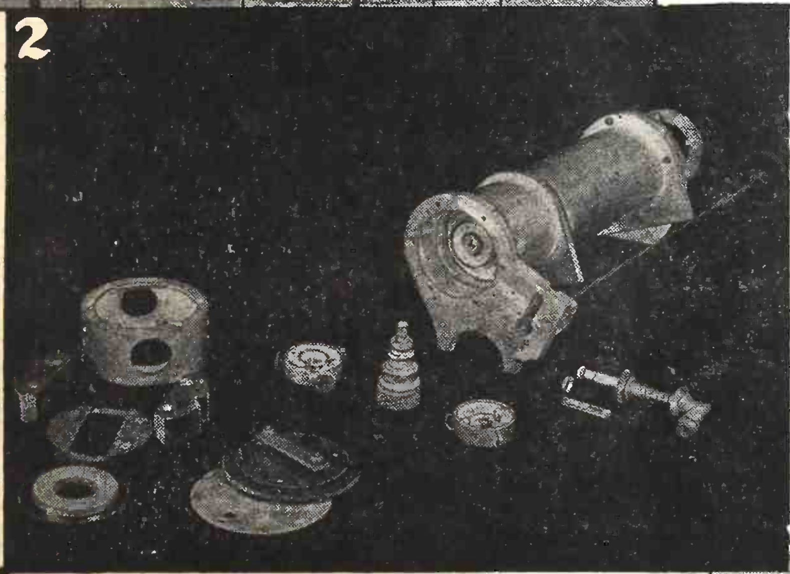
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By JORDAN McQUAY

ELECTRONIC TRANSIENTS

The Future Belongs to These Odd-Shaped Waves

PERIODIC waves of electrical energy may have many different shapes. Simplest of these is the pure sine wave. More complex waves may have a large number of harmonic frequencies—voice, music, or random noise. In most audio and radio work the exact shape of these waveforms is unimportant—provided the output of the operating device or equipment is not *too* distorted. Even so-called high fidelity allows for considerable distortion inaudible to the human ear.

In electronic applications — radar, television, and electronic timing, delay, and control circuits—the shape of these waves is very important. They control microsecond action of other circuits and components of the equipment, where accurate timing and measurement often depends entirely upon the wave shape.

Despite their apparent simplicity when viewed on a test oscilloscope, such control waves are usually extremely complex in composition. Simple-appearing waves—such as the saw-tooth, square, and peaked waves, rectangular pulses, and others (Figure 1)—are complex combinations of many waveforms.

Although not sinusoidal, such electronic waves *are* periodic. That is, they repeat themselves at regular time intervals, permitting examination with a synchronized test oscilloscope.

The composition of these periodic, nonsinusoidal waves is important to an understanding of the operation of all electronic circuits. Because these waves, under the guidance and control of the special types of electronic circuits, perform the many functions of timing, modulation, measurement, and delay in radar, television, and general electronics work.

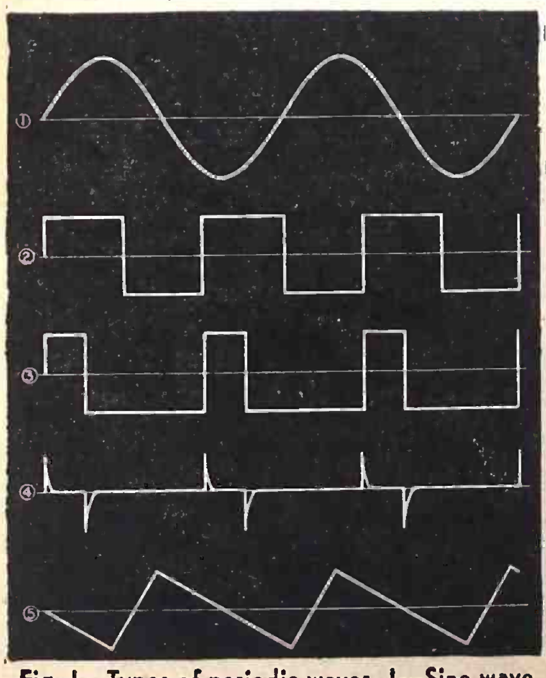

Fig. 1—Types of periodic waves. 1—Sine wave. 2—Square wave. 3—Rectangular wave. 4—Peaked wave-forms. 5—Saw-toothed wave.

USE OF HARMONICS

All complex, periodic waves have their basis in the pure sine wave, the recurrent sine wave having the same frequency as the complex wave. This is called the fundamental or first harmonic.

Component waves of multiple frequency are known as second, third, fourth, fifth, etc. harmonics. And the waves are designated according to ratio of their recurrence frequency to the fundamental. That is, a frequency three times that of the fundamental is known as the third harmonic, a frequency six times the fundamental as the sixth harmonic, and so on.

By skillfully combining certain harmonics (of different amplitudes) with the fundamental, basic sine wave, a complex wave having almost any given shape can be created by electronic circuits.

The *saw-tooth wave*—familiar as a time base control in test oscilloscopes and certain radar applications—consists of the fundamental wave to which are added harmonics of lower amplitude. When only the second and third harmonics are combined with the basic sine wave, the resultant wave [Figure 2 (4)] begins to assume a saw-tooth form. But the positive and negative peaks are not sharp and the slope is irregular. To obtain an acceptable saw tooth wave [Figure 2 (5)] a great many other harmonics—often as many as eight or nine—must be combined with the fundamental.

A *perfect* saw tooth wave—with sharp edges and a perfectly flat slope—would have to consist of an infinite number of added harmonics. For most radar and electronic purposes, however, saw tooth waves with harmonics up to the eighth or ninth are acceptable.

A *square wave* consists of a fundamental and a number of *odd* harmonics only. When the fundamental is combined with a third harmonic of lower amplitude [Figure 2 (6)], the general "square wave effect" is illustrated. Addition of more *odd* harmonics—the fifth, seventh, ninth, and sometimes the 11th—results in a wave shape more nearly approaching a perfect square. However, a *perfect* square wave is impossible to obtain since it would have

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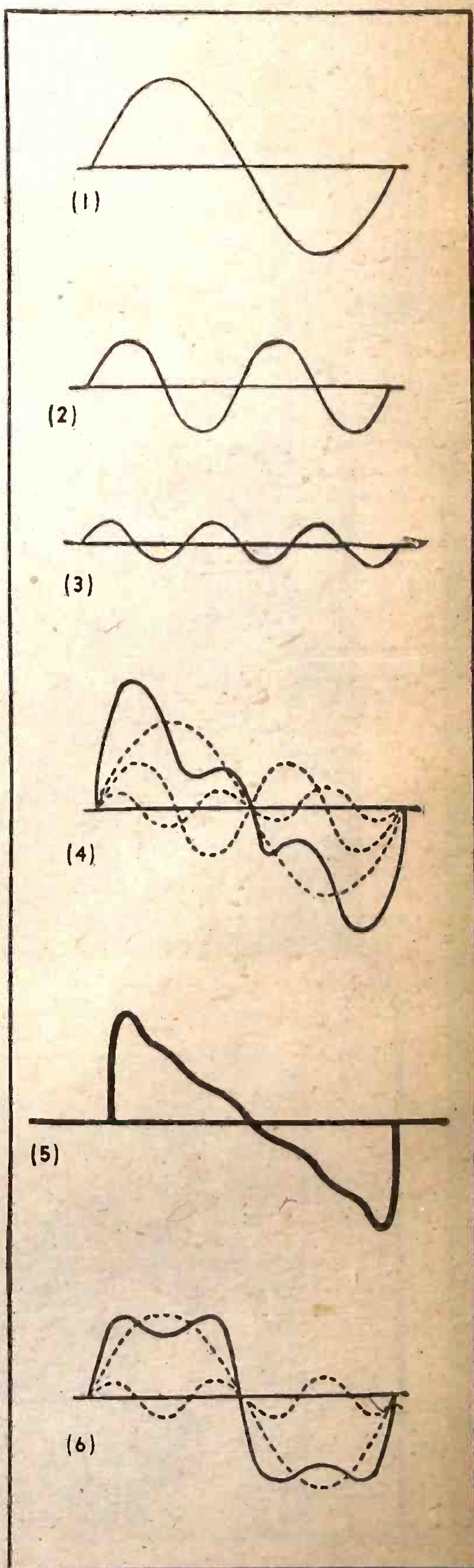

Fig. 2—Composition of complex wave forms: 1—Fundamental sine wave. 2—Second harmonic. 3—Third harmonic. 4—Fundamental and 2nd and 3rd harmonics. 5—Fundamental with 2nd, 3rd, 4th, 5th, 6th, 7th and 8th harmonics. 6—Fundamental with third harmonic.

By WESLEY NEELANDS

A "PORTABLE SHOP"

The Radioman Goes to Live in an Apartment

THE housing shortage is no respecter of persons. My radio hobby and I had grown up together with space unlimited. There was a large room to tinker in, a big work table, home made instruments and apparatus, built with no regard for compactness. Then came a better job in a crowded city . . . . and a four-room apartment. Also came a baby into our apartment, who in spite of her pint size occupied at least one-half the space. There just wasn't room for so much as a variable condenser to open out. My "junk" was packed and stored in an old unheated shed. But friends kept saying, "Wish you'd take a look at my radio." Besides, I was getting mighty lonely for the feel of a soldering iron. I began making trips to the shed. The photo shows the result.

The whole thing tucks away into a closet when not in use but comes right out into the living room in the evening and perches on a kitchen chair in front of the Chesterfield. There's room in the bottom for tools. The shelves at the right hold test prods, plug-in coils and a pocket volt-ohm-milliammeter. This meter is my one piece of "boughten" apparatus. In the lower left corner is a 110-volt outlet (Fig. 1) controlled by the switch just above it. There's a pilot light shunted across the outlet (so you won't forget and leave the soldering iron on). Above the switch is another 110 outlet and there's another one behind the panel. The test instruments plug into it. This completes the first section. The apparatus is built in sections on masonite backed with metal shields. Different sections can be removed separately. Above the outlets is a four-inch dynamic speaker. The audio channel is located in the lower central section, with the off-on switch at the left. Below the electron-eye is a neon bulb. To the left of the attenuator knob (below) is a single-pole double-throw switch. This is shown in the diagram and explained later. The three pin jacks at the left are: Common, B-plus, and 6.3 volts A.C. The two at the right are Input and Ground. The upper section was built directly on the back of the panel with no chassis but is carefully shielded. The large dial above is for tuning. The pin jacks at the right are for R.F. input (or aerial) and output. To the left is the regeneration control and two Diode Voltmeter pin jacks. The upper is an A.C. input and the lower is plus D.C. output. The plug-in coil can be seen protruding slightly from behind the panel at the right.

THE AUDIO CHANNEL

The circuit diagram is given at Fig. 2. The unit consists of the loud-speaker, 6V6 output tube, 6SQ7 voltage amplifier, 6E5 electron-ray voltage indicator, 2-meg. attenuator and a switching arrangement. The switching arrangement allows one to listen to any audio signal or its effects may be noted on the electron-ray indicator. The electron-ray indicator is especially useful in making voltage gain tests and in balancing phase-inverter circuits. It is sensitive to frequencies above and below the limits of the loud-speaker. The 6V6 is much superior to the more common 6F6 because of its greater sensitivity, which is very valuable when listening to weak signals. Voltage variations of low frequency—hum, etc., cause the edge of the indicator-shadow to waver, flicker or blur. Frequencies above the audible range to 50,000 cycles or more close the eye smoothly but no signal is heard from the loud-speaker. It should be noted that when the speaker is in the circuit the diode rectifier is inoperative. If it were left in the circuit it would cause distortion. The 2-megohm attenuator causes little loading in any circuit and allows a range of from 1 volt to 500 to be measured. With good building and careful calibration this unit will give accurate A.C. measurements which compare favorably with those of a good electronic voltmeter. Strong I.F. signals are rectified by this instrument and close the eye smoothly. Even R.F. signals from a strong local station have been picked up by a test probe and have found their way to the grid of the 6V6 and appeared as an untuned and unwanted program.

The Neon Tester—shown in the Audio Circuit diagram—needs no explanation. As a condenser tester it is the most used apparatus on the panel.

R.F., I.F. AND SIGNAL GENERATOR

This, as can be seen from Fig. 3, is a simple one-tube regenerative circuit of the Hartley oscillator type. This is the simplest and most satisfactory circuit for this purpose. It has good stability with respect to load, because the only coupling between the oscillating circuit and the load is the elec-

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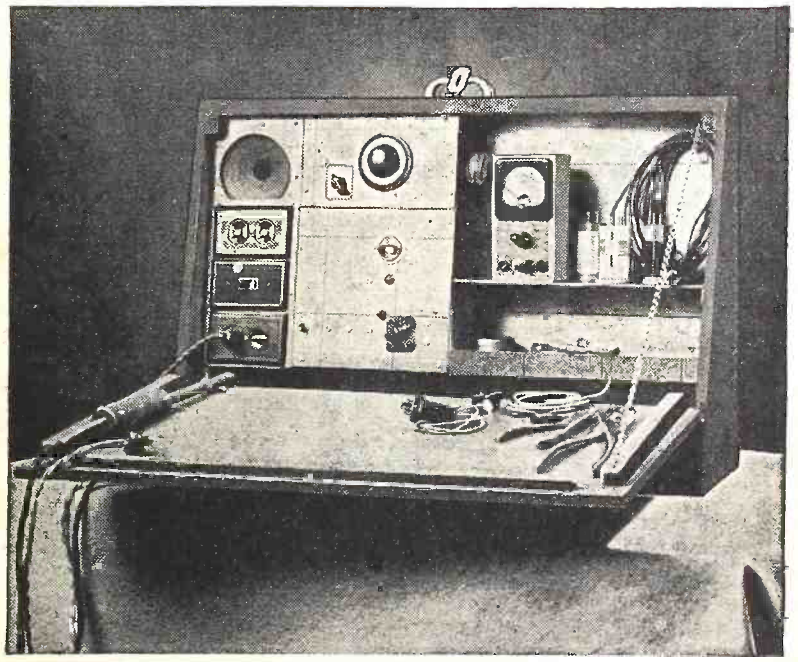
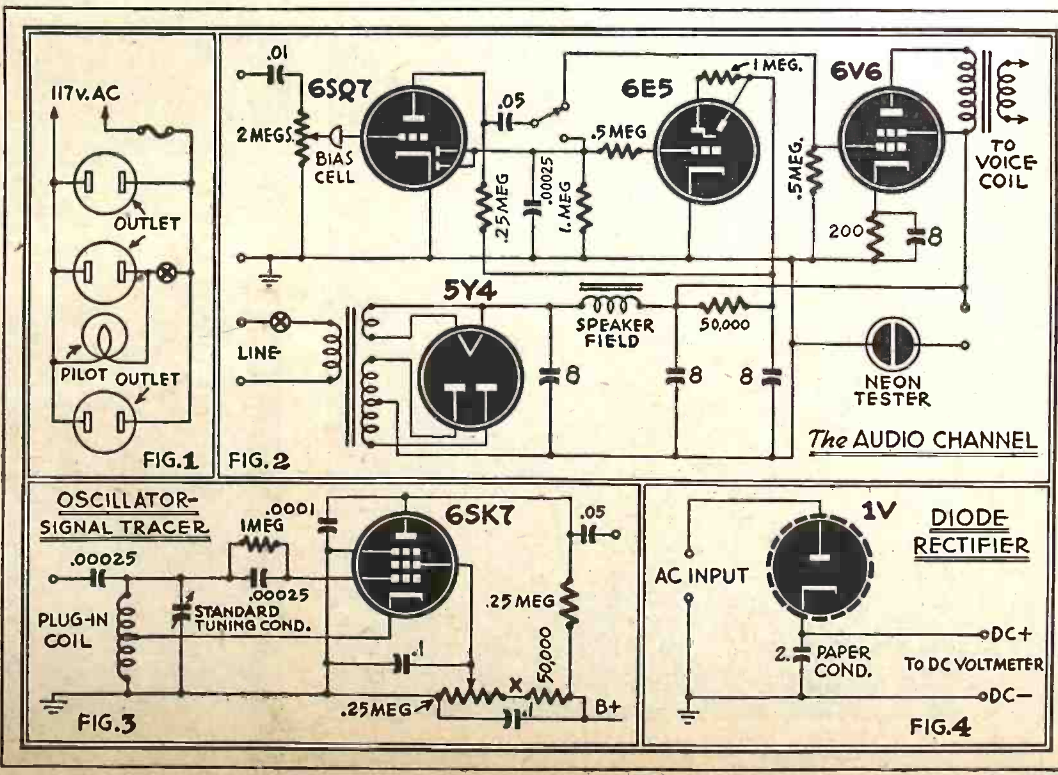


Right—Photo of the "portable radio shop." Below—the four circuits, an oscillator, signal tracer, VTVM and amplifier.



SWISS RADIO RENTAL

Steiner puts out its own radio publication.

RADIO receiver rental plans have never been popular in the United States, although many small-scale attempts have been made to sell such plans to the public. In Switzerland the case has been different. One firm, Radio Steiner, has built up over the last 18 years, a large business based on what it calls a *subscription lease plan.*

The firm has 225,000 subscribers, and employs over 400 people, including 90 fully-equipped independent servicemen. Comparing the Swiss figure of 819,000 radio listeners with that of 30,000,000 radio families in the United States, that would be 7,650,000 subscribers for a comparable U. S. enterprise.

Radio Steiner offers different subscriber plans: for those who own no radio at present, for those who wish to trade in an old set, and for those who have a radio receiver but wish to subscribe for repair service only.

This is how the plan works. Suppose Mr. Jones decides that he wants a radio for the first time. He is offered a selection of sets ranging from about $23 to $230. In each price range, however, only one set is available.

Suppose Jones picks out a $48 set. He signs a contract by which he agrees to pay a rental fee of $1 a month (1/48 of set price per month). During the first three months he agrees to pay a rental charge of $3 a month instead of the regular $1 fee. In addition Jones will pay an additional monthly insurance fee ranging from 80 cents to $1.40. This fee also covers cost of any necessary repairs. From the fourth month on Jones can break the contract by giving one month's notice, or (if he wishes) he can purchase the set outright at its normal new sale price. In this case the rental he has already paid (less the insurance) is deducted from his purchase price. If Jones decides to continue on a subscriber basis he will own the set after 42 months. When a set becomes the property of a subscriber, the insurance and repair benefits are discontinued.

By the terms of the contracts, Steiner is guaranteed at least 10 months' rental fee in each case. This fee covers the expense of those cases where the subscriber breaks the contract after the initial three-month period and does not purchase the set.

If Mr. Jones turns in an old set at the time he subscribes for new-set service, he is allowed ten to fifteen percent of the price of the new set, thus reducing his rental fee. The old sets are overhauled and used in two ways. They may be used in subscribers' homes while the regular set is removed for re-

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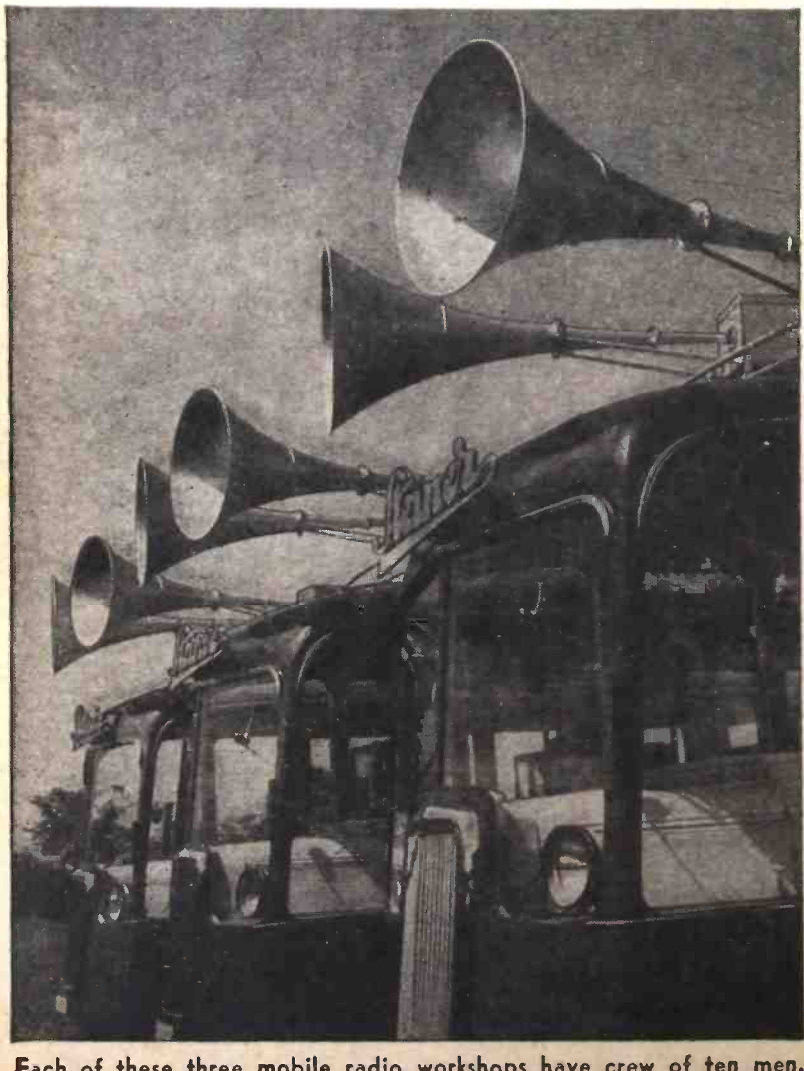
Just a few of the types of radios leased to subscribers. These are mostly trade-ins which are overhauled and refinished before renting out.



Overhauling trade-in radios in preparation for renting out.

Each of these three mobile radio workshops have crew of ten men. Right—Excellent music attracts crowds to the travelling shops.

By J. C. HOADLEY

HUM ELIMINATION

Some New Ideas on an Old and Important Subject

HUM, that bane of every engineer's existence, the spoiler of recorded and transcribed music, can be eliminated. It merely requires careful analysis and a large dose of common sense. There is a myriad of ways that this insidious nuisance can creep into an otherwise well-designed piece of equipment, either through faulty design or from aging or faulty components.

First, hum may be eliminated through proper design. One of the most violent sources of hum is lack of filtering. Proper filter components are arrived at by designing the power supply—for the unit under consideration—to have a certain percentage ripple when loaded with the load the unit will draw. This is not always enough. It is sometimes necessary to utilize a voltage-regulated power supply to reduce the ripple to the desired amount. This may take the form of the well-known RCA circuit which uses a sharp cut-off pentode to receive the variations in the D.C. output voltage and with a resistor in its plate circuit to influence the grids of several power tubes such as 6B4G or 2A3's, connected in series with the power supply. Their resistance is increased or decreased, and, thereby, the voltage held constant and the ripple wiped out. For smaller loads, a gaseous regulator of the VR-150 type may be employed.

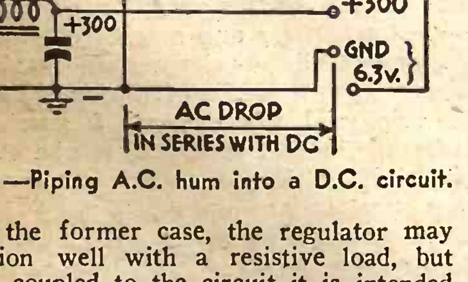


Fig. 1—Piping A.C. hum into a D.C. circuit.

In the former case, the regulator may function well with a resistive load, but when coupled to the circuit it is intended to power, ripple develops. This may be caused by several things. First and foremost is the shielding of the grid circuit of the pentode which controls the regulator tubes. If 60 cycles is introduced at this point, the tube will amplify the 60 cycles and swing the D.C. voltage at this frequency. Secondly, *this type of power supply cannot be overloaded.* It must be designed to handle the maximum current to be delivered. The regulation and ripple increase very rapidly after its maximum output has been reached.

If a VR tube is used as a regulator, its current range cannot be exceeded. This tube must be supplied with a minimum of 5 milliamperes, else it will not remain in a conducting condition. It must be remembered that the line voltage may change, so a low line voltage condition should be used to figure the minimum current value and the highest line voltage for the maximum current value. This current should not exceed the current rating for the tube.

These tubes under certain conditions will oscillate. This condition may be cured in some cases by inserting a series resistance of about twenty ohms between the VR tube and ground. It is interesting to note that VR tubes have an effective resistance in the order of 40 ohms.

MAGNETIC FIELD COUPLINGS

The power supply should be laid out with the fields generated by the power transformer and chokes properly oriented. The chokes and power transformers should be magnetically shielded and placed so their cores are at right angles to each other, as there is no point in building a good low-ripple power supply and then inducing a volt or so of 60 cycle from the power transformer into the chokes. This hum source will cause even more trouble if audio transformers are involved, as there is usually a considerable amount of amplification following these items and the induced hum is amplified accordingly.

Audio transformers should of course be kept away from power transformers and chokes and should be oriented properly as well. If these components are mounted on a common iron or steel chassis, their cores should be kept away from the chassis by mounting them on aluminum or brass bushings, as the magnetic chassis becomes a common lamination in the core of each transformer and comprises a convenient path for the transference of magnetic fields.

In general, the smaller an audio transformer is, the fewer external magnetic lines will cut it and, consequently, the less it will be bothered by external fields.

Remember that the field around a conductor is proportional to the current that conductor is carrying, so be very careful with leads such as supply lines for the power and filament transformers, and filament wiring which supplies a large number of tubes. Grounding one side of the heater winding on the filament transformers *in one place* is helpful, but keep the filament wiring to itself. This, of course, applies also to high voltage wiring to the rectifier tubes. Don't forget to shield all mercury-vapor rectifiers.

"GROUND" CIRCUIT COUPLINGS

Where the power supply and the unit to be powered are separated, do NOT run the negative B voltage and the grounded side of the filament through a common wire, because (as a look at Fig. 1 will show you) you will effectively connect an A.C. voltage in series with the D.C. supply which you consider hum-free. Although this voltage is small, being due to the filament current, it may be amplified many times by several tubes and assume much greater proportions in the output of your device.

It is somewhat risky to ground the filaments of high-gain amplifiers in several places or depend on the chassis to carry one side of the filament current. This is quite all right from the current standpoint, but if a previous plate is by-passed at Point A in Fig. 2 and a subsequent grid

> J. Carlisle Hoadley was born in Washington, D. C., November 22, 1916. Began his radio career at the age of ten, and was president of his High School radio club (McKinley Tech) a few years later.
>
> After ten years in the servicing and sound apparatus business, sometimes with repair organizations and sometimes on his own, Mr. Hoadley went to the Naval Research Laboratories at Anacostia, D.C., as a radio engineer. Was engaged on pre-Pearl Harbor radar research, later studied captured enemy equipment and ran tests on Navy gear.
>
> 
>
> Went to the Bryant Chucking Co. of Springfield, Vermont, as Electronics Engineer, in 1943. At completion of the project on which he was engaged, he accepted a position with the Raytheon Manufacturing Co. of Waltham, Mass., as engineer on design and development of radar apparatus.
>
> Started radio writing while at Springfield, Vt. Still spends most of his waking hours in his radio laboratory. Engaged at present in high-fidelity reproduction of music.

is returned to point B, then a hum voltage may be placed in series with the grid of the second tube. Even though this voltage is in the order of .01 volts or smaller, if that tube is a pentode with an amplification of several hundred followed by several more amplifier stages, as in a micro-

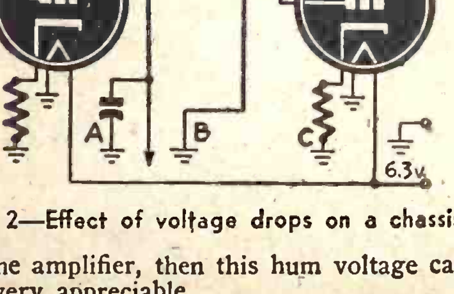


Fig. 2—Effect of voltage drops on a chassis.

phone amplifier, then this hum voltage can be very appreciable.

In high-gain stages, incidentally, hum

(Continued on page 355)

By FRED SHUNAMAN

PPM—NEW TECHNIQUE

Pulse Position Modulation—Radio of the Future

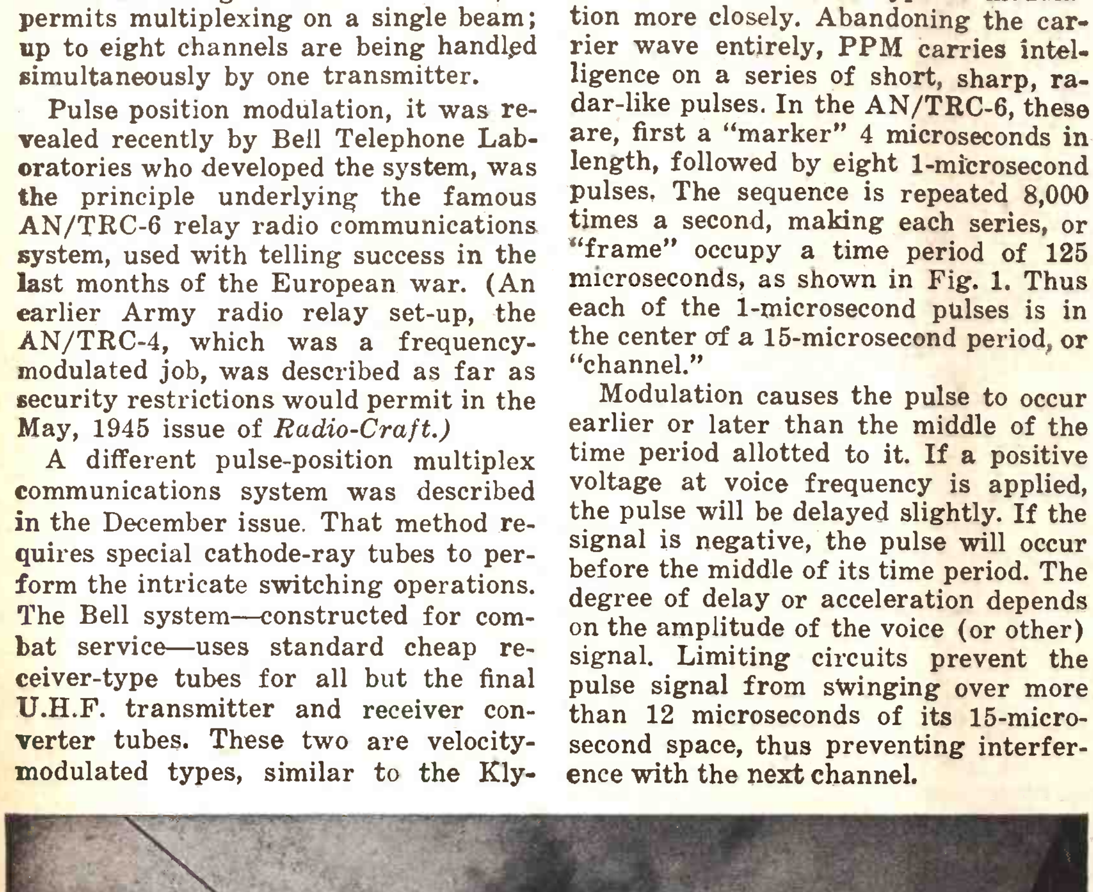
A COMPLETELY new radio signaling system—Pulse Position Modulation—opens up new vistas in both voice and telegraph communication. Differing from AM and FM, it permits multiplexing on a single beam; up to eight channels are being handled simultaneously by one transmitter.

Pulse position modulation, it was revealed recently by Bell Telephone Laboratories who developed the system, was the principle underlying the famous AN/TRC-6 relay radio communications system, used with telling success in the last months of the European war. (An earlier Army radio relay set-up, the AN/TRC-4, which was a frequency-modulated job, was described as far as security restrictions would permit in the May, 1945 issue of *Radio-Craft.)*

A different pulse-position multiplex communications system was described in the December issue. That method requires special cathode-ray tubes to perform the intricate switching operations. The Bell system—constructed for combat service—uses standard cheap receiver-type tubes for all but the final U.H.F. transmitter and receiver converter tubes. These two are velocity-modulated types, similar to the Klystrons already described in more than one article.

Pulse-position modulation cannot be classed with either AM or FM, though it resembles the latter type of modulation more closely. Abandoning the carrier wave entirely, PPM carries intelligence on a series of short, sharp, radar-like pulses. In the AN/TRC-6, these are, first a "marker" 4 microseconds in length, followed by eight 1-microsecond pulses. The sequence is repeated 8,000 times a second, making each series, or "frame" occupy a time period of 125 microseconds, as shown in Fig. 1. Thus each of the 1-microsecond pulses is in the center of a 15-microsecond period, or "channel."

Modulation causes the pulse to occur earlier or later than the middle of the time period allotted to it. If a positive voltage at voice frequency is applied, the pulse will be delayed slightly. If the signal is negative, the pulse will occur before the middle of its time period. The degree of delay or acceleration depends on the amplitude of the voice (or other) signal. Limiting circuits prevent the pulse signal from swinging over more than 12 microseconds of its 15-microsecond space, thus preventing interference with the next channel.



Rear view of three parabolic antennas on roof of the Telephone Building, New York City.

At the receiver end, circuits timed by the "marker" measure the time difference between the start of a modulated pulse and the time it would start if it were unmodulated. Translating

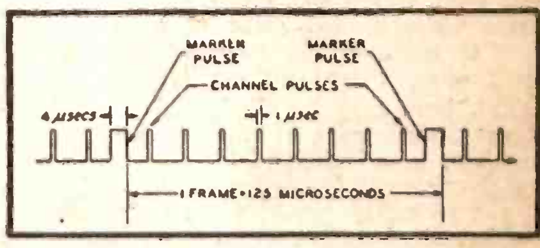


Fig. 1—Frame of PPM time-division signals.

that time difference back into signal amplitude, the original voice frequencies are reconstructed.

All eight pulses could be used to handle one transmission, but experience has shown that it is not necessary. A "sampling" of the signal eight thousand times per second by the pulses of one channel is sufficient to transmit voice signals clearly and with excellent telephone quality. Each of the other seven pulses per frame can carry its own transmission.

SIMPLIFIED OUTLINE

A simplified block diagram is shown in Fig. 2. Heart of the circuit is the *8-kilocycle oscillator* which originates the marker pulse and triggers the eight channel circuits. Its output goes to the *marker generator* and *marker amplifier* to produce the 4-microsecond marker pulse. Meanwhile the *oscillator clipper* has triggered the channel 8 *position modulator*, action of which will be considered later. Phone signals from the *voice frequency amplifier* vary the pulse's position according to the amplitude of the voice signal. It is then passed through a clipper, which ensures that all pulses shall be of the same amplitude, and then is introduced into the main line. There it is further amplified, with the marker pulse (and the seven other channel pulses) through two more video amplifier stages before being introduced to the transmitter unit, mounted behind the parabolic reflectors of the antenna.

The signal is amplified through two more stages in the transmitter unit, then introduced to the modulator. This tube supplies heavy pulses of power to the velocity-modulated oscillator, which oscillates only when these pulses are applied to it. Since the pulses take up a very small part of the total time (about 12 out of the 125 microseconds in each frame) exceptionally heavy signals can be put out with low average power, as in radar transmitters.

The position modulator is the unit which actually converts speech-actuated voltages to changes in pulse position. It consists of a multivibrator and a pulse generator. The multivibrator consists of the two halves of a 6SL7-GT (V 52 A and B), so biased that free oscillation without outside excitation is impossible. It thus tends to act as an electronic switch. The two cathodes are connected together and grounded through R286 (Fig. 3). Grid of the second section is connected to 300 volts through resistors R284 and R278, and the plate direct to the 300-volt lead. (Resistor and condenser numbers are from the Bell Laboratories blueprints.) Because of the positive grid, this section of the tube draws a heavy current, biasing the cathodes about 50 volts positive because of the heavy current through R286 to ground. Grid of the tube's first section is biased about 35 volts positive with respect to ground by the voltage divider system R270, 378 and 288. It is therefore 15 volts more negative than its own cathode, a bias beyond cut-off for this tube.

Application of the excitation pulse from the oscillator clipper drives the first-section grid far enough positive to permit the tube to pass current. The resulting increased voltage drop across R266 and P8 now causes the plate voltage to drop rapidly, applying a negative voltage to the second section's grid through coupling condenser C120. Plate current of the second section is accordingly reduced and the voltage drop across the cathode resistor R286 falls, reducing negative bias on the first section of the tube, thus permitting it to carry current even after the initiating pulse has ceased.

Current continues to flow in the first section of the multivibrator tube until the second section grid becomes sufficiently positive to bring the voltage across the cathode up to a point which cuts off the first section. When the first section cuts off, the tube goes back to its original condition with the characteristic suddenness of a multivibrator.

The second section's grid is connected directly to the grid of another 6SL7-GT section, V53B, the *pulse generator*. During "normal" condition of the multivibrator, this tube draws a small current through the 2.2-megohm resistor (R280) in its plate circuit, due to its positive grid voltage. When the second section of the multivibrator is triggered by the initiating pulse from the oscillator clipper, current flow in the pulse generator tube is cut off and rising plate voltage charges the plate blocking condenser (C126). When multivibrator conditions reverse, the plate voltage drops suddenly as a surge of current passes through the tube. A pulse appears in the output circuit, the exact instant of which depends on the instant of the multivibrator's reversal to "normal." The inductance L_1, which is common to four channels, together with tube and wiring capacity, fixes the pulse length at about one microsecond.

The instant at which the reversal takes place is dependent on a number of factors, most important of which is the potential applied to the grid circuit of the second section through resistors R278 and R284. Since R278 is also in the voice amplifier plate circuit, instantaneous voltage at the junction of R278 and

(*Continued on page* 348)

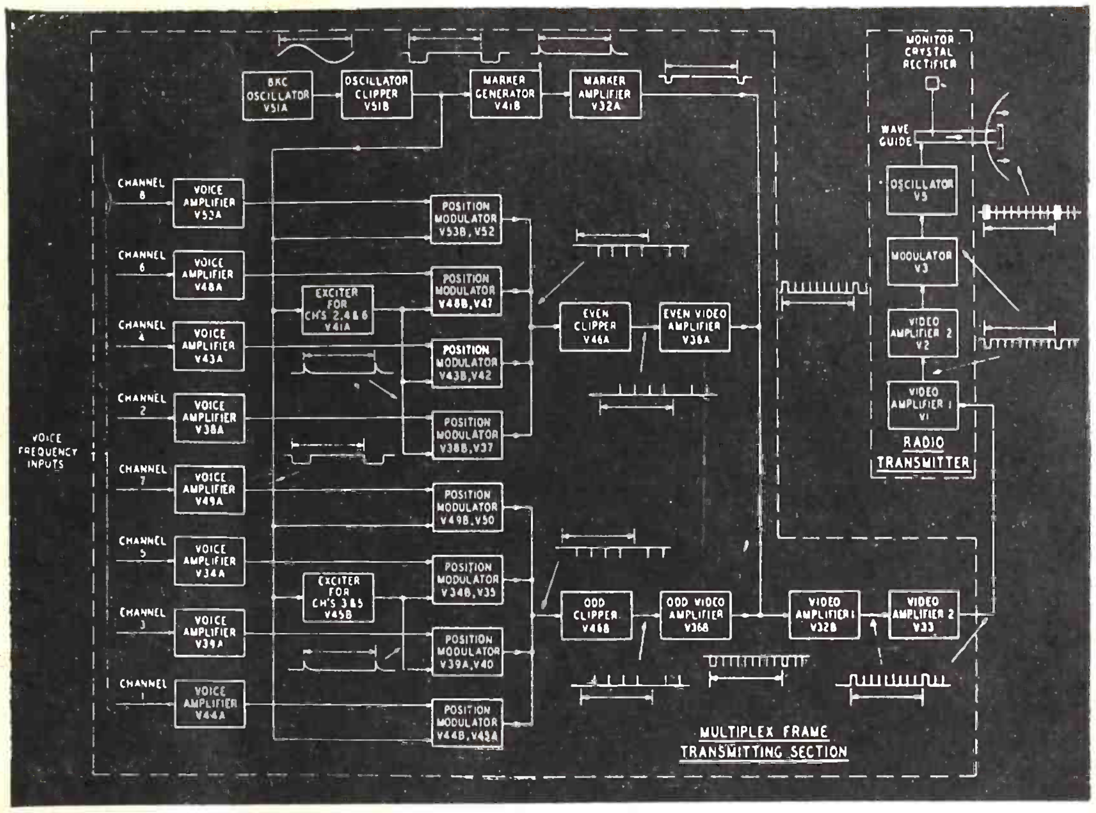


Fig. 2—Complete block diagram of the transmitter circuits, from voice input to antenna.

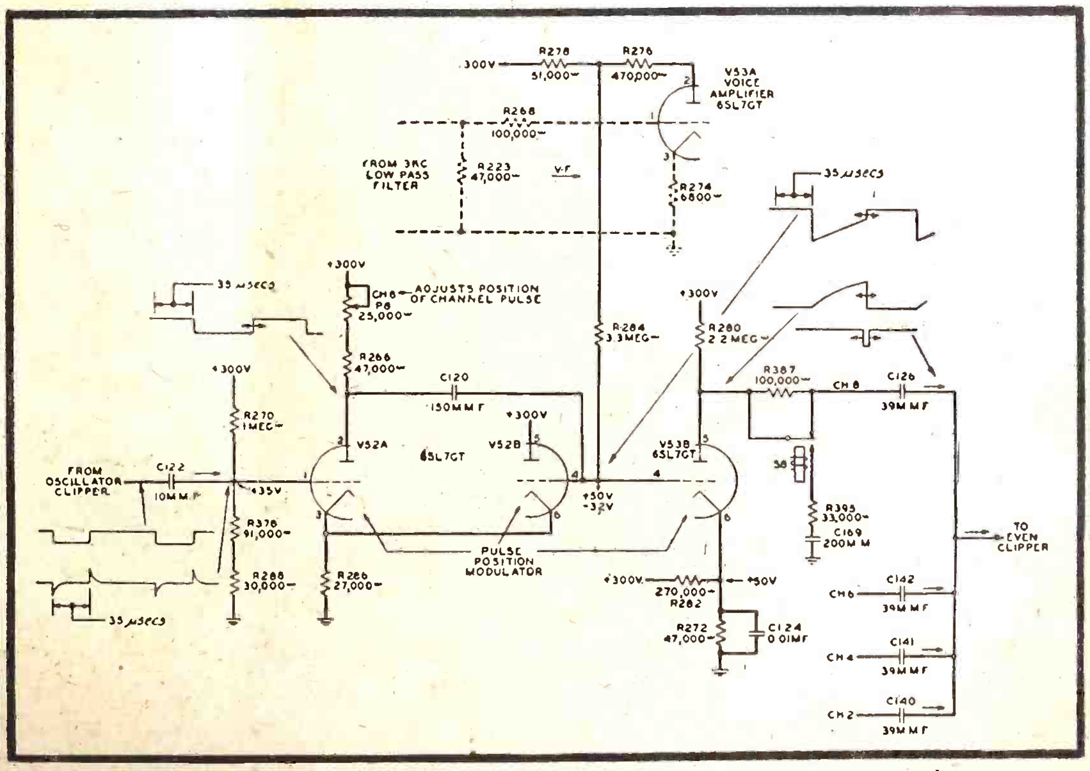


Fig. 3—The eight position modulators change voice variations to changes in pulse position.

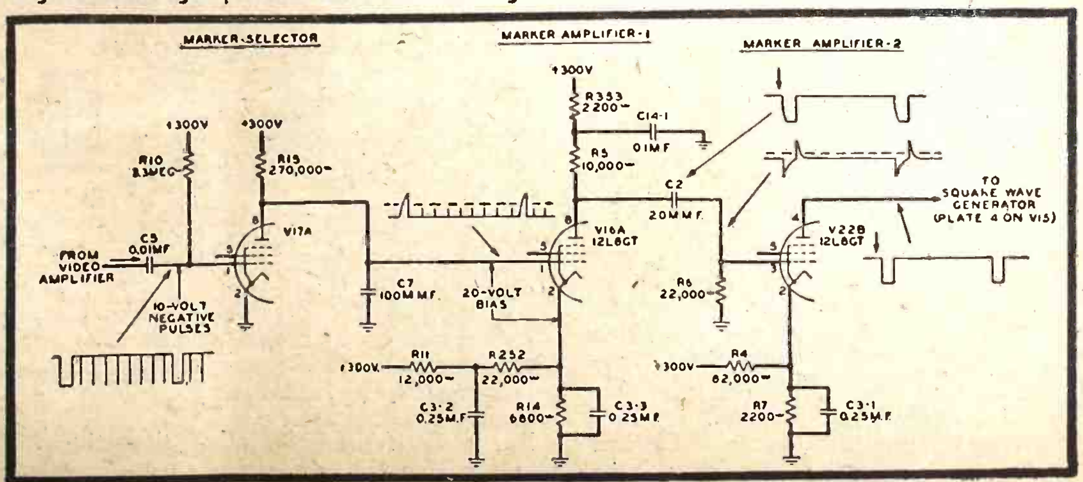


Fig. 4—Marker selector and amplifier which triggers the receiver circuits into action.

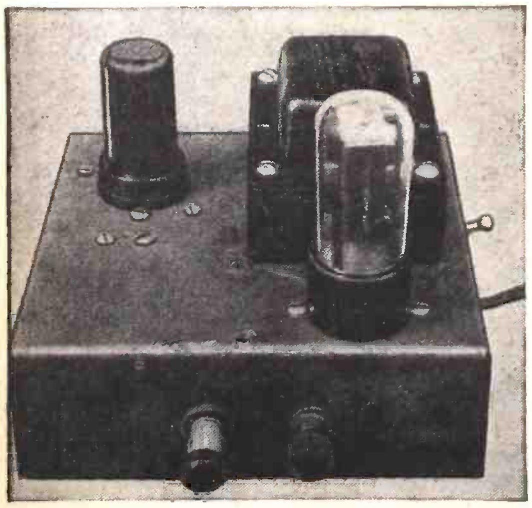
By ROBERT B. ESSEX

BRIDGED-T CIRCUIT

Pointing Out Possibilities of This Useful Circuit and Describing a Self-Powered Two-Tube Unit

THE Bridged-T circuit has been placed upon a shelf and almost entirely cast aside by the home experimenter, Ham, serviceman and design engineer, because of its seeming complexity. In reality, this circuit is very easy to handle, and may be applied with little difficulty by anyone with a little radio knowledge.

The Bridged-T is actually an R-C filter network, and when employed as shown in Fig. 1, will attenuate or suppress only one frequency. In other words, if we knew that several widely separated frequencies were present in the plate circuit V_1 Fig. 1, we could by choosing the proper values of the Bridged-T following V_1, suppress any one of those frequencies. All other frequencies would appear at the output of the Bridged-T (grid circuit of V_2 Fig. 1). The circuit as shown in Fig. 1 is applicable as a scratch filter in high- or low-fidelity phonographs, and as a "whistle



Bridged-T filter with self-contained power supply, as constructed for the author's use.

eliminator" in high-fidelity, wide-band broadcast receivers. The whistle or heterodyne phenomenon is caused by two stations in adjacent channels beating with each other and giving rise to a high frequency audio note. The scratch noises and whistles are subdued by choosing the components of the Bridged-T to suppress 10,000 cycles. Frequencies much above 10,000 cycles are generally not reproduced by even good phonographs or broadcast receivers, and therefore noise in this portion of the spectrum is not our concern. The values of R and C for some very common frequencies are shown at the end of this article; also the mechanics of computation for a 2,000-cycle filter. For frequencies other than indicated, component values may be chosen and substituted in the formula for computation of the 2,000 cycle filter.

The great advantage in using an R-C network of this type is that no bulky and expensive iron-core inductances are necessary as in many of the more common frequency-discriminating circuits and filters.

When the Bridged-T is applied as shown in Fig. 2 an interesting phenomenon takes place. The tube V_2 will amplify only one frequency. In other words the circuit becomes a selective amplifier and rejects all but that one frequency. The constants and frequencies shown in the table below may be substituted for R and C in Fig. 2

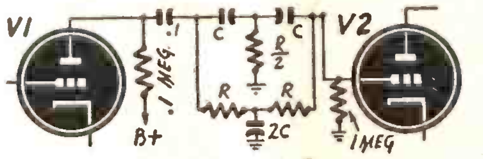


Fig. 1—A standard bridged-T filter circuit.

and the desired amplifier characteristics obtained. Thus, if a selective amplifier is required in a CW receiver for code reception to cut down static, noise and interfering signals, a Bridged-T may be employed. Most CW signals sound best to the ear when heterodyned to give a 1,000-cycle beat-note. A selective amplifier operating at 1,000 cycles will permit only one signal to pass through and suppress any other signal producing heterodyne notes of a higher or lower frequency than 1,000 cycles. Naturally, static and noise are also considerably reduced, as this type of interference is generally high-frequency audio and much above 1,000 cycles.

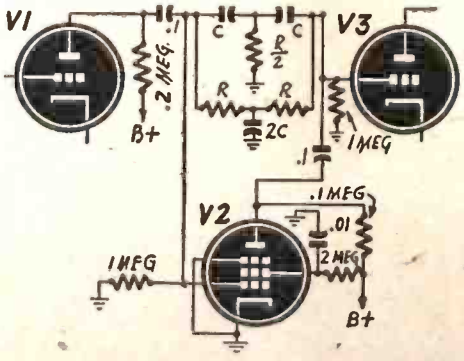


Fig. 2—This circuit passes one frequency.

R AND C FOR COMMON FREQUENCIES

Cycles	C–mfd	R–ohms	2C–mfd	R/2–ohms
60	.005	530,000	.01	265,000
120	.005	265,000	.01	133,000
400	.001	398,000	.002	199,000
1,000	.0005	318,000	.001	159,000
5,000	.00025	127,000	.0005	635,000
10,000	.0001	159,000	.0002	79,500

All tolerances should be held within 5%.

The basic formula is:

(1) f=½π RC;

or solving for R:

(2) R=½π FC;

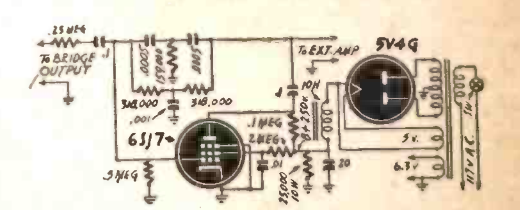
F = frequency in cycles

R = resistance in ohms

C = capacity in farads

2π = 6.28

For audio frequencies other than those shown in the table and falling between 60 and 10,000 cycles, "C" is chosen as the value corresponding to the next highest frequency. This value of "C" is substituted in formula (2) and "R" obtained.



Schematic of equipment shown in photograph.

Let us suppose that it is necessary to have the filter operate at 2000 cycles. The next highest frequency above 2000 is 5000 cycles. The value of "C" corresponding to 5000 cycles is .00025 MFD., and is substituted as shown below:

$$R = \frac{1}{(6.28)\ (2000)\ (.00025\ [10]^{-6})}$$

Therefore

R = 318KΩ approx

C = .00025

R/2 = 159KΩ

2C = .0005 MFD.

The foregoing represent only a few of the many uses of the Bridged-T. The author constructed the Bridged-T selective amplifier shown in the photograph.

Excellent results were obtained when it was used in conjunction with a capacity and inductance bridge, to suppress the harmonics of the internal 1,000 cycle mechanical vibrator.

Other applications would call for changes in the R and C constants of the circuit to meet the special conditions of the given job. Used for phonograph scratch filter, as suggested earlier in the article, these constants might be adjusted to 5000 cycles or slightly higher. At 10,000 cycles, as stated previously, the circuit might be used to cut out 10-Kc. beat notes between adjacent broadcast stations. An item on a bridged-T circuit as a simple 10-Kc. filter appeared in the June, 1945, issue of *Radio-Craft* on page 585. This circuit, a coil-condenser-resistor combination without a tube, is not as adaptable as those described here, as the tube's amplification compensates for the insertion loss otherwise experienced when a filter is placed in any circuit.

The writer has not attempted to work with a bridged-T circuit having a variable resistor, though the idea immediately suggests itself in connection with many kinds of experimental work. A unit could also be constructed which could be switched from a "rejector" to an "acceptor" circuit, thus making it more versatile for use in the home laboratory or shop.

It is hoped that this article will direct the attention of the technician to the many possibilities of the Bridged-T circuit, as well as to the ease of designing and constructing it.

By JORDAN McQUAY

ELEMENTS OF RADAR

Part III—Radar Receivers and Indicators

ECHO signals from distant objects or surfaces are characteristically weak, because targets reflect or reradiate echoes in all directions. Only a relatively few succeed in returning to the radar set. For this reason the radar receiver must be extremely sensitive, providing considerable amplification. The superheterodyne is admirably suited for radar.

At lower u-h-f carriers, the superhet circuit resembles any typical u-h-f communications receiver (Fig. 1) with the important addition of a large number of I.F. amplifier stages and a video or wide-band amplifier in the output stage.

Referring to the upper block diagram (Fig. 1), the incoming signal from the antenna system is amplified by one or two stages before being mixed with a locally generated signal. Intermediate frequencies on the order of 30 megacycles are used, and the I.F. stages designed to pass a band of frequencies about two to three megacycles in width. Since reception is of the double-side-band variety, passage of video frequencies up to about one megacycle is permitted. Combined stages of I.F. amplification supply a maximum gain of 100 to 150 db. The video amplifier will also pass an equally wide—or sometimes wider—band of frequencies to preserve the shape of the radar echo. The cathode follower is merely an impedance-matching device for coupling to the radar indicator.

As the u-h-f operating frequency is increased, however, the superhet circuit undergoes considerable change. (Fig. 1).

Direct amplification of the received echo is impossible when operating in the microwave region, and R.F. amplifier stages must be omitted. The signal is fed directly to a sensitive mixer stage. There the echo signal is combined with a locally generated signal, mixed in the cavity of a resonant chamber, and an intermediate frequency (the difference frequency) extracted through a crystal.

A Klystron tube (Sperry) is the best type of local oscillator. With a suitable cavity resonator, this velocity-modulated tube can generate any desired frequency. The output power of the Klystron is very low, however, precluding its use as an R.F. oscillator in the radar transmitter. As a local oscillator, the Klystron is unexcelled.

The use of a crystal and resonant cavity as a mixer is required because of its fairly high efficiency when compared with any other type of mixer. For microwave operation, it surpasses even the diode.

After several stages of I.F. amplification, radar receivers may reconvert to a second, lower intermediate frequency by means of a second mixer stage. Such a mixer is of the more conventional diode type. Further amplification of the new intermediate frequency follows. Finally the signal is detected, and the video impulses amplified by one or two stages of wide-band amplification.

Microwave receivers require other special considerations. Chief among these are: shortness of leads, and careful shielding of every stage of the receiver.

SUPERREGENERATORS

Radar sets of small size, designed for extreme mobility, may use a much simpler circuit: the superregenerative receiver (Fig. 2).

This is a variant of the familiar regenerative receiver, with a means provided to throw the detector in and out of oscillation. Frequency of this quench voltage is usually between 50,000 and 250,000 times per second, and permits a considerable increase in the sensitivity of the detector.

When no signal is being received, the usual hiss of regeneration is greatly amplified. Hissing then diminishes in proportion to the strength of the received signal, strong signals eliminating the regenerative hiss completely.

The frequency of oscillator interruption causes a voltage variation on the plate of the detector. Receivers of this type require adequate shielding to prevent radiation into other components of the radar set and consequent harmonic distortion of both radar pulse and received echo.

VIDEO AMPLIFICATION

Energizing voltages of from 50 to 250 volts (peak) with a band-width of from two to three megacycles are required by the indicator of a radar set.

It is the responsibility of the video amplifier of the receiver to supply such a signal.

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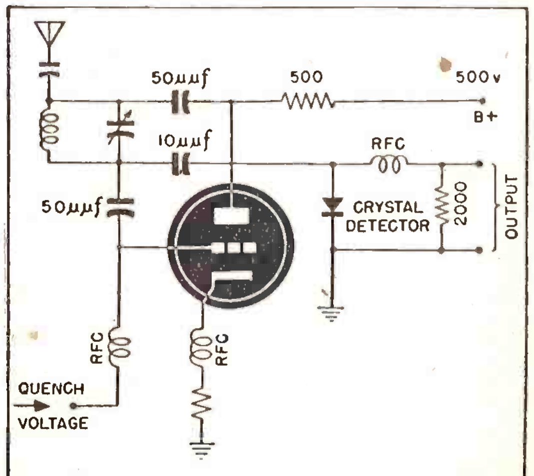
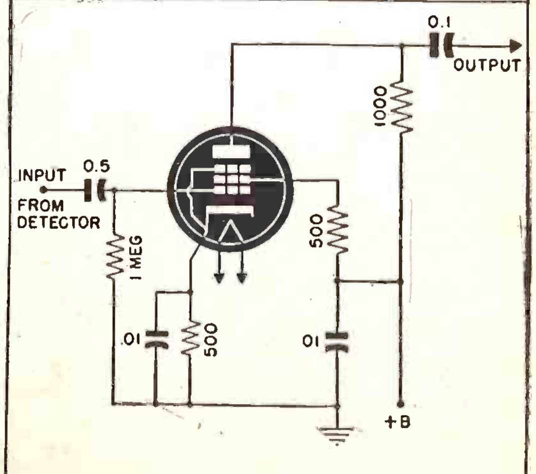


TYPICAL SUPERREGENERATIVE RECEIVER FOR RADAR ECHOES



TYPICAL VIDEO AMPLIFIER STAGE USED IN RADAR RECEIVERS

Fig. 2, Top—The Superregenerative receiver. Fig. 3, Bottom—Typical video amplifier stage.

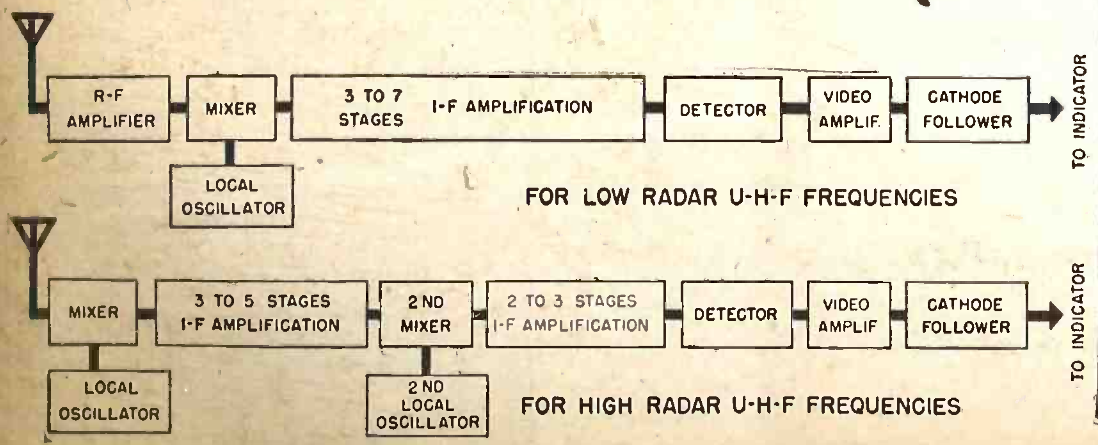


Fig. 1—Block diagram of two typical receivers, for "low" and "high" radar frequencies.

One or two stages of video amplification can be used, each stage having an almost-flat gain response over the entire range of frequency operation. Gain of each stage is from 30 to 50 db.

Unlike audio-frequency amplifiers, the video amplifier must be free from phase distortion. This would result in a distorted pulse detail, rendering the echo unuseful.

A typical video amplifier circuit is shown in Fig. 3. The circuit operates as a distortionless Class A voltage amplifier, using resistance coupling. Each stage uses a high-gain pentode—such as the 6SH7, 6AC7, or 6SJ7 types. The video output is usually coupled to a cathode follower stage.

Some video circuits require filters or other compensating devices to insure a uniformly flat frequency response.

Plate and grid leads of pentodes must be kept short as possible. Grid coupling condensers should have a very small capacitance to ground.

The output signal from the radar receiver may be either a positive- or negative-going impulse. The type of cathode ray oscilloscope used in a radar set normally does not influence the shape of the video output from the receiver.

Although the T/R switch protects the radar receiver from the violent power surges of the transmitter, a very small signal—known as the "transmitter pulse"— is allowed to filter through the receiver circuits each time the radar transmitter functions. This signal is allowed to reach the indicator and registers at the start of the base line on the oscilloscope, providing a reference point from which to measure distance along the linear time base.

To prevent serious overloading of the receiver circuits by this "transmitter pulse," a blocking or *gating* signal is sometimes applied to the I.F. stages of the receiver during the time the transmitter is pulsing. This blocking signal de-sensitizes these stages. But when it is removed, the I.F. stages operate in the normal manner.

Echo information collected by the radar receiver is displayed visually by the indicator—final link in the radar echo-detection system.

The cathode ray oscilloscope is ideal for the presentation of radar data, because it not only shows a variation of a single quantity such as voltage, but also gives an indication of the relative values of two or more synchronized variations.

There are two general kinds of radar oscilloscopes: (1) the deflection type, and (2) the intensity-modulated type.

DEFLECTION-TYPE INDICATOR

Simplest radar indicator—the deflection type—uses a cathode ray tube with electrostatic plates (Fig. 4). The tube is employed much in the manner of a conventional low-frequency test oscilloscope. Most of the controls are somewhat similar.

A saw-tooth voltage (Fig. 5) applied to the horizontal deflecting plates establishes a linear, horizontal base line. This permits a rectilinear calibration of the screen of the cathode ray tube. The total length of the time base on the screen bears no direct relationship to the time scale.

Periodicity of the saw-tooth wave is determined by the pulse recurrence frequency or p-r-f of the synchronizer. The base line is retraced each time a radar pulse is radiated into space by the radar transmitter.

Video signals from the receiver are applied to the vertical deflecting plates of the oscilloscope, and cause actual deflections or interruptions of the base line proportional to the strength of the received echo. The scope screen can be calibrated according to any given range. Sets used for long-range reporting have scales as high as 100, 150, or 250 miles. Short-range radar sets can measure targets only up to a few thousand yards. The slope of the saw-tooth wave (Fig. 5) determines the rate of speed of the sweep and therefore the range.

There are many variations of the straight-line time base (Fig. 6). For greater accuracy, a circular time base may be used—with range measurements computed from a given starting point on the circular sweep.

A vertical base line requires only the complete turning of the cathode ray tube through 90 degrees.

There are other variations. But all depend upon a *deflection* of the electron beam to cause a deflection or interruption of the time base.

INTENSITY-MODULATION

Another type of indicator causes the appearance of echo signals by an entirely different electronic means.

An electromagnetic type of cathode ray tube is generally used for this kind of radar indicator. In such tubes, the deflection plates of the electrostatic tube (Fig. 4) are replaced by one or two pairs of coils, wound around the neck of the tube.

Currents passing through the coils establish a measuring pattern on the scope of the screen, much like a television raster. A saw-tooth wave of *current* applied to one pair of coils causes a linear movement of the electron beam in one plane. And a synchronizing current applied to the second pair of coils causes movement of the beam in a second plane.

Echo signals from the radar receiver are applied to this measuring screen by means of intensity modulation. If the video signals are negative-going, they are applied to the grid of the tube—resulting in an intensification of the beam: a brilliant spot of light on the screen of the tube. If the video signals are positive-going, they are applied to the cathode of the tube—with identical results.

Use of intensity-modulated indicators permits measurement of more than just one quantity on a single cathode ray tube.

For instance, such a tube could measure range *and* azimuth—since the latter direction could be indicated by currents flowing through one of the two pairs of magnetic coils.

One such type of tube is known as the PPI—or plan position indicator. The time base actually begins at the center of the scope screen and moves outward radially in a direction corresponding to the position of the radar antenna. Time base and antenna are synchronized, thus giving immediate direction in azimuth. Returning echoes intensity-modulate the electron beam, and appear on the

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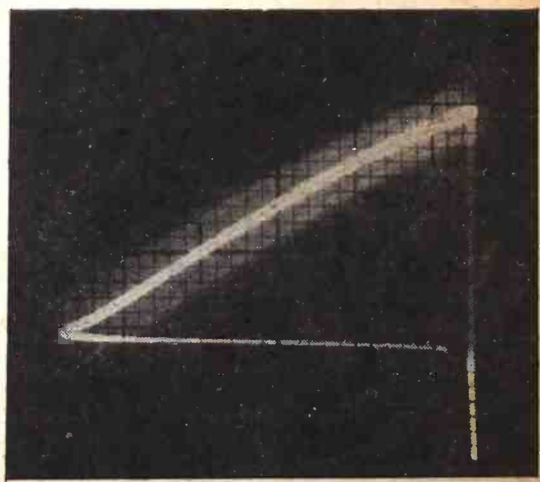
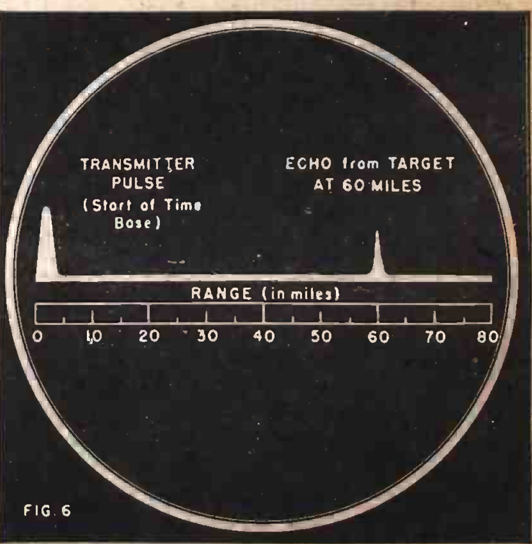


Fig. 5—Sawtooth sweep voltage on C-R screen.



Echo on straight time base of radar screen.

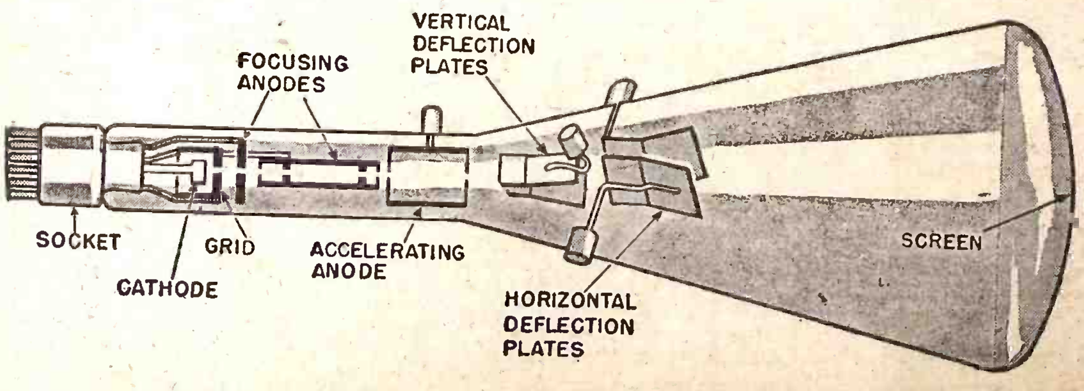


Fig. 4, above—Typical electrostatic cathode-ray tube such as is used for radar indicators.

By I. QUEEN, W1HCO/2

144-MC TRANSMITTER

This Low-Power Unit Gives Excellent Results

THE former 112 mc. and the present 146 mc. bands are unique, at least in the widely divergent opinions expressed about them.

On 2½ meters we met many fellows who were wondering why they ever invested time and money on a band which they claimed produced far inferior results to those obtainable on a local telephone call. On the other hand, others were obtaining very satisfactory and even (relatively) spectacular results with apparatus similar to that used by the disgruntled hams. We found that in many cases the last named had at least average VHF locations (good height, radiator space, etc.).

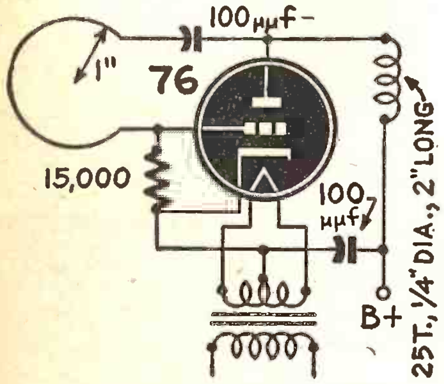


Fig. 1—A simple circuit with 76-type tube.

Now that the 2-meter band has been open for a little while, the same difference of opinion exists. We hear (both over the air and through personal QSO) that the new band is far more effective with regard to distance than the former one. Others who worked the band for some weeks have moved to other bands, many vowing never to return!

In our opinion, the 2-meter band is definitely more limited than 2½ was, at least at W1HCO/2. Many stations contacted on 112 just do not have the same pep now and others cannot be heard at all. Theoretically, of course, the higher frequencies should have a shorter range. Note that the record for 1¼ meters is far less than half that of 2½!

In our opinion, height, which was important before, becomes even more so now. The importance of height over power output was well demonstrated last month when W4IFW, operating portable-airborne near Philadelphia, was heard R9 in the New York-New Jersey area. Using eight watts above 6000 feet, his clear signals easily outclassed many higher power local stations. Needless to say, the appearance of his signals created as much commotion as would the sudden appearance of a full-grown whale among a group of sardine fishermen.

VHF TRANSMITTERS

Not many tubes oscillate efficiently below 5 meters. This does not mean that ordinary receiving type tubes cannot be used. Many QSO's have been completed here with a rig using two 6V6G's in push-pull with 325 volts on plates and screens. With 18 watts input on 2½ the output was approximately 4 watts (and slightly less on 2 meters). Metal types and GT tubes are more efficient since they possess smaller capacitance and shorter leads.

Postwar tubes may be more adaptable to v.h.f. than any obtainable at present.

Experiments carried on here show that a triode of the 76 or similar type generates almost 1.5 watts of power with little coaxing. We apply 300 volts to the plate, obtaining about 20 Ma. plate current when the load is applied, at 146 mc. The tubes seem to take it well. See Fig. 1.

Lower power (with greater efficiency) is possible with a 955 type tube. With a plate voltage of 180 and a current of about 7 Ma., the output is approximately one-half watt.

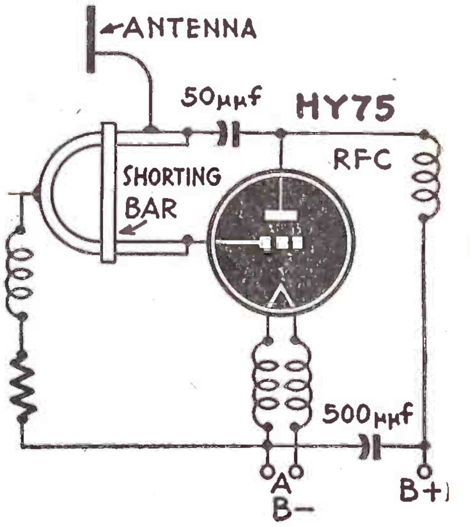


Fig. 2—An efficient long-lines transmitter.

An efficient rig using an HY75 is shown in Fig. 2. This rig is used at W1HCO/2 for low-power work and is operating satisfactorily. This tube pro-

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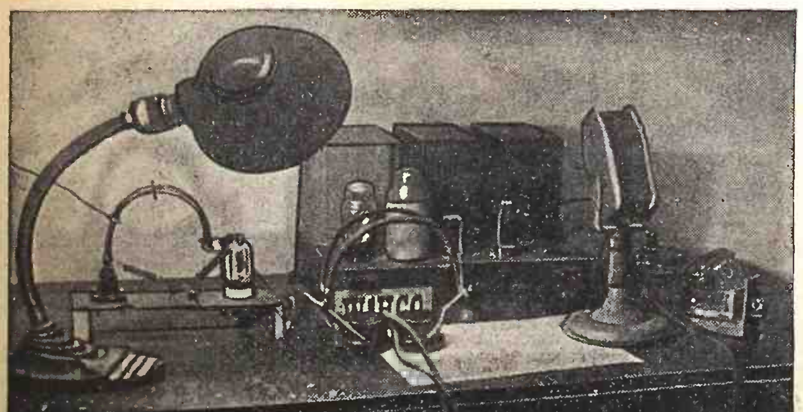
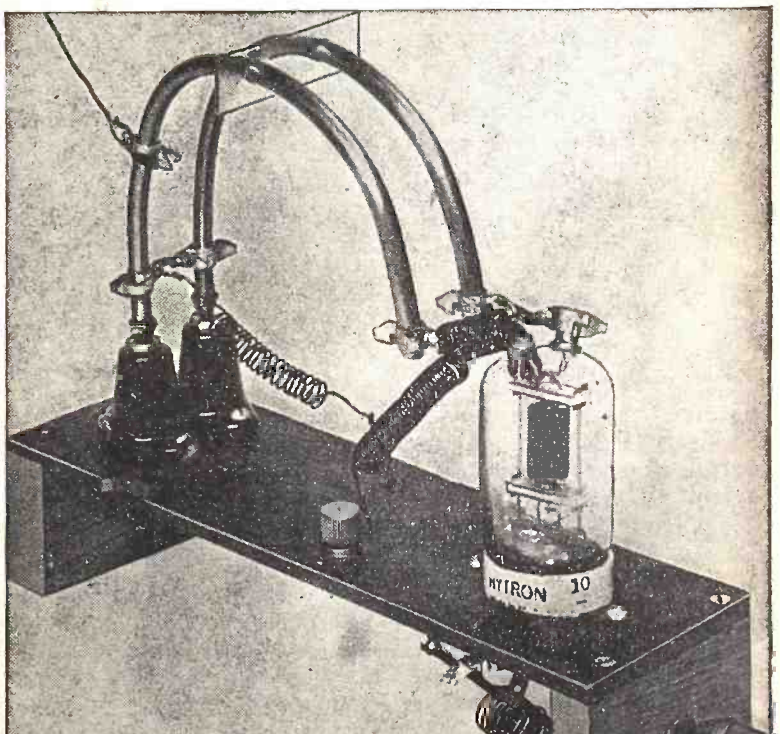
Right—The tuned-line 144-mc. transmitter. Below W1HCO/2. The unit at rear contains speech and audio amplifiers as well as power supply.





By JOHN B. LEDBETTER

DECIBEL PROBLEMS

Explanation of a subject which often puzzles

UNDERSTANDING the various uses of the decibel is not at all difficult, even though the beginner is often nonplussed at the extremely complicated formulae generally used in expressing ratios of sound. These same formulae may be expressed in simple everyday terms so that even the non-technical reader may grasp a working knowledge of them.

First, we all know what sound *is*. From the moment of birth we were conscious of sound and its pleasant effects upon us. Later, in school we learned that tone is the difference between music and noise; pitch is the difference between various keys in the musical scale; and an octave is a *multiple* or *sub-multiple* of a certain pitch.

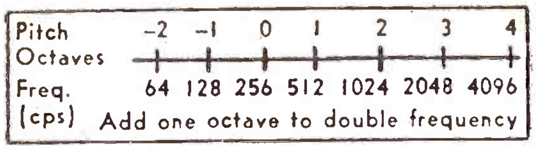


Fig. 1—Octaves express pitch in logarithms.

This means that in order to go an octave *above* any pitch, the frequency of the original pitch must be *doubled;* to *drop* the pitch one octave, the frequency must be *divided* by *two.* Thus 4000 cycles (per second) is one octave *above* 2000 cycles, and 400 cycles is one octave *below* 800 cycles.

The pitch scale is shown in Fig. 1. In this diagram, figures above the vertical lines represent octaves of the physical pitch of C, and the figures below are the corresponding frequencies.

THE DECIBEL SCALE

With the advent of the telephone, and later radio and its numerous applications, came the necessity of measuring accurately the levels and various power ratios of sound energy. Since the human ear is much more sensitive to changes in sound at *low* than at *high* levels, all means of expressing sound changes and ratios electrically must be made in the same manner. A standard unit called the Bel was introduced by sound transmission engineers for these measurements. The Bel, however, proved to be rather unwieldy for small ratios of sound and so a more suitable unit, the *Decibel* (one-tenth Bel) was adopted. Since one Bel (10 Db) indicates an amplification by 10, two Bels (20 Db) mean an amplification by 100 and three Bels (30 Db) mean amplification by 1000.

The decibel scale shown in Fig. 2 is similar to the pitch scale except that its major steps represent changes by a factor of 10 instead of 2 and its basis is power in watts instead of frequency in cycles. To go up the scale by 10 Db, the power must be multiplied by 10; to go 10 Db further, the power is again multiplied by 10. We now have gone up the scale 20 Db and the power is 10 x 10 or 100 times what we started with. To go down 10 Db the power is divided by 10.

Another convenient step found on the Db scale is 3 Db. To go up 3 Db means to *double* the power; to go down 3 Db the power is divided by 2.

The clue to the rest of the scale is found in the definition: The Bel is equal to an amplification by 10. One Db, then, is a step which, taken 10 times, will multiply the original power by 10. This requirement sets the value of 1 Db as a power ratio of 1.26. In other words, the addition of 1 Db multiplies the original power by 1.26. This ratio can be proved as follows: Start with 1 watt, for example, and increase this power by 1 Db or 1 x 1.26 = 1.26 watts. Increasing again by 1 Db, 1.26 x 1.26 = 1.588 watts. Increasing the third time by 1 Db, 1.26 x 1.588 = 2.0 watts. (Note that we have made 3 one-Db steps and have doubled the power). Increase by three more one-Db steps, a total of 6 Db, and we have 2 x 2 = 4 watts. Again increase by 3 Db, a total of 9 Db, and we have 2 x 4 = 8 watts. Now increase by 1 Db to make the total increase 10 Db and we have 1.26 x 8 = 10 watts, or 10 times the original power.

There we have the decibel unit, and that's about all there is to it. The Db is a unit for expressing a change in *power*. This it does on a *relative* basis

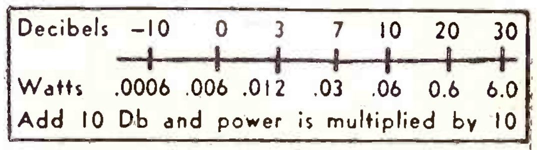


Fig. 2—Watts versus decibels. Not to scale.

so that a 1 Db change is always a change of approximately 26% regardless of the power we start with. A tenth of a watt is a big change if we had only .1 watt to start with, but .1 watt added to 25 watts would be hardly worth bothering with. A change of 1 Db, however, is the same *relative* size change for any value of power, 26% for .1 watt or 26% for 25 watts.

If you have been interested only in knowing what the decibel is, stop here! For a review of the uses and rules for applying this unit, the following should serve for the practical man. For the mathematician who likes these things served up rich in complicated formulae, study of some of the classical treatises on the subject is suggested, such treatment being beyond the purposes of this paper.

IMPORTANCE OF RATIOS

The ratio of one number to another is the *first* number divided by the *second* number, as, for example, the ratio of 10 to 5 is 10/5 = 2. The ratio of 5 to 10 is 5/10 = .5, and the ratio of W_2 to W_1 is W_2/W_1.

The ratio of the output voltage of an amplifier to the input voltage is constant. For instance, in a certain amplifier an input of one volt becomes 5.6 volts at the output. Two volts input would result in 11.2 volts output, and 10 volts in would appear as 56 volts out. These ratios of output to input are 5.6/1 = 11.2/2 = 56/10. The output of an amplifier bears a *constant ratio* to the input.

Let us say that another amplifier has a voltage ratio of 1.6. Then the combination of this amplifier with the one mentioned above would result in a ratio of 1.6 x 5.6, or the *ratio* of an amplification system is the *product* of the *ratios* of its components.

The ratio is encountered in every phase of our work—even after the sound has emerged from the speakers and we listen to it. If we start with 1 microwatt (one-millionth watt) at the ear and increase it to 2 microwatts, we notice a small increase in loudness. Increase from 2 to 4, from 4 to 8, 8 to 16, etc., and the steps of loudness will be approximately the same. In these cases

(*Continued on page* 339)

John B. Ledbetter was born at Hugo, Oklahoma, June 4, 1917. Started in radio service and obtained amateur license (W5FFI) in 1934. Later specialized in public address and sound equipment and maintenance of U.H.F. communications equipment.

Obtained Radiotelephone First Class License in 1941 and joined WRR, Dallas as transmitter and maintenance engineer. Later joined KFJZ, Ft. Worth, as transmitter-studio engineer and in 1942 assumed present duties of studio-field-recording engineer with WKRC, Cincinnati.

Hobbies—Amateur radio, crossword puzzles, writing. Associate member I. R. E., member ARRL. Present ambition is to stop spare-time work on aircraft radio and B. C. receivers long enough to build a .5-Kw 10-6-2-meter portable-mobile rig.

By D. W. UHL

BLIND SERVICEMEN

THE blinded veteran and his future is one of the major problems of the Veterans Administration. Full of hopes and plans for the future, the handicapped GI is unwilling to settle down to rug making or basket weaving. He spurns these and other "traditional" occupations that are often forced on the blind. Like most of us, he wants what many think he can't have. He longs desperately to make his living in one of the normal professions of his sighted brethren.

That is why the Veterans Administration is enthusiastically welcoming the brain child of blind LaVon Peterson of Omaha, Nebraska—a radio engineering school for the blind. It is the only one in the world and was dubbed "impossible" before Mr. Peterson proved it could be done.

Mr. Peterson's Radio Engineering Institute teaches blinded veterans as well as other blind men to become independent radio servicemen; and even to become in many cases better servicemen than the average sighted shop owner.

The lineup of courses taught at the institute sounds like a college curriculum. It goes far beyond the usual instruction in ailing tubes and receivers. All the latest developments in radio and related fields are included. Training is given in both theory and operation of frequency modulation equipment, for instance. Even industrial electronics is taught.

The blind graduate will be able to build as well as service record players, record changers, home recorders, public address systems and push button sets.

The institute also offers a number of courses aimed at making the blind man an efficient shop keeper and business man. He gets a touch of elementary psychology in the course on "Selling Your Repair Work." Proper business methods are covered in bookkeeping, typewriting, keeping an inventory, and good business ethics. A special type of Braille, comparable to business English, teaches him to write down the complicated terms of his profession.

A BRAILLE MULTITESTER

The most important thing in the school, however, is a machine—a special multitester which makes a blind radio man the equal of his sighted colleagues. Like the multitester of the seeing radio service man, it measures voltages, traces current, etc. But Mr. Peterson's Braille Multitester goes further. When attached to a conventional tube tester, it will record the relative strength of the tube tested.

Because its patent is still pending, Mr. Peterson is reluctant to reveal details of his invention. But here is the principle:

Inside and out of sight is the conventional dial of a multitester. A photoelectric cell reads this dial for the blind radio man. The operator swings a pointer on the face of the machine until he hears an audible signal. The sightless man then "reads" with his sensitive fingers the outside Braille dial.

The Braille Multitester is believed to be the only one in the world. It was developed and used successfully by Mr. Peterson in his own radio service shop. Each student will build his own before leaving the school.

The school at present is set up in the Omaha Y.M.C.A. in rented offices and laboratories. There is a side agreement for housing the institute's blind students at the Y. Thus it is made easier for them to get to classes. They also eat most of their meals in the Y dining room.

Students are from all sections of the country. For, in addition to the Veterans Administration, state rehabilitation agencies have expressed great interest in the school.

The idea for the Institute was planted in Mr. Peterson's mind eight years ago when he hung out his shingle as a radio service man. He refused to listen to teachers who said "It can't be done!" He had already gone too far by then to give up his passion for radio.

The earnest, red-haired young man with the determined chin and the eyes that had been blind since birth had got hold of the Braille Radio Amateur's Handbook. The book was well worn and dog-eared before young Peterson would give up trying to gain more information from it. He found a few more books, translated into Braille, which gave him a little more meager knowledge of radio.

Then he was stopped. He could find no more books on radio which he could read with his sensitive fingers. He went to teachers at the Idaho School for the Blind and told them his dream of becoming a radio serviceman. He asked for help.

They were kind. But they answered: "It is impossible." They told him sight was an absolute necessity for recognizing types of tubes, for reading dials, for handling the intricate apparatus of a repair man, for using a hot soldering iron. He listened but he was not convinced. There was no one who could teach him what he wanted to know. He determined to learn for himself. And he did.

1—Mr. Peterson's Braille Multitester in use.
2—Blinded servicemen use power machinery.
3—Some of the students working at the bench.
4—The soldering iron tip is located by "feel."

He got some parts and began to learn them by touch. He puttered with old radios until he knew them inside out. Then he began his toughest job—soldering. "You'll burn yourself if you try to solder," his teachers had told him. They were right! He burned his hands repeatedly. But he finally learned a method of handling the hot iron. He gently fingers the spot to be soldered, bringing the iron ever closer. Then suddenly his fingers draw back and the iron comes down on the critical spot. Today he solders as efficiently as any sighted man. Professional radio men who can see are amazed at the smooth and workmanlike job he does.

Last came his idea for the Braille Multitester. That did it. He could do anything

(Continued on page 360)

By HYMAN HERMAN

REVAMPED TESTER

An Old High-Quality Instrument Is Put to Work

THE pre-war Model 90 Supreme Analyzer was and is a very fine instrument. It used an analyzer plug, (with various adapters) which was inserted into the receiver, the tube being placed in a socket in the analyzer, while the various readings were taken with the use of buttons.

It was also used as a multimeter tester. The meter has a very sensitive, 350 microampere movement, with a built-in rectifier.

The present day V-O-M does not use these plugs, some radio sets being so small as to make it impossible to replace the tube with the analyzer plug.

This revamped instrument is much smaller, because the sockets, buttons and analyzer plug have been eliminated.

All the original wire-wound resistors and shunts have been retained. The only new addition necessary was a four-gang eleven-position switch.

In the original instrument, the resistors and shunts, which were on individual spools, were mounted on a circular bakelite disc, which was secured to the meter, with additional holes provided to make connections to the meter terminals.

In the revamped instrument, these spools were mounted on a rectangular piece of bakelite, making the terminals of the meter more accessible.

Due to the peculiar arrangement of the connections within the meter, all readings are taken through the rectifier. This arrangement, together with the 2000-ohm series resistor and the tapped shunt, acts as a protector of the sensitive movement, should the range switch be set in a wrong position.

There is no polarity on either of the probes. Both A.C. and D.C. readings can be taken with the same range switch and without the use of any special A.C.-D.C. switch.

There is a 3150-ohm resistor, incorporated in the meter, controlled by an A.C.-D.C. switch, but this is used only to make the A.C. readings linear with the scale. The difference in the reading, by using this switch is unimportant for servicing purposes. A.C. readings may be taken with the switch in the D.C. position as well as taking D.C. readings with the switch in the A.C. position.

For all voltage and current ranges, a tapped shunt is used across the meter, increasing the full scale current to 0-1 milliampere, resulting in a 1000 ohm-per-volt meter, on both A.C. and D.C. This tapped shunt is disconnected for all resistance measurements and the 350-microampere movement is taken advantage of, resulting in a 0-500,000 ohm reading with a self-contained 4½ volt battery.

This range can be easily increased to 0-5,000,000 ohms by the addition of a small 45-volt battery in series with a 150,000-ohm resistor.

As the current for a full-scale deflection is only one-third of a milliampere both the 4½- and the 45-volt batteries should last a long time.

As the zero adjustor—used in resistance measurements—is a variable resistor across the movement, it should be in the OFF position when taking voltage and current readings. This is necessary because the original volt-resistance switch has been eliminated.

The low-ohm scale is a closed circuit in the 0-5000-ohm range. Resistance as small as a fraction of an ohm can easily be read.

A small chart can be glued to the cover of the instrument or the new values inked on the original scale, which is easily accessible.

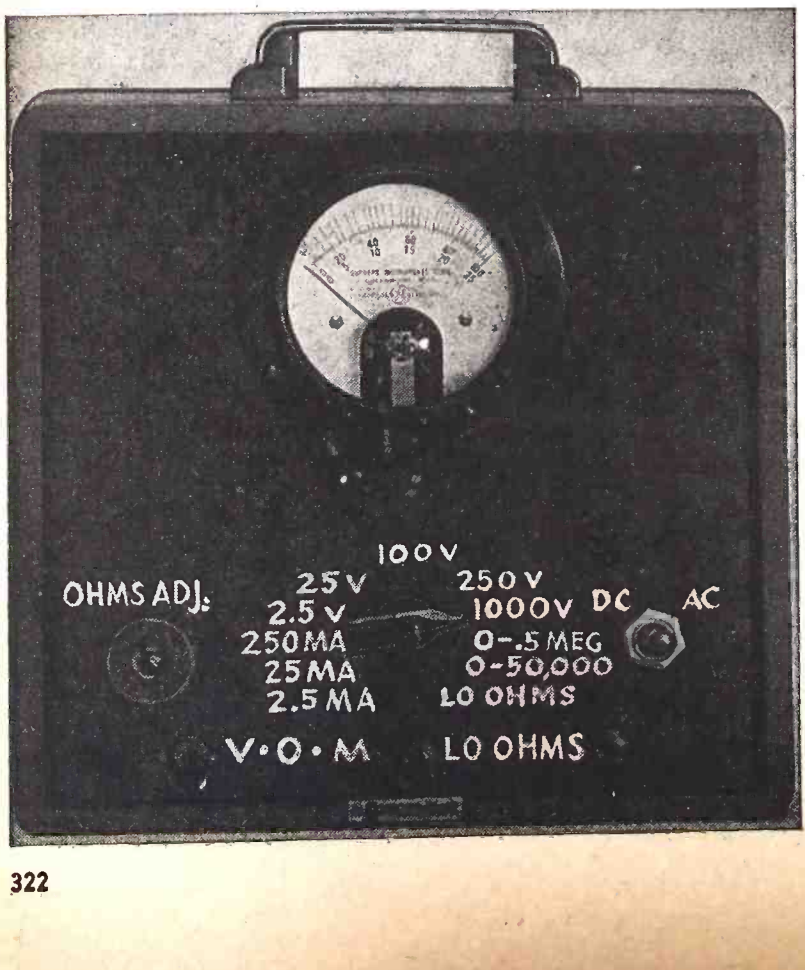
As bakelite was difficult to obtain, I used the ⅛-inch pressed board, which was very easy to drill.

There was sufficient room in the instrument to use the larger flash-light batteries, which with normal use, should last at least a year. All the leads to the battery were soldered directly to the battery carbon and the zinc casing. The three cells were soldered in series.

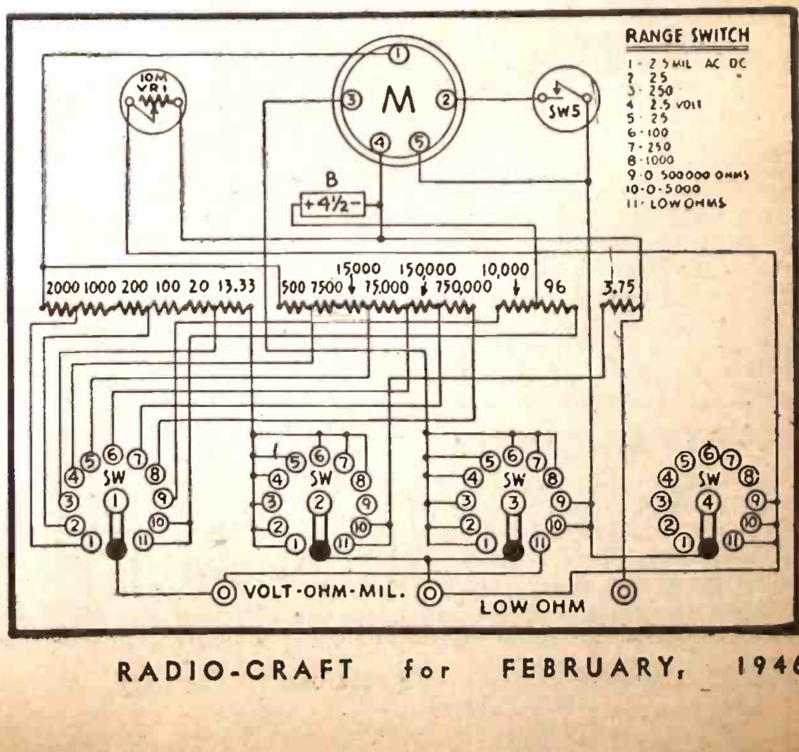
The markings on the panel were easily made with white gummed paper. After the positions of the range switch was marked out, the words and figures were typed in, before pasting it into position on the panel.

Output readings can be taken without any changes of the switches, the ranges being the same as A.C. voltages. This

(Continued on page 345)



Left—The multitester in a compact case. It will be noted that only three terminals and one switch—for A.C. and D.C.—other than the gang are needed for a large number of checks. Below—Schematic of the reconstructed tester showing parts values, also switch positions.



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By JACK KING

SOME FM FACTORS

Underlying Principles of Frequency Modulation

VARIATION of the frequency of the signal rather than its amplitude is the feature of frequency modulation. In Fig. 1, a simple R.F. oscillator is shown. Frequency of the oscillator is governed primarily by the values of effective inductance and capacitance in the tuned circuit, being equal to:

$$f = \frac{1}{2\pi\sqrt{LC}} \qquad (1)$$

where f = cycles per second, frequency
L = inductance in henrys
C = capacitance in farads

The above is the basic formula from which other formulas may be derived. The following one is convenient to use in making calculations:

$$f_{kc} = \frac{159{,}160}{\sqrt{L_{\mu h} C_{\mu\mu f}}} \qquad (2)$$

Assuming that a 10 microhenry coil and 100 mmfd. condenser are used,

$$f_{kc} = \frac{159{,}160}{\sqrt{10 \times 100}} = \frac{159{,}160}{31.61} = 5035.11 \text{ kc.}$$

These figures are more accurate than those given by a slide rule and were worked out by hand. Six- or seven-place log tables could be used. Assuming that the frequency is swung higher on the positive modulation peak and that the change in capacitance value is 10% of 100 mmf. or 10 mmf., the new value will be 100—10 or 90 mmf. Then,

$$f_{kc} = \frac{159{,}160}{\sqrt{10 \times 90}} = \frac{159{,}160}{30} = 5305.33 \text{ kc.}$$

Since the capacitance value is reduced, the shift is toward a higher operating frequency. The 10% shift in capacitance has caused a change of 729.78 kilocycles. Now assume that the capacitance value is shifted from 100 mmfd. to 100 mmfd. plus 10 mmfd., a 10% increase in C value. The new capacitance is 110 mmf. and the frequency is:

$$f_{kc} = \frac{159{,}160}{\sqrt{10 \times 110}} = \frac{159{,}160}{33.16} = 4799.75 \text{ kc.}$$

The difference between this new frequency and the original resting frequency is 235.36 kc., obtained by subtracting 4799.75 kc. from 5035.11 kc.

From this, it is seen that an equal capacitance change in opposite directions from the resting capacitance value does not produce an equal frequency shift in each direction. Therefore, the system must be arranged so that a smaller change in capacitance results on positive than on negative modulation peaks, assuming that the tuned circuit capacity is decreased on positive and increased on negative modulation peaks, or some other means of securing linearity of modulation would need to be employed.

We have assumed a 10% change in the C value and have observed the effect. Now, for this circuit, of Fig. 1 and the assumed 10 microhenry coil and 100 mmf. condenser use a 10% change in inductance and observe the results. We swing from 10 microhenries to 9 microhenries on positive modulation peaks (assuming the modulation on positive peaks causes a rise in frequency) and to 11 microhenrys on negative modulation peaks. For the 9 microhenry value:

$$f_{kc} = \frac{159{,}160}{\sqrt{9 \times 100}} = \frac{159{,}160}{30} = 5305.33 \text{ kc.}$$

Note that the 10% change in inductance gives us the same frequency shift

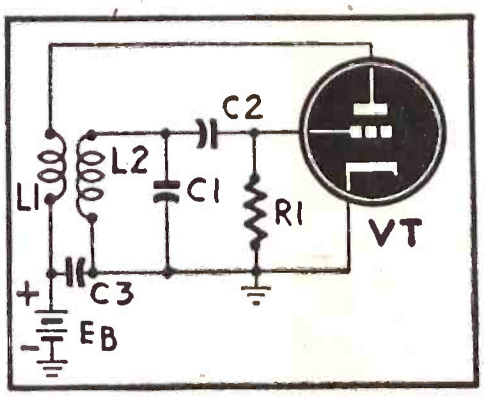

Fig. 1—L and C values determine frequency.

as the 10% change in capacity from 100 mmf. to 90 mmf. For a 10% increase in inductance (11 microhenries) the LC product is 1100 as in a previous example, so that:

$$f_{kc} = \frac{159{,}160}{\sqrt{11 \times 100}} = \frac{159{,}160}{33.16} = 4799.75 \text{ kc.}$$

Therefore, equal changes in either L or C will produce equal frequency shifts, the 10% shift in C producing the same effect as the 10% shift in L, since both affect the LC product in the basic formula (1).

EFFECT OF SMALLER SHIFT

Let us now see what happens when the frequency shift is made smaller. Assuming that a 1% shift in C is used and the shift on positive modulation peaks, going higher in frequency, would be from 100 mmf. to 99 mmf., while on negative modulation peaks, going lower in frequency, the shift would be from 100 mmf. to 101 mmf. The first frequency would be:

$$f_{kc} = \frac{159{,}160}{\sqrt{10 \times 99}} = \frac{159{,}160}{31.46} = 5059.12 \text{ kc.}$$

The second frequency is:

$$f_{kc} = \frac{159{,}160}{\sqrt{10 \times 101}} = \frac{159{,}160}{31.78} = 5008.11 \text{ kc.}$$

The difference in the frequency limits of 5059.12 and the resting or unmodulated frequency of 5035.11 is, for a 1% shift of capacitance, from 100 mmfd. to 99 mmf., equal to 24.01 kilocycles. The negative modulation peak swings the frequency lower, to 5008.11 kc. The difference between the 5035.11 kc resting frequency and the lower limit of 5008.11 kc is 27.00 kc. Note that as L or C are varied by a smaller percentage of their normal values, better modulation linearity is obtained. In the above example, there is a difference in the shifts of 27.00 minus 24.01 kc or only 2.99 kc.

FREQUENCY DOUBLING CIRCUITS

The frequency change, or bandwidth, extends over a range of 27 plus 24.01 or 51.01 kilocycles in this example, from 5059.12 to 5008.11 kilocycles. Suppose, now, we feed the signal frequencies into an amplifier which is tuned to twice the frequency of the unmodulated FM oscillator, twice the resting value or twice 5035.11 equals 10,070.22 kilocycles. The oscillator fundamental frequencies of 5008.11 kc. and 5059.12 kc. will have second harmonics of 10,016.22 kc. and 10,118.24 kc. and the new bandwidth will extend between these second harmonic frequencies,

$f_a = f_1 - f_2 = 5059.12 - 5008.11 = 51.01$
$f_b = 2f_1 - 2f_2 = 2(5059.12) - 2(5008.11) = 10{,}118.24 - 10{,}016.22 = 102.02 = 2f_a = 2(51.001) = 102.02$ kc.

A small percentage shift in L or C results in linearity of modulation, while the use of a double stage permits increasing the bandwidth as well as raising the frequency of operation. The bandwidth is doubled. If the new carrier frequency of twice the original, equal to 10,070.22 Kc. is now fed into another doubler, a third frequency of 20,140.44 Kc is obtained. That is, 5035.11 (fundamental carrier) now becomes 4 x 5035.11 or 20,140.44 Kc and the output of the second doubler stage is four times the frequency of the fundamental FM oscillator. The output of this doubler may be fed into a third doubler stage to obtain twice 20,140.44 Kc or 40,280.88 Kc as the FM carrier. Using a fourth doubler stage in the transmitter, we obtain twice 40,280.88 or 80,561.76 Kc as the final FM carrier. The ratio of 80,561.76 to the original carrier frequency of the FM oscillator is 16 to 1, so

(Continued on page 354)

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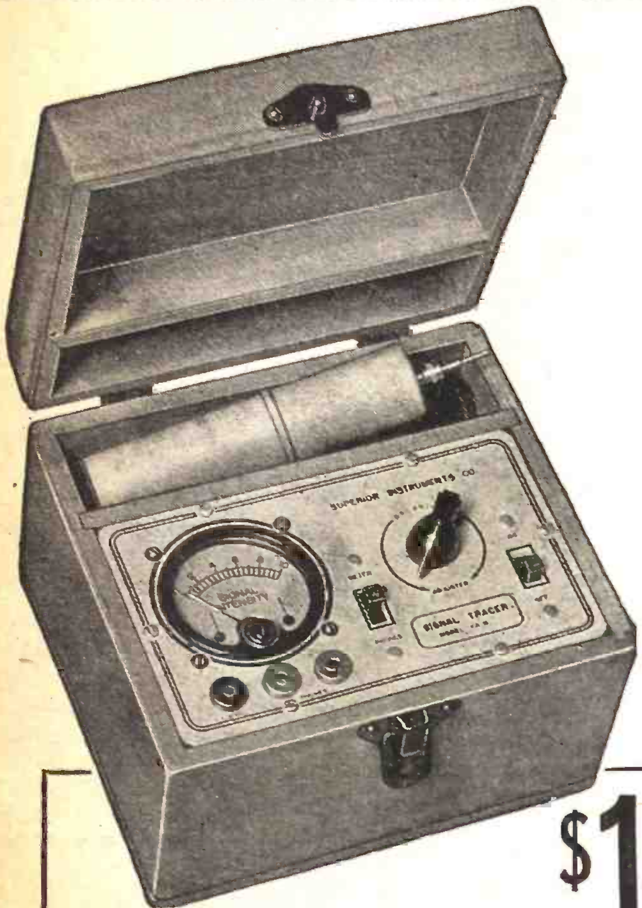

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5 OUTPUT METER RANGES: 0 to 10/50/250/500/1000 Volts
4 D.C. CURRENT RANGES: 0 to 1/10/100 Ma. 0 to 1 Amp.
2 CAPACITY RANGES: .0005 Mfd. to .3 Mfd. .25 Mfd. to 100 Mfd.
3 DECIBEL RANGES: —10 to +15; +10 to +35; +30 to +55
4 RESISTANCE RANGES:
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By ELMER R. FULLER

WORLD-WIDE STATION LIST

CONDITIONS on the ten-meter ham band have been constantly improving, and lately some very fine business results have been obtained during the daylight hours. A few times, this band has been open until seven-thirty or eight in the evening, but it usually closes down about five-thirty or six during this season of the year. A few reports have been received on this band, and we would like more as well as reports on the other ham bands as soon as they are put back into use.

A letter was received from a friend in France a short time ago. He stated that it would probably be six months to a year before the French amateurs would be able to get back on the air. At the present time, equipment there is available only for industrial uses. Most of the formerly used transmitters were confiscated by the invaders. We were very glad to hear from this friend, as he was one of our observers before France went to war, and nothing was heard from him for about four years. His last letter was mailed just a few days before France fell. We wrote to him twice during the war, but the letters were never received. A third letter written in October of this year got through to him, and he had wanted to write to us, but had lost all of his possessions, and did not know my address. His letter stated that as soon as he can get a receiver together, he will send us reports on what he hears over there. With his brother, who could not speak English, he owned and operated amateur station F8UE, and hopes to have it on the air sometime this year.

The other day we received a most welcome card from Commander H. J. Scott of Oakland, California. It was a short note criticizing our graph "An evening on the short wave band," but it was certainly constructive. Personally, I have never been farther west than New York State, hi, and so did not realize, even though I should have, that by twelve midnight our evening is over, but in California on the west coast, it is only nine o'clock, and their evening is only about half over. Because of this, next month we will print an addition to our graph, showing the most important stations on the air from 9 pm to 12 m Pacific time. Cards and letters of this type are surely appreciated; and will be of great aid in getting the type of material you want into this publication.

This month we have added a few stations to our list which have been skipped over in the past. It is hoped to keep this log as complete as possible, but stations are coming, going and moving around the dial every day; as well as changing skeds until it is almost impossible to keep track of them. Every report received is a help in doing this.

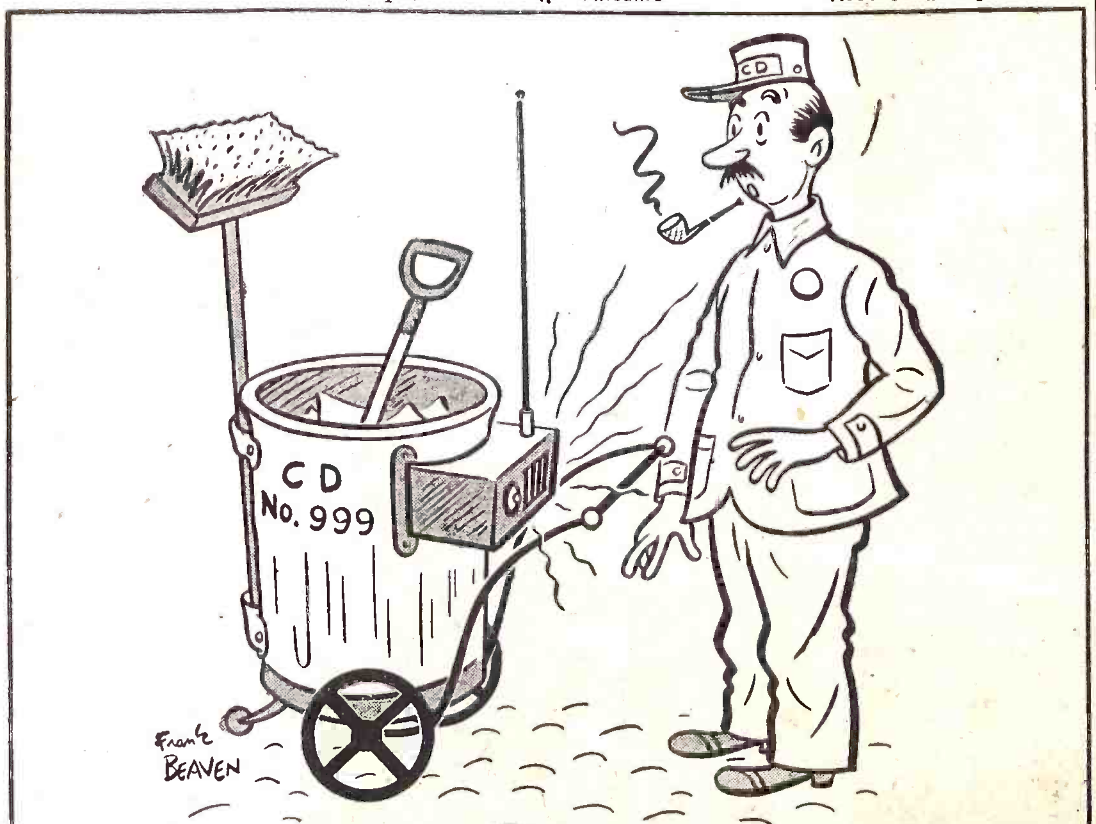
New Listening Post Certificates have been mailed to all active observers; and we have quite a supply of them waiting for new observers, particularly overseas. So let's keep up the work that you have been doing such a fine job at, and see what new sigs we can pull in.

Got a postwar receiver here a few days ago, and it sure has it all over the old one. Hard to take out time enough to sleep and work, hi!

All schedules U. S. Eastern Standard Time.

Location	Station	Frequency and Schedule	
SOUTH AFRICA			
Capetown	ZRK	5.863	11:45 pm to 1:30 am; 10 am to 4 pm
Johannesburg	ZRH	6.028	11:45 pm to 1:30 am
Capetown	ZRL	9.608	3 to 7 am; 9 am to 4 pm
Johannesburg	ZRH	6.007	11 pm to 2 am; except Saturdays
Johannesburg	ZRG	9.520	3 to 7 am
Johannesburg	ZTJ	9.900	7:15 to 7:45 am
SPAIN			
Alicante		7.950	off at 5 pm
Madrid	EA2	9.370	2 to 3 am; 7 to 9 am; 10 am to 5 pm; 6:30 to 9 pm
SPANISH MOROCCO			
Tetuan		6.065	5 to 6:15 pm
SURINAM			
Paramaribo	PZX3	5.750	6 to 8:45 pm
Paramaribo	PZX5	15.405	11:30 am to noon
SWEDEN			
Stockholm	SBU	9.535	1:30 to 5 pm; 8 to 9 pm; Sundays only, 5 to 9 am
Stockholm	SDB2	10.780	3:15 to 5 pm
Stockholm	SBP	11.705	11 pm to 1:30 am; 3 to 8 am; 10 to 11 am
Stockholm	SBT	15.155	6 to 7 am; 10 am to 1:15 pm; Sundays, 2:45 to 1:15 pm
SWITZERLAND			
Berne	HER3	6.165	1 to 3 pm
Berne	HEI2	6.345	12:30 to 1:45 am; 2:45 to 7 am; 1 to 5:15 pm; 8:30 to 10 pm
Berne	HET3	7.360	6:30 to 8 pm
Berne	HEK3	7.380	10 am to 12:30 pm; 3:15 to 3:30 pm; 8:30 to 10 pm
Berne	HEF4	9.185	North American beam, 7:15 to 7:45 am; 4:20 to 5:20 pm; 6:30 to 8 pm; 8:30 to 10 pm
Geneva	HBL	9.345	1 to 3 pm
Berne	HEJ5	11.715	Tuesday and Saturday, 10 am to noon
Berne	HEK4	11.960	Tuesday and Saturday, midnight to 1:30 am
Berne	HEO4	15.875	2:15 to 2:50 pm
SYRIA			
Damascus		8.000	11 pm to midnight
TAHITI			
Papeete	FO8AA	6.980	Fridays and Saturdays, 11 pm to midnight
TURKEY			
Ankara	TAP	9.465	11 am to 4:45 pm
Ankara	TAP	9.510	1 to 2 pm
Ankara	TAQ	15.195	4:15 to 8 am

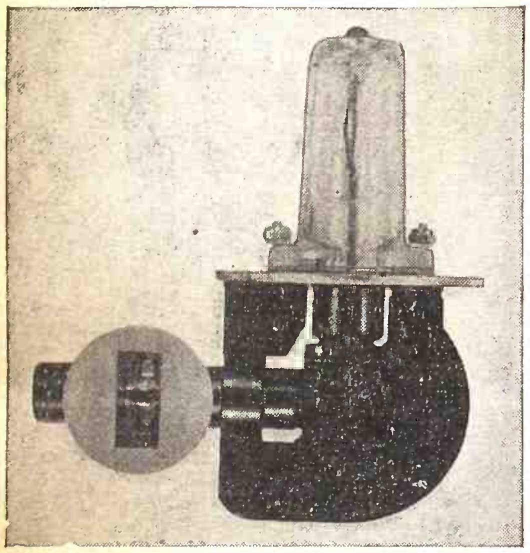
(Continued on page 344)



Suggested by: F. J. Dunnett, Vancouver, B. C., Canada
"Calling cleaner No. 999! Proceed at once to 42nd St. and Vine—the circus parade is over! That is all!"

cathode. Consequently, it comes to rest on the lower-voltage anode.

This is a true case of negative resistance. A lowering of voltage results in an increase of current, and vice versa. In a circuit like that of Fig. 3, which has a number of resemblances to a triode Hartley, if the voltage on one of the anode sectors is increased the current to it drops and that to the lower-voltage sector increases. Due to voltage drop through the inductance, this further decreases the voltage on the low-voltage sector. The action continues to a limit set by the circuit factors, including plate voltage and magnetic field strength. When this limit is reached,



12-cavity magnetron for fire control systems.

the plates start to return to a condition of equal voltage, discharging circuit capacities and building up an inductance field around the coil in the ordinary fashion of a coil-condenser combination. When the plates reach a condition of voltage equilibrium, current flow continues as the magnetic field around the inductance collapses, reducing the voltage on the former high-voltage anode and increasing it on the other. The action continues in the opposite direction, resulting in steady oscillation at a frequency determined by the inductance and capacity in the circuit.

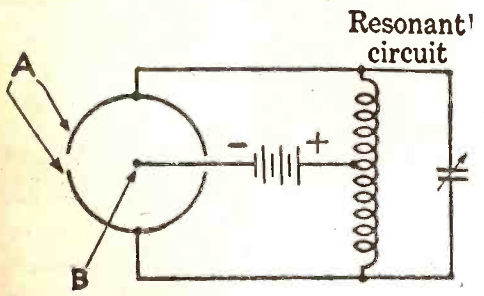


Fig. 3—Circuit for magnetron oscillations.

As is the case with oscillating circuits which use ordinary tubes, it is not necessary to make any special provision for supplying the plates with an initial unequal voltage. Random effects, variations in supply voltage—all the causes to which oscillation in triodes are ascribed—suffice to start oscillations in a circuit similar to that of Fig. 3.

The ability of magnetrons to reach

MAGNETRON TUBES

(Continued from page 308)

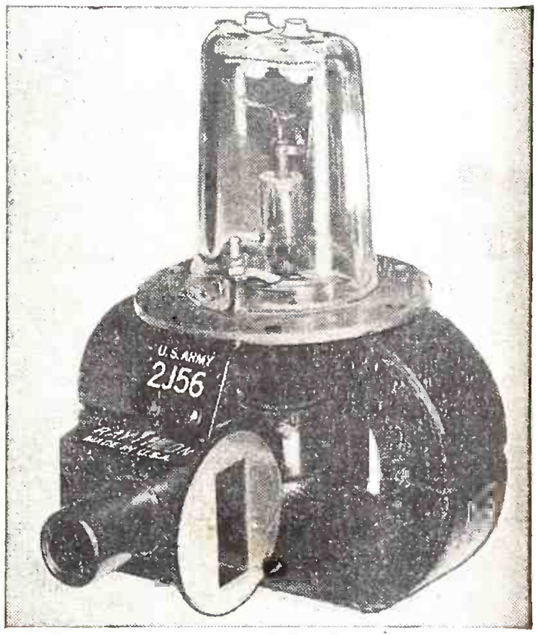
higher frequencies is increased by reducing the external coil-condenser combination to a pair of Lecher wires. The total capacity in circuit is supplied by the plates and distributed capacity of the wires. The two-sector anode, in other cases, is further split into four or more sectors, each with its Lecher-wire oscillating system.

The next step in the evolution of the tube was the cavity magnetron, with the whole Lecher-wire system converted into resonant cavities and enclosed in the tube itself. Descriptions of cavity magnetrons are still somewhat limited by war security restrictions. Raytheon, who released the photographs shown in connection with this article, explains their product in the following simplified form:

"Basically, the cavity magnetron is made up of a heavy cylinder of copper around whose inner diameter a series of identical key holes have been cut with the narrow slot opening into the center hole. Each of the key holes represents a transmitter circuit. In the center of the body is placed an emitting cylinder, usually a nickel sleeve coated with an active material which upon heating produces a copious flow of electrons. If each hole and slot is identical to its adjacent member, and if the configuration is correct, the tube, upon application of proper voltages and magnetic field can be made to produce thousands of watts of pulsed microwave energy. This energy is taken out of the tube by coupling into one of its key-hole cavities and conducting the energy to an external lead. This may be achieved either by use of a coupling loop, or by a wave-guide.

The electrical operation of the cavity magnetron can best be understood by remembering that the oscillators are placed cylindrically around the axis of the cathode and a means of exciting these cavities must be provided. A magnetic field is applied axially to this diode which causes the electrons emitted from the cathode to perform circular paths about the cathode. The electron motion can be considered as an air stream passing a slot, which, when it acquires the correct velocity, causes the cavity to resonate. This is a simple analogy; however, the complete problem of the growth of oscillations is too complex to be dealt with completely at the present time. The critical speed of the electron stream is obtained when the velocity is such that one cavity represents a negative portion of the output wave while the next cavity is positive."

Microwaves, as generated by the magnetron, have been of decisive value in wartime applications. Immediate benefits to be felt in peace time will be that large commercial airlines which



Another magnetron used for fire control work.

have been badly restricted in operation by weather conditions will soon be able to fly and land on schedule regardless of weather. Ships will no longer have to wait the lifting of fog to get into harbors. However, the magnetron and other microwave types offer many other possibilities which to date have not been pursued. With peace, newer applications and uses for these tubes will be brought forth in ever increasing number.

PEACETIME USES FOR ATOMIC POWER

AMERICAN industry and science can begin reaping the benefits of large-scale atom-splitting right now, without having to wait for the development of atomic power, A. L. Baker, general manager of the Kellex Corporation of Oak Ridge, Tenn., declared recently at a press conference in New York. These benefits will flow from the new engineering principles, new equipment and new methods which had to be used under the forced draft of war to produce the atomic bomb in time for use as a weapon.

Some of the beneficial by-products of the work on large-scale atom-splitting enumerated by Mr. Baker are: Cheaper, more abundant sources of radioactivity for the treatment of cancer.

Improved methods for combating industrial hazards due to presence of poisonous substances.

High-vacuum, low-temperature dehydration of foods.

Improvements in vacuum distillation for the production of vitamins.

Better heat exchangers, new methods of separating gasoline fractions and more efficient mass-spectrum analysis for the petroleum industry.

New electronic techniques in high vacua for the electrical industry.

More efficient gas pumps; some of these, developed for this project, can deliver a stream of gas at a velocity greater than that of sound.

All told, about 5,000 new and improved products and procedures are now available to American industry, awaiting only governmental release for volume production, Mr. Baker stated. He especially emphasized the improvements that have been made in pumps, and declared that in 20 years the benefits accruing from this one source alone would probably be worth the outlay of $2,000,000,000 made by the government for the whole atomic bomb project.

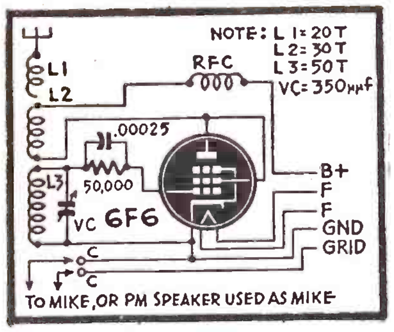
RADIO-ELECTRONIC CIRCUITS

CAR TALKIE

The diagram shows an outfit which, when plugged into your car radio, makes a transceiver. This car talkie transceiver derives all of its power from your car radio itself through an Amphenol connector plugged into a special socket on the radio. The necessary connections are brought to this socket from the various parts within the radio itself.

The connection marked "B-plus" is run directly to the plate terminal of the receiver's power output tube. The two terminals marked "F" are connected to the filaments of one of the receiving tubes in the car radio. The one marked "Gnd" is run to the chassis of the radio. The connection marked "Grid" is run to the grid of the first audio tube in the receiver where the volume control is usually connected. The terminals marked "C" are any type of microphone connectors which the builder may have on hand. The mike can be a small PM speaker. The oscillator coils are all wound on a 3-inch form. (A salt box makes a good one.) The coil wire size is No. 22, silk or cotton covered, single-layer wound ¼-inch space between each coil.

To operate as a transmitter, plug the oscillator terminal plug into the radio receiver receptacle and turn the



volume control of the receiver to the off position. You are then ready to transmit. The audio amplifier section of the radio acts as the modulator for the transmitter. To receive, just turn up the volume of the receiver and tune for stations. With two cars equipped this way, a two-way conversation may be carried on between cars, each oscillator having a different operating frequency.

This can also be used in the home, if desired, as long as FCC regulations in regard to licenses and operation of transmitters, is observed. In either case, home or auto, a license is required before transmitting, with heavy penalties for operation without a license.

Howard L. Culbertson,
Zanesville, Ohio

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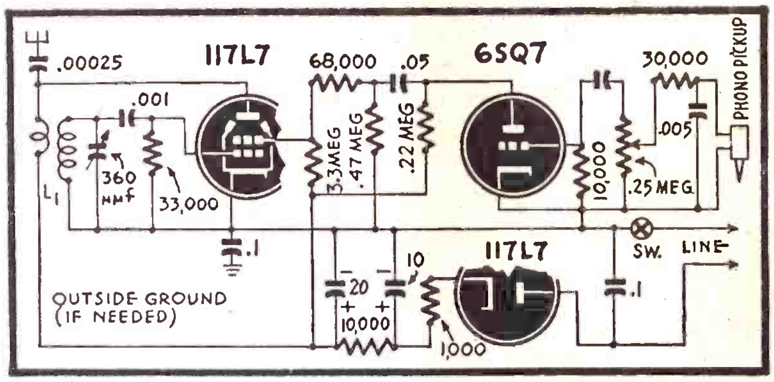
PHONO OSCILLATOR

This is a circuit of a phono oscillator that I have been using for quite some time. The tone is just about the best I have heard from any phono oscillator, and I have tried a good many other types of circuits.

The average constructor should find no difficulty in building this unit. The scratch-filter resistor and condenser may be varied for best results. Coils are standard broadcast type.

T. Bjorn,
Chicago, Ill.

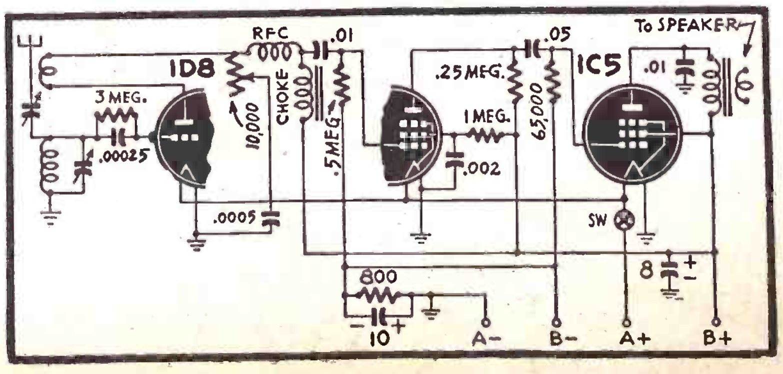
(A word of caution is again in order. Make sure that this does not radiate more than 157,000/f[Kc] feet, in accordance with FCC regulations. More than this amount on the broadcast band is likely to interfere with the neighbor's reception.—*Editor.*)



TWO-TUBE REGENERATOR

Here is a diagram for a 2-tube regenerative long and short wave receiver which gives excellent performance with good volume and selectivity. It uses two pentode output tubes in cascade as A.F. amplifier. Real volume was obtained with little or no distortion. A 1D8GT was used for the first stage of audio and the detector; a 1C5GT for the output. The R.F. choke and impedance coupling between the first A.F. and the detector were both necessary for good regeneration. Ordinary plug-in coils were used in this hookup but fixed wired-in coils can be used if desired.

L. Clare Fowler,
Aldersyde, Alberta



TEST RESISTOR

I have had radio sets brought in for repair that had one or more carbon resistors so badly burned out from overheating that it was nearly impossible to determine what resistance they used to be. I therefore devised a gadget that makes repair jobs on these sets very easy. I use a 500,000-ohm variable resistor which is connected to the two test leads with alligator clips on one end.

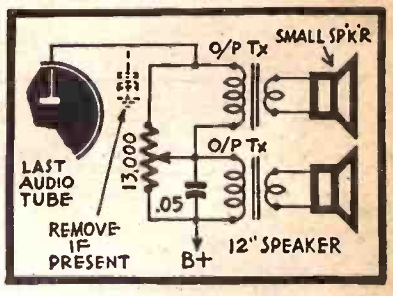
The defective resistor is cut out of the circuit and the two alligator leads are connected in its place. The radio is then turned on and the resistor is adjusted to the point where best performance is noted. The variable resistor is then disconnected and checked for resistance with an ohmmeter. A carbon resistor of that particular resistance is selected, installed, and the job is done.

Several of these units can be made for covering a wider range.

C. G. Peterson,
Rosepine, La.

DIVIDING NETWORK

This is an idea for a tone control which I am using at present and which gives excellent results. A small speaker with little baffling is used for the high frequencies and a 12-inch speaker in a bass reflex cabinet for the lows. The .05 condenser is used as a high-frequency bypass. Any change in condenser will serve to vary the tone slightly. The 13,000-ohm variable resistor is used as the tone control, properly apportioning the



amount of signal given to each speaker. The difference in volume between that reproduced by the "high" speaker and the "low" speaker gives the listener an "apparent" tone control. The resistor should be a wirewound type capable of handling double the plate current of the last audio stage.

Capt. Vaughn G. Layman,
Wendover Field, Utah

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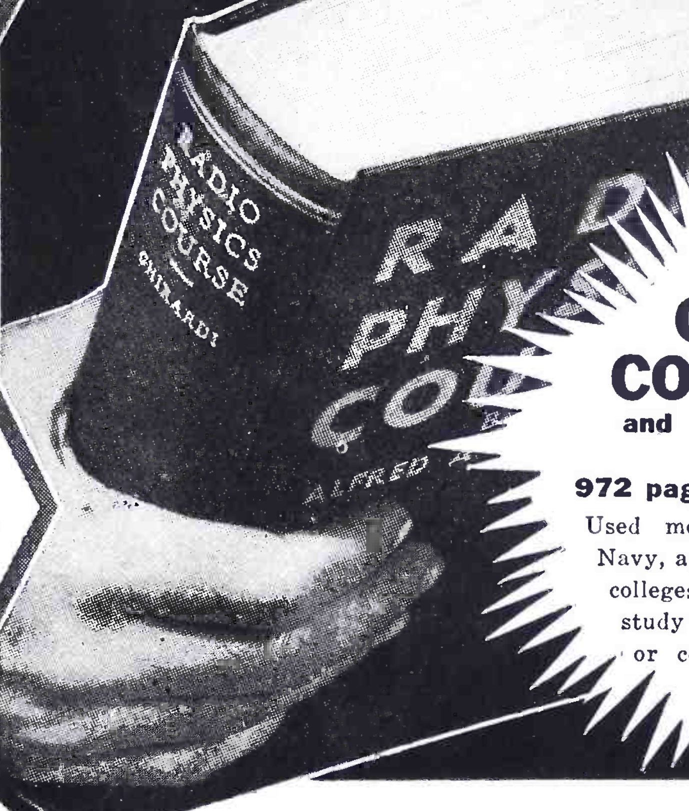

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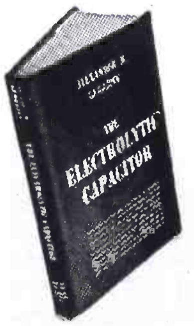

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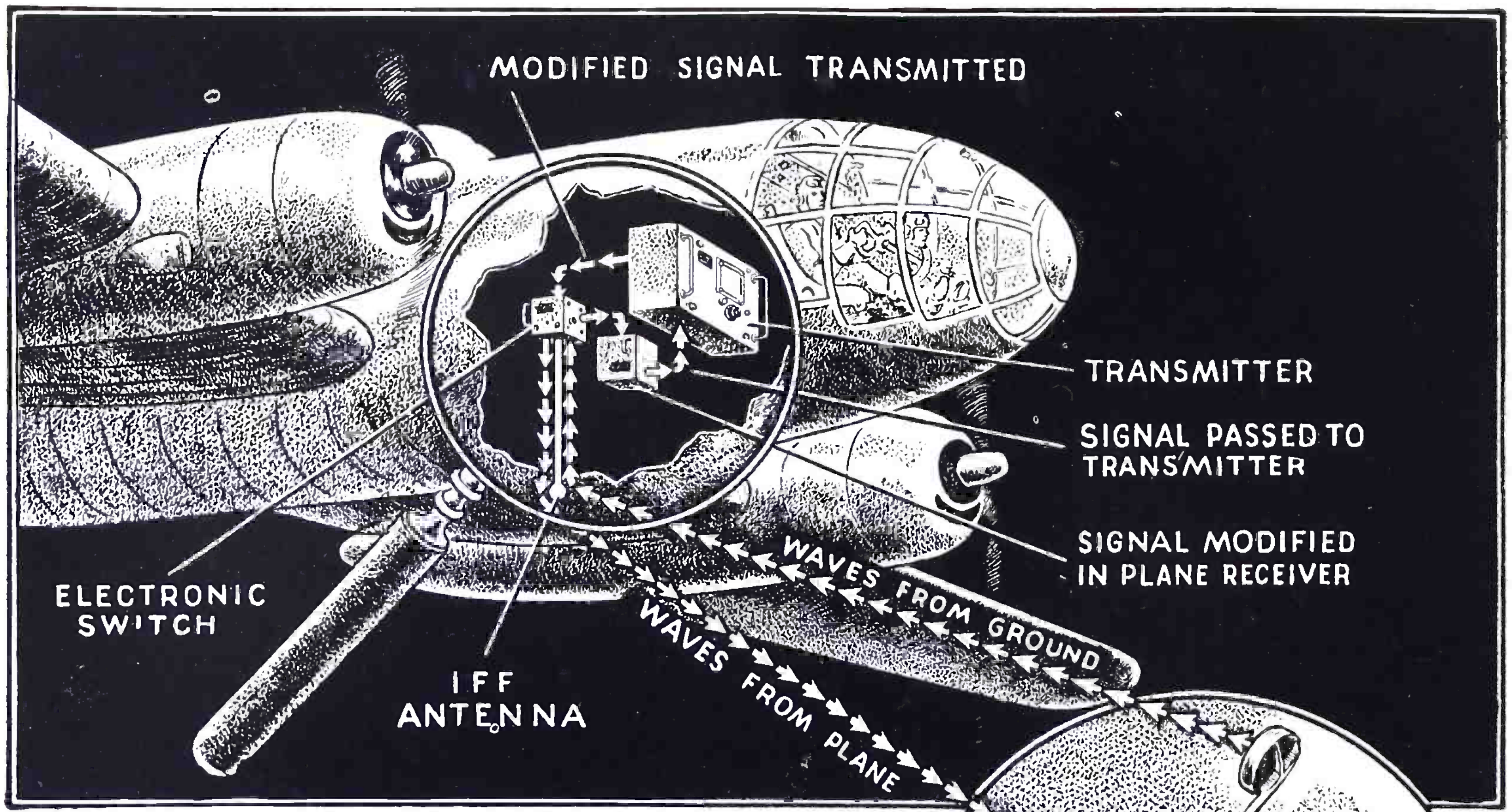

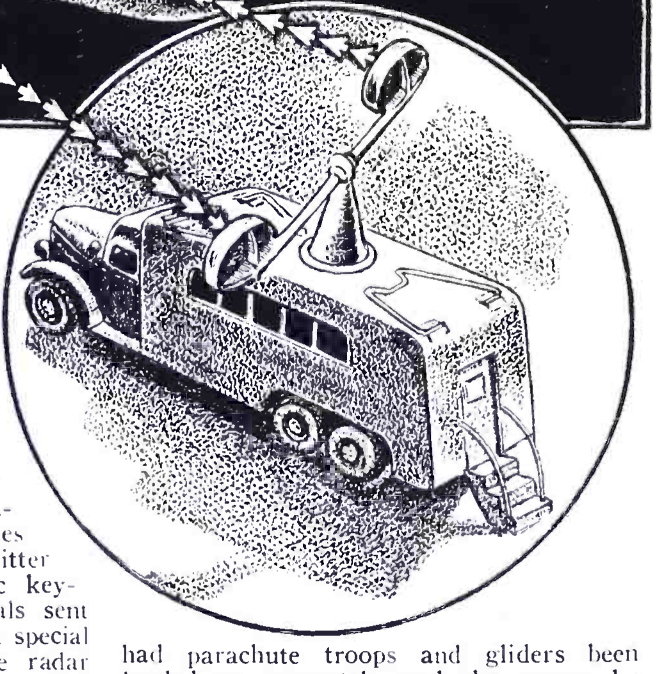

Route of IFF signals from ground station to plane and back to identifying indicator.

I. F. F.

IDENTIFICATION, FRIEND OR FOE

THE device known as IFF (Identification, Friend or Foe) in military circles has been surrounded by such great secrecy that it has not yet been given a name more appropriate for peacetime purposes. The necessity for such a device was determined as soon as radar was adopted for military uses because all types of airplanes give exactly the same response to the radar beam. While radar served to warn of the approach of enemy aircraft when it was known definitely that none of our planes were in the air, it lost its effectiveness in areas where there was continuing air activity by both sides in warfare.

Early in the war, the British devised several means of identifying aircraft by modifying the type of reflection of the radar impulse. Although none of these systems was completely satisfactory, the experimental work indicated the elements which were necessary. These experiments also showed the necessity of a standard system to be used by all the Allied nations.

American work on the device—co-ordinated with that of other United Nations and working to common specifications—was handled by the Belmont Radio Corporation, with the assistance of engineers from Wells-Gardner Co. and Admiral Corp. After six months of intensive endeavor, an IFF system was perfected which gives positive identification and is now used with all radar equipment by the armed forces. IFF is essentially a form of radar, but it also requires a separate ground unit with a directional antenna, as well as a special receiver and transmitter in the airplane.

Here is how the IFF system works:

The radar picks up an approaching plane and indicates its position and range. From this information, the directional antenna on the IFF ground unit is adjusted to point directly to that position. Secondly, the range circuit is adjusted so that the response, in the event it is a friendly flyer, will come only from the plane previously detected by the radar.

Then the IFF ground unit sends out a pulse of radio frequency energy. If the plane is friendly, it is equipped with a receiver for this impulse. This receiver, when it receives radar signals, sets an FM transmitter which also contains an automatic keying circuit, into action. The signals sent out by the plane are picked up by a special receiver which forms part of the radar equipment and after detection are applied to the vertical deflecting plates of the cathode-ray tube indicator, setting up the special traces below those caused by echoes from the aircraft.

From the nature of the code signal received, the IFF ground unit operator can immediately determine whether the plane under observation is friend or foe.

By means of the I.F.F., the image which appears on the fluorescent radar screen is not the same when it comes from an enemy plane as when it is caused by a friend. In the former case, the reflected waves produce a line above the horizontal sweep line. But when a friendly plane finds itself in the beam sent out by the radar transmitter, there is in addition to the upright vertical line, another vertical line below the sweep base. This second "pip" is intermittent, modulated in the form of Morse signals. These vary daily according to a pre-established code.

The equipment in the airplane is turned on when the ship leaves the ground and its operation is completely automatic. *No attention from the pilot is required.*

IFF was adopted for a new and important use at the time of the Normandy invasion. The ground units were planted at points inland by Allied secret service agents and the electronic beams served to guide planes and gliders so that paratroopers could be dropped at the most strategic points. Never before in warfare had parachute troops and gliders been landed so accurately and the means by which it was done remained a mystery to the enemy.

IFF devices were among the topmost secret apparatus of the war; according to some sources being so secret as to prevent full realization of their value. Each of them was said to have been so booby-trapped that any attempt of the enemy to open a captured one would result in an explosion which would—at the least—destroy the apparatus beyond possibility of discovering its purpose.

According to experts in the field of electronics, IFF equipment has a definite application to peacetime aviation. Any plane carrying a small IFF unit can be located almost instantly by its home airport or the airport to which it is flying. If a pilot flew off his course, he could, using regular radio communication, ask the nearest airport to determine his exact location by stating his IFF code. In this case, the IFF operator at the airport would search with his antenna until he received a signal with this code and, from readings on position and range, could advise the pilot of his exact location.

The advantage of IFF is that it does not have the defects of the radio compass because it operates on higher frequencies. At the present time the radio compass is not infrequently affected by climatic conditions which render it subject to considerable error.

3 STAR NOW TEAMED

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MEISSNER

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Meissner *precision built* components include Antenna, R.F. and Oscillator Coils; plastic, standard and Ferrocart Transformers; Cartwheel and replacement Windings; Coils, Chokes and Accessories.

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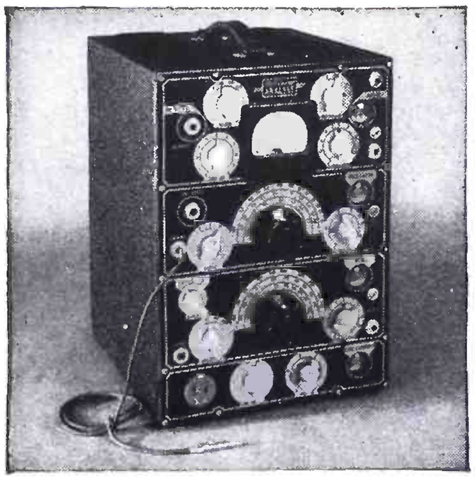

MEISSNER ANALYST

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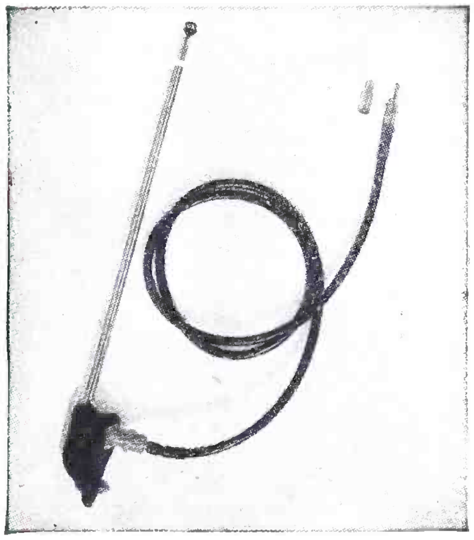

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Radiart Correct Replacement Vibrators are individually engineered to meet exactly the physical as well as the electrical requirements of each application.

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Quality built and precision-engineered for all requirements; replacement, communications, sound amplifier, industrial, experimental and amateur. Tropex-impregnated for protection against moisture, salt air and humidity.

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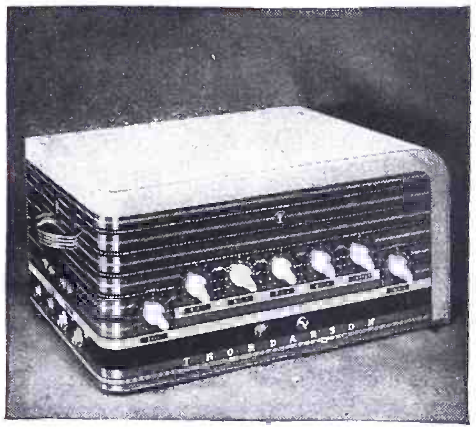

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TRU-FIDELITY AMPLIFIERS

True-Fidelity Amplifiers, in new modern designs, feature advanced tone compensation, conservative ratings, ample ventilation for continuous operation, low hum level, multiple input channels, and maximum flexibility of controls.

MAGUIRE INDUSTRIES, INC.

936 NORTH MICHIGAN AVENUE, CHICAGO 11, ILLINOIS

ELEMENTS OF RADAR

(Continued from page 318)

scope screen as brilliant dots of light. Reflections from land, ships at sea, tall buildings, and other obstructions *also* appear on the indicator screen. Thus the PPI tube virtually draws a "map" of the area surrounding the radar set (Fig. 7). A high degree of screen phosphorescence permits examination of the "map" long after the antenna and base line have passed target echoes.

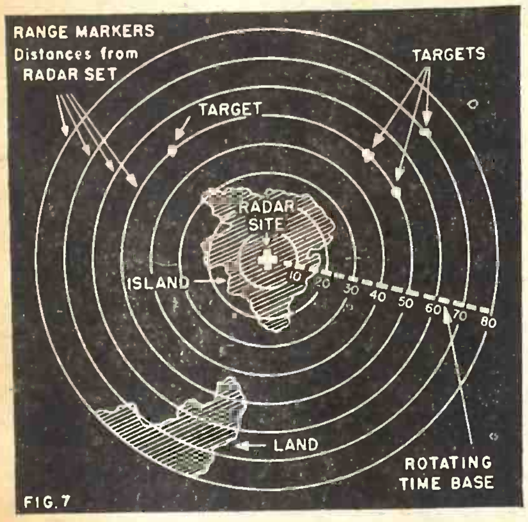


Fig. 7—PPI indicator shows surrounding area.

Radar indicators often have several oscilloscopes; one for measuring range, one for azimuth, one for elevation of aircraft. For obtaining precise data, some radar sets may have as many as five or six oscilloscopes. But their function is primarily the same: to present in detail information gathered by the remainder of the radar equipment.

In succeeding articles Mr. McQuay will explain in detail a number of the electronic phenomena and circuits used in radar transmitters. The first of these "Electronic Transients" will appear in our next issue.

TESTS ON NEW RADIOS

Postwar receivers should be purchased with caution, *Consumer Reports* stated last month. Tests on three of the earliest sets put on the market—all of them carrying unknown brand names—indicated shock hazard, over-pricing and other shortcomings.

Set No. 1, a large midget, priced at $32.95, had fairly good tone, sensitivity, and volume, some hum and telegraph interference. Workmanship was poor, and set had a loose connection which crackled when cabinet was jarred. Set 2, a small table model, priced at $39.95, had poor, boomy tone, not remediable by adjustment of the "tone control." Set 3, priced at $44.05, was the poorest of the three, combining poor calibration with poor sensitivity at the low-frequency end of the dial, which exhibited excessive backlash. Tone quality was fair, construction poor. Higher price was apparently due to the standard short wave band incorporated in the set.

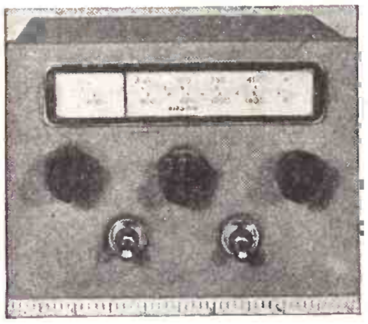
All three sets were A.C.-D.C., and had "live" parts such as screw heads projecting through the bottom, creating shock hazard. All were overpriced by pre-war standards, none of them comparing with a standard 1942 model which sold for $28.95.

No standard brand radios manufactured by any of the leading manufacturers were available for testing at the time these radios were put on the market.

NEW RADIO-ELECTRONIC DEVICES

AIRCRAFT RADIO
Airadio, Inc.
Stamford, Conn.

THIS two-way communication system is compact, highly sensitive, and ruggedly constructed. The two-band aircraft receiver and transmitter give highest performance and dependability under all flight conditions. The set offers standard plane-to-ground communication, radio range, weather broadcast, and standard broadcast reception, as well as interphone between pilot and passengers.



A space the size of a post-card is all that is necessary on the aircraft instrument panel for mounting the receiver. The edge-lighted slide rule dial is accurately calibrated and greatly simplifies tuning. The transmitter does not have to be accessible in flight and may be installed in a remote location.—*Radio-Craft*

SOLDERING IRON
Sound Equipment Corp of Calif.
Glendale, Calif.

THE Kwikheat Thermostatic Soldering Iron has a thermostat self-contained — maintaining constant heat at all times and preventing overheating.

The iron has an unusually long life expectancy because it eliminates the excessively high temperature acquired by the conventional electric soldering iron when in "idle" condition . . . the major contributing factor in soldering iron deterioration. Tips, too, last longer because they are never overheated and consequently need less retinning in this modern tool.

It heats up ready-to-use only 90 seconds after plugging in. This is made possible by a special powerful 225-watt quick-heating element—held in check by the thermostat.

Six different tip styles can be easily interchanged. The tips are made of corrosion-resistant copper alloy. They screw into the iron for good contact and are tapered for efficient heat conductivity. One tip is an aluminum alloy melting pot for tinning, etc.—*Radio-Craft*

MIDGET VIBRATOR
Radiart Corporation
Cleveland, Ohio

THIS is the smallest vibrator made. It measures 2⅛ inches high by 1⅛ inches in diameter. One of the new radio developments of the war, it is designed for operation from a small 6-volt storage battery, furnishing power to replace dry-battery power in certain communications equipment. The entire power supply including the storage battery had to be made for a space 6½x3½x1¾ inches.

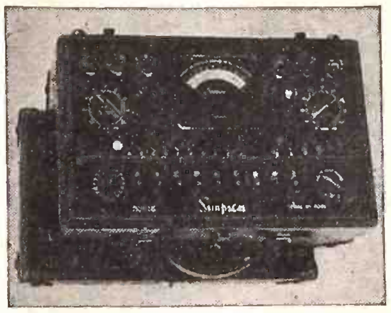
Naturally the vibrator had to be as small as possible.

Specifications of the VR-2 follow:

Vibrator frequency, 185 CPS±10%; input voltage nominal, 6.0v; input voltage range, 4.5v to 7.5v; input current, 1.5 amps max. at 6.0v; output voltage, 200v D.C. maximum; potential difference between primary reed and secondary reed, 25v maximum.—*Radio-Craft*

TUBE TESTER
Simpson Electric Co.
Chicago, Illinois

FEATURING a method of testing tubes in terms of percentage of rated dynamic mutual conductance, the new tester is believed by its creators to be so revolutionary that it will start a new trend in tube testing methods. A tube under test by the instrument is compared with the standard rated micromho value for that tube. Colored zones on the dial coincide with the micromho rating or



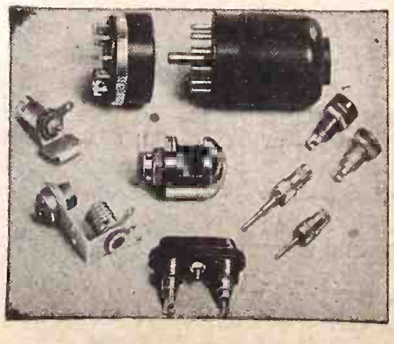
percentage of mutual conductance, indicating that the tube is good, fair, doubtful or definitely bad.

Ten push-button switches and nine rotating switches of six positions each provide a multitude of combinations in tube element and circuit selection. Very complicated tubes require only a few settings. A tube chart is provided for identifying the tube and setting the controls.

An automatic reset button returns all switches to normal when the test is completed, rendering the tester instantly ready for a new test. —*Radio-Craft*

CONNECTORS, ETC.
E. F. Johnson Co.
Waseca, Minnesota

CABLE connectors, pilot and dial light assemblies, tip plugs and tip jacks, formerly Mallory-Yaxley products, have been added to the Johnson line of radio parts

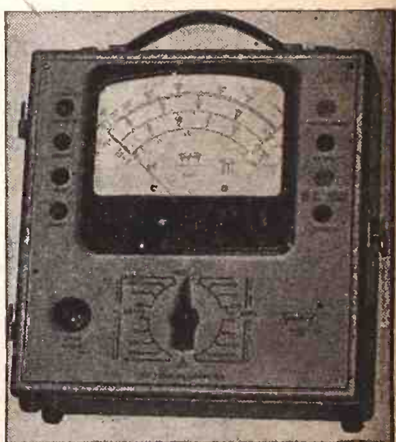


and in the future will be manufactured and sold solely by Johnson. The seven- and 12-wire cable connectors are polarized and contacts are clearly marked for convenience.

Tip plugs are of the solderless type and supplied in a long and short length. Tip jacks are available with either metal or bakelite type heads and both are available with round and hexagon heads. Pilot lights can be supplied with a variety of jewel colors and jewels may be purchased separately for replacement. Dial lights are supplied as shell assemblies and with slip-on brackets to facilitate speed and ease in installation and bulb replacement.—*Radio-Craft*

V-O-MA METER
Triplett Electrical Instrument Co.
Bluffton, Ohio

MODEL 2405 ranges are: DC volts: 0-10-50-250-500-1000, at 25,000 ohms per volt; AC volts: 0-10-50-250-500-1000, at 1000 ohms per volt; DC amperes; 0-10; AC amperes; 0-0.5-1-10; DC mil-



liamperes: 0-1-10-150-250; DC microamperes: 0-50; ohm-megohms; 0-4000-40,000 ohms — 4-40 megohms. Output: Condenser in series with AC volts.

The large 6-inch model 626 Microammeter is adjusted to 40 microamperes. Scale is 5.6 inches long.

"SQUARE LINE" metal case, 10x10x5¾ inches, detachable, hinged cover, compartment for instructions and accessories. Leather strap handle for portable use. Batteries self-contained. Leads furnished. Weight approximately 11 pounds.—*Radio-Craft* the ratio of change is 2 to 1. So, it may be said that the successive *increase* of acoustic power by a *constant ratio* results in increases of loudness by approximately *constant* steps.

From the foregoing it is evident that the word "Ratio" is all-important. It is the business of the decibel to express such ratios in a convenient form which tremendously simplifies calculations and the interpretation of the results.

DECIBELS AND LOGARITHMS

The subject of decibels could easily be handled without once using the word "logarithm." This has been seriously contemplated, since many seem to be afraid of the word. But it is so great a help that it just isn't fair to pass it up. We could walk twenty miles on foot, but we prefer to drive a very complicated automobile. "Logs" have certain complicated aspects (which do not enter into Db work), but we need only to know what logarithms are and how to use them—a very simple matter. Now, if necessary, forget all you know about logs and study the relation between the columns in the following tabulations.

Power Ratio	W_2/W_1	Logarithms	Bels	Decibels
10	$= 10^1$	1	1	10
100	$= 10^2$	2	2	20
1000	$= 10^3$	3	3	30
10000	$= 10^4$	4	4	40

Proceeding downward from 10 we have zero and negative exponents, as may be seen in the next table. Note that a power ratio of 1:1 is expressed by 10^0, a rather strange-looking expression, but one justified by its position in the scale.

DECIBEL PROBLEMS

(Continued from page 320)

Power Ratio	W_2/W_1	Logarithms	Bels	Decibels
10	$= 10^1$	1	1	10
1	$= 10^0$	0	0	0
.1	$= 10^{-1}$	−1	−1	−10
.01	$= 10^{-2}$	−2	−2	−20
.001	$= 10^{-3}$	−3	−3	−30
.0001	$= 10^{-4}$	−4	−4	−40
.00001	$= 10^{-5}$	−5	−5	−50

First the power ratio is re-written as 10 raised to some exponent, the exponent being the number of zeros to the right of the 1 and preceding the decimal point (for numbers *less* than 1 the zeros are to the left, so the exponents are negative). This exponent of 10 is called the *logarithm* of the ratio.

We already have enough to define the common logarithm; the log of a number is the *power* (exponent) to which 10 must be raised to equal the number. In other words, if 10^n equals a certain number, then "n" is the log of the number. *That's all there is to the logarithm.*

Bels are logs provided we start, not with just any number, but with a ratio of two values of power (watts) since Bels, to avoid confusion, apply only to power ratios. Decibels, as the prefix Deci- implies, are 10 x the *number* of Bels or 10 x the log of a power ratio. In other words, Db power change = 10 x the logarithm of the final power divided by the original power. This formula may be stated:

Db power change = 10 log W^2/W^1, or Db = 10 log P^2/P^1.

We have taken easy cases in the above tables—exact powers of 10. Finding the logs of other numbers requires the use of log tables since it is not so easy to find the exponent to which 10 must be raised to produce, say, 5.

LOG AND DECIBEL RULES

(Refer to logarithm tables)

When the ratio is more than 1, the log and Db value will be positive. If less than 1, they are negative. When the ratio is exactly 1 they are zero.

For a ratio between 1 and 10, the log is somewhere between 0 and 1 (a fraction or decimal) and the Db value is between 0 and 10. For a ratio between 10 and 100, the log is between 1 and 2 and the Db value is between 10 and 20, etc.

When ratios are to be *multiplied* together, their logs or Db equivalents must be *added* together. This may be illustrated by the example—100 x 1000 = 100,000. Expressing this in exponential form, $10^2 \times 10^3 = 10^{(2+3)} = 10^5$. The log of 100 is 2, the log of 1000 is 3, and the log of 100,000 is 5, since 2-3 = 5. The preceding operation may be written: log 100 + log 1000 = log 100,000. By decibels, a power ratio of 100 is 20 Db, of 1000 is 30 Db, and of 100,000 is 50 Db. Hence 20 Db + 30 Db = 50 Db is another way of writing 100 x 1000 = 100,000.

A second article on this subject will appear in an early issue. In it, Mr. Ledbetter will discuss voltage and power levels, and describe how decibel tables are made.

TRY THIS ONE!

EMERGENCY IRON

Figure 1

While working on a set that used type 26 tubes, I found a broken wire in the plate circuit. I had no soldering iron immediately available, so I decided to let the set itself do the job. First I removed all the tubes. I turned the switch and fastened one of the transformer filament leads to the socket terminal that had the broken connection. The other side of the filament winding was brought to the broken lead.

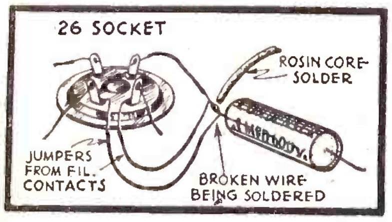


Figure 1

When the broken leads are brought together, this automatically shorts the filament winding, heating up the broken connection. A bit of solder is then applied, and the joint is soldered. The short-circuit of the filament winding should not be maintained too long however, as it might damage the radio's power transformer.

WRAY E. WYCKOFF,
Ingleside, Nebraska

COMMUNICATOR

Figure 2

This little communicator is a good thing to have, particularly if you do a lot of up-and-down-stairing.

It can be built on a 4½ x 9½ x 1½-inch chassis and a neat looking cabinet can be made to fit it. The speaker used was a four-inch PM type, which can do double duty as a speaker and as a microphone. The output transformer should match the tube.

A small A.C.-D.C. filter choke can be used, since this has a D.C. resistance of from 600 to 800 ohms, which would give correct bias for the 43 tube.

All resistors are ½ watt; the condensers across the power supply are rated at 150 volts and all other condensers at 400 volts.

THOMAS I. BRITT,
Raleigh, N. C.

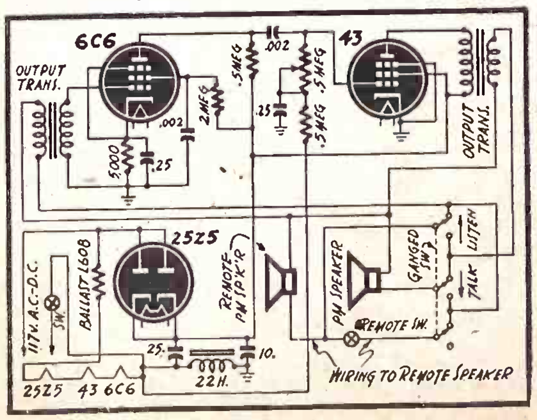


Figure 2

Radio-Craft wants original kinks from its readers, and will award a seven-month subscription for each one published. To be accepted, ideas must be new and useful. Send your pet short-cut or new idea in today!

TEST SPEAKER

Figure 3

This speaker can be used to check any speaker which comes into the shop. Use chart furnished by the manufacturer of the universal output transformer to determine which switches are to be used with the tube or tube combination on each receiver.

To use, connect receiver to proper terminals on test unit. Use terminals "P" and "P" for single-tube output. From the chart, determine which switches are to be used and close one in *each* bank. Be sure all others are open. Connect field terminals to receiver, using the ohmage nearest to that of the set's own speaker, or try the selector switch SS for best results. The field value is not too critical, as will be found by experiment. If the output transformer is on the receiver, merely use taps marked "VC" and keep all switches (except SS) open. This may result in slight mismatch but the unit will usually work well enough for testing purposes.

I suggest that all terminals be binding posts, and that a 5-wire cable terminating in pins for inserting in the speaker socket on the set, be used. Prongs of old radio tubes seem to be best for pins. I also have a couple of adaptors with alligator clips, for sets with no speaker socket.

This universal speaker combination has paid for itself over and over in savings of time that otherwise would have been used carting speakers to the shop with receivers. There is also a saving in actual repair jobs on speaker cones damaged during such transportation, or even in the shop.

GERALD B. CLARKE,
Middletown,
Conn.

COIL WINDER

Figure 4

This winder may be either hand or motor driven and has given very satisfactory results. As sketched, the motor (if used) directly drives section E which may be moved (along its slot) against the driving wheel by pressure on the clutch lever, while the spring tends to cause its return. Hand operation is used where heavy wires are involved, the handle being connected to either the top or middle shaft. Gears A and C are preferably of the same size so that a 1 to 1 ratio is obtained for motor drive. B may be large enough to give a 4 or 5 to 1 ratio.

To mount the coil form, the end bracket is pulled back along its hinge and the squared cone J (see Figure) removed. The form is placed in position and the cone replaced. The latter is then tightened by means of a set screw. The other cone K may be permanently fixed. The shape of cone as illustrated has been found very satisfactory in practice.

To carry the wire spool, two brackets may be mounted away from the winder. Two ordinary cones (not squared) may then be mounted on a ½" shaft, the wire spool being inserted between them. This allows smooth running.

L. W. SMITH,
R.S.G.B. Bulletin.

SHOP KINKS

When replacing nuts or bolts, wrap a piece of adhesive tape around your finger with the gummed side facing outward. Place a nut on the tape and it will stick there until you get the bolt started. Then just pull the tape away.

When tracing wires, use a crochet needle which has a small barb on it. Then you can reach in and pull your wires apart (from each other).

When checking small tubular condensers, number them with a piece of clay chalk. For example, start from input and mark condenser No. 1. Continue to output. This will indicate that the condensers have been checked.

READER

CRYSTAL TUNER

Figure 5

If you have a PA. system or amplifier, this little tuner will come in handy. It can be connected directly to the input circuit of the amplifier and will give better than average reception.

The coil is wound on a form 3 inches in diameter, using 100 turns No. 24 cotton-covered or enameled wire tapped every ten turns.

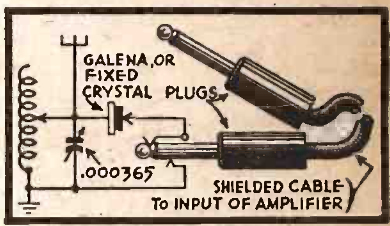


Figure 5

I have received programs from WWVA in Wheeling, West Virginia, along with other powerful stations in the U.S.A. The local Canadian stations come in with excellent volume and quality.

A. LAPOINTE,
Marysville, N. B., Canada

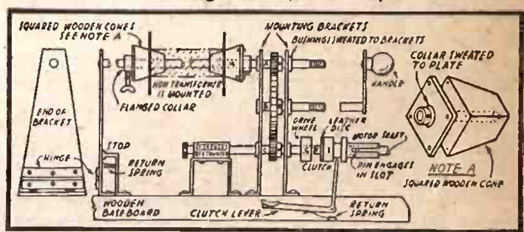
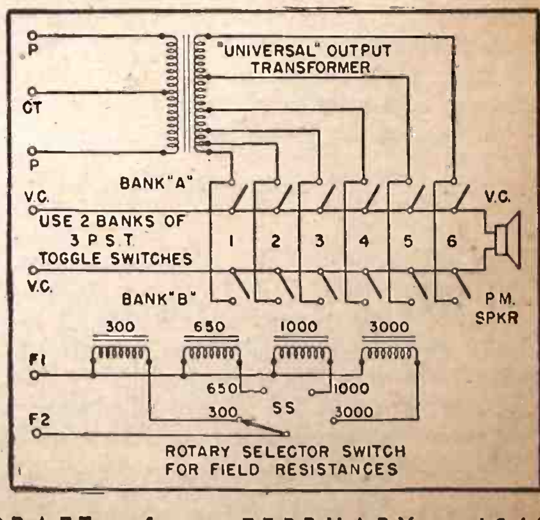


Figure 4 (above) Figure 3 (below)




SILVER
12 A
DC
COM-GND
+V-Ω-MA
R. F. PROBE
MODEL 900
MODEL
900
VOMAX
McMurdo Silver Company
HARTFORD, CONN. MADE IN U.S.A.
FUNCTION
RANGE
30V-120 MA
200K Ω-30 DB
120V-300 MA.
2 M Ω
12V-30 MA
20K Ω
300V-1.2A
20M Ω-50 DB
3V-1.2-MA
2K Ω-10 DB
1200V-12A
2000M Ω
DC -
Ω
AC
MA
AJD. Ω
OFF

300-MC TRANSCEIVER

? *I would like a diagram of a portable one-meter transceiver, using battery tubes. The range should be about three miles. I would like the set to be as small as possible.—J. M., Barnesville, Ohio.*

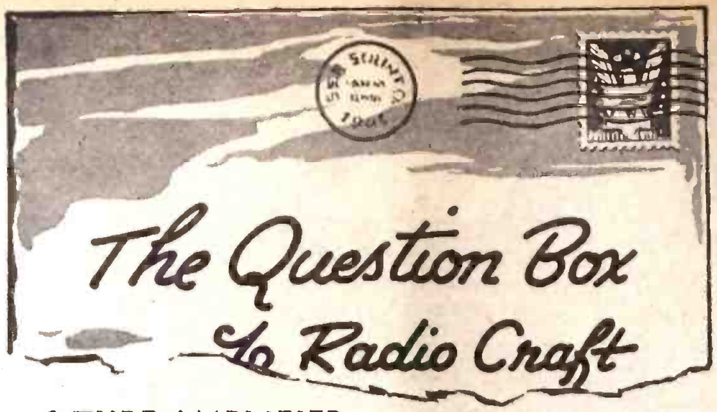
A. Radio transmission is prohibited to the general public without a license. The possession of an amateur radio license permits transmission in certain bands, but 300 mc is not included at the present time. The set shown will operate on 2½ meters. See Fig. 1.

In the diagram the HY114 is used both as super-regenerative receiver and transmitting oscillator. The antenna coil is one turn of No. 14 wire and the secondary has two turns, both with a diameter of ¼". The spacing of the secondary must be determined by experiment, as with Lecher wires, for example.

More than three miles can be covered from a suitably high location with a good antenna. The latter should be about 9 inches long, using the system shown. If a dipole is desired, each half should be 9 inches long and the center goes to a twisted pair or coaxial cable.

A carbon microphone is used, and operated from the "C" battery.

A diagram of a transmitter for working on these short waves appears on page 319. The use of Lecher wires are also explained in the same article.



The Question Box is again undertaking to answer a limited number of questions. Queries will be answered by mail and those of general interest will be printed in the magazine. A fee of 50c will be charged for simple questions requiring no schematics. Write for estimates on such questions as require diagrams or research.

6-TUBE AMPLIFIER

? *I would like to build an amplifier using the following tubes: 56, 53, 2A5's in push-pull, and an 80. The input side of the amplifier should be equipped to handle a phono pickup and a mike.—B.S.N., Stratford, Conn.*

A. The diagram shows an amplifier using the tubes requested. However, there would be insufficient gain for a microphone, so an additional 57 high-gain stage has been added. With reasonable care, there should be no difficulty in construction and operation. The usual problems in shielding can be solved in the ordinary manner. Leads should be kept close to the chassis and as short as possible. (See Fig. 2.)

A.C. AMPLIFIER

? *Please print a diagram of a small A.C.-operated amplifier that uses as few parts as possible yet will give adequate power for a portable phono. W.F., Blairstown, N. J.*

A. The amplifier shown is designed to give you the most power with a minimum of parts and reasonably high fidelity. The values of all parts are given on the diagram. (Fig. 3.) Choke should be one of about 200-ohms resistance. A phono pickup with an output of about one volt should drive the amplifier to full power output. Very little shielding should be necessary if the input leads and the 6J5 are kept away from the power and output transformers.

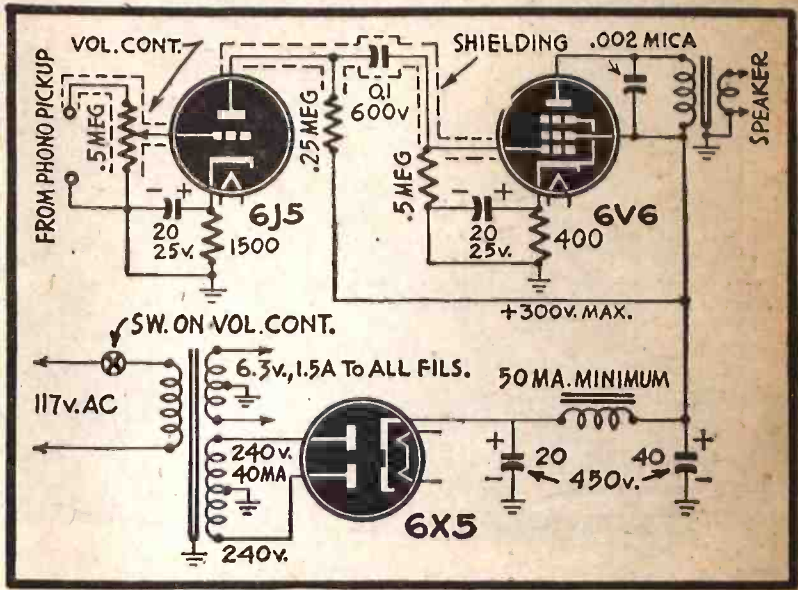
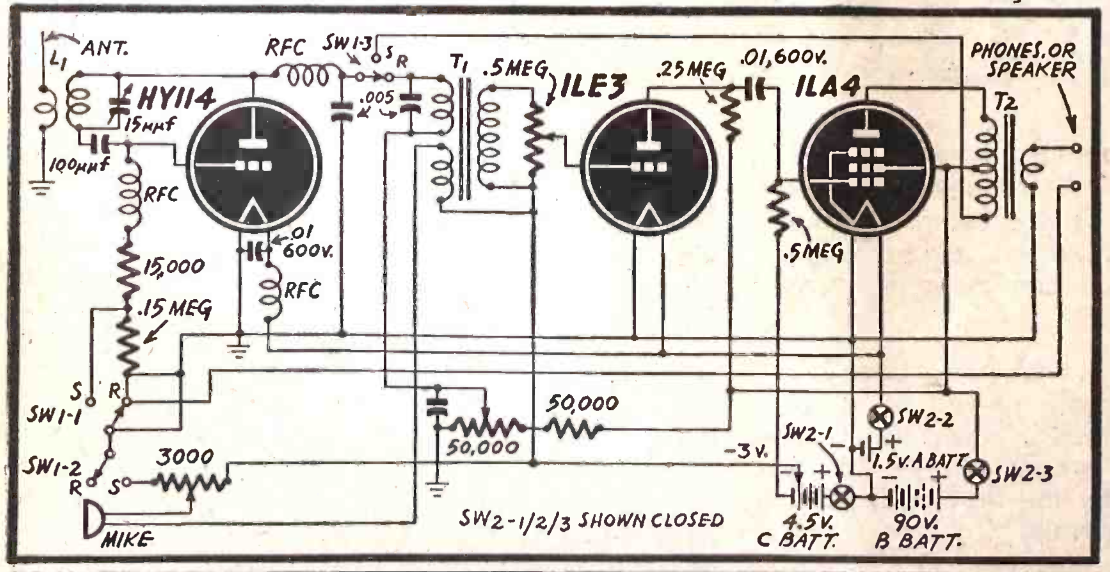


Fig. 3—A two-tube amplifier for A.C. use.



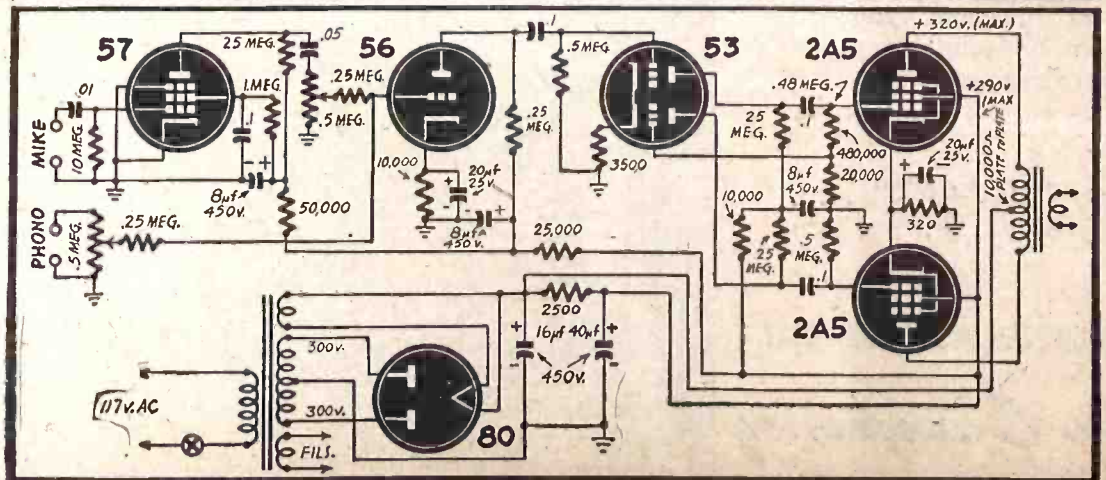


Fig. 1, above—Transceiver for 2 meters. Fig. 2, below—Amplifier for 2½-volt tubes.

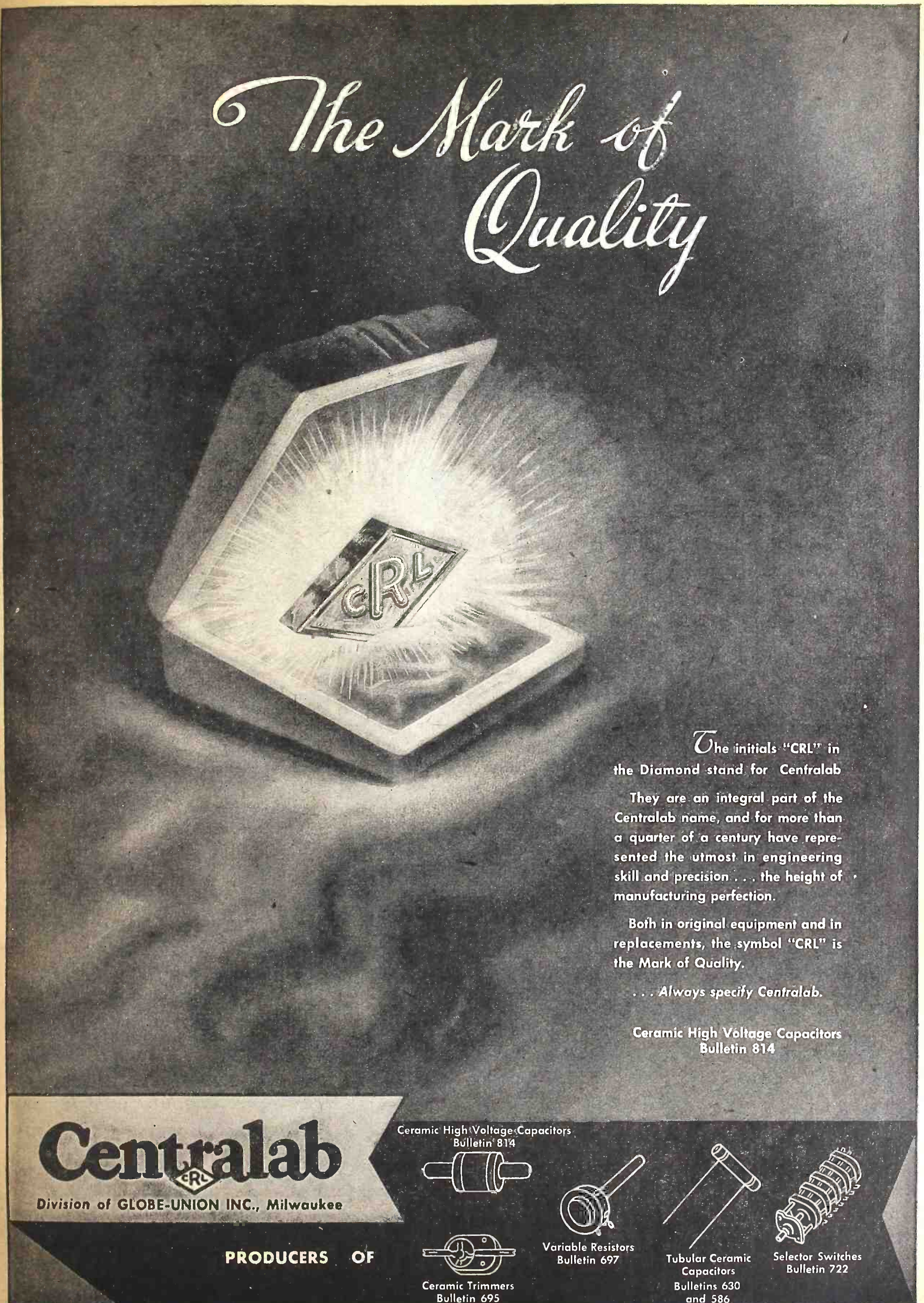
ALIGNMENT TROUBLES

? *I have built the two-tube radio shown in the Radio-Electronic Circuits last September. This set is very weak at one end of the dial only. Can this be remedied?—S. F. L., Indianapolis, Ind.*

A. This, or any other TRF set using a two-gang condenser, may be aligned easily. You need a dial calibrated in kilocycles and an extra variable condenser of about the same capacity as one section of your gang.

Disconnect one of the gang sections from its coil, tuning the coil with the temporary variable. Tune in several stations, using both condensers. Check their positions on the dial, and add or remove turns from the coil still connected to the gang section till they come in at the correct points. This will align one coil, which is then connected to the temporary condenser, while the other coil is attached to its gang section and similarly aligned.

In other words, you simply adjust each circuit with the help of the calibrated dial, using the temporary condenser to tune the other circuit while doing so.


The Mark of Quality
The initials "CRL" in the Diamond stand for Centralab
They are an integral part of the Centralab name, and for more than a quarter of a century have represented the utmost in engineering skill and precision . . . the height of manufacturing perfection.
Both in original equipment and in replacements, the symbol "CRL" is the Mark of Quality.
. . . Always specify Centralab.
Ceramic High Voltage Capacitors
Bulletin 814
Centralab
Division of GLOBE-UNION INC., Milwaukee
PRODUCERS OF
Ceramic High Voltage Capacitors
Bulletin 814
Ceramic Trimmers
Bulletin 695
Variable Resistors
Bulletin 697
Tubular Ceramic Capacitors
Bulletins 630 and 586
Selector Switches
Bulletin 722

WORLD-WIDE STATION LIST

(Continued from page 326)

UNITED STATES

Boston, Mass.	WRUW	6.040	Central American beam, 8:30 pm to 1 am
Boston, Mass.	WRUA	9.570	European beam, 4:30 to 6 pm
Boston, Mass.	WRUS	9.700	Central American beam, 6:30 pm to 1 am
Boston, Mass.	WBOS	9.897	European beam, midnight to 3:15 am; 1 to 5:45 pm
Boston, Mass.	WRUL	11.730	North African beam, 6 to 8:45 am; Mexican beam, 6:30 pm to 1 am
Boston, Mass.	WRUW	11.730	European beam, 1 to 5 pm; Caribbean beam, 5:15 to 5:45 pm
Boston, Mass.	WRUS	11.790	European beam, 6 am to 4:15 pm; 4:30 to 6 pm
Boston, Mass.	WRUW	15.130	European beam, 6 to 8:45 am
Boston, Mass.	WBOS	15.210	European beam, 6 am to 12:45 pm
Boston, Mass.	WRUL	15.290	North African beam, 9 am to 5 pm; Caribbean beam, 5:15 to 5:45 pm
Boston, Mass.	WRUA	15.350	European beam, 6 am to 4:15 pm
Boston, Mass.	WRUW	17.750	Central American beam, 6:30 to 8:15 pm; European beam, 9 am to 12:45 pm
Cincinnati Ohio	WLWK	6.080	South American beam, 7:30 pm to 12.15 am
Cincinnati Ohio	WLWO	9.590	European beam, 3 to 4:45 pm; South American beam, 6 pm to 12:15 am
Cincinnati Ohio	WLWRI	9.750	North African beam, 3:15 to 6 pm
Cincinnati Ohio	WLWK	11.710	European beam, 7:30 am to 4:30 pm
Cincinnati Ohio	WLWS2	11.710	South American beam, 5 to 7:15 pm; 7:30 to 9:30 pm
Cincinnati Ohio	WLWLI	11.810	European beam, 6 to 7:45 am; 1 to 5:45 pm
Cincinnati Ohio	WLWSI	15.200	South American beam, 5 to 7:15 pm
Cincinnati Ohio	WLWL2	15.230	North African beam, 6 to 7:45 am; 8 am to 12:45 pm; 1 to 5:45 pm
Cincinnati Ohio	WLWK	15.250	South American beam, 5 to 7:15 pm
Cincinnati Ohio	WLWRI	15.250	North African beam, 7:30 am to 3 pm
Cincinnati Ohio	WLWO	17.800	South American beam, 5 to 5:45 pm; European beam, 7:30 am to 2:30 pm
Cincinnati Ohio	WLWLI	17.955	European beam, 8 am to 12:45 pm
Los Angeles Calif.	KCBR	9.700	Oriental beam, 2 to 4:45 am; 5 to 11 am
Los Angeles Calif.	KCBF	9.750	South American beam, 11 pm to 1 am; East Indies beam, 4 to 9:45 am
Los Angeles Calif.	KCBR	15.270	Oriental beam, 4 to 10 pm; 10:15 pm to 1 am
Los Angeles Calif.	KCBF	17.850	South American beam, 5 to 10:45 pm
New York City	WCBN	6.060	Mexican beam, 6:30 pm to 1 am
N. Y. City	WOOW	6.120	European beam, midnight to 3:15 am
New York City	WNRE	7.565	European beam, midnight to 3:15 am; 4:30 to 6 pm
New York City	WOOC	7.805	European beam, midnight to 3:15 am; 3:30 to 5:45 pm
New York City	WCBX	9.490	Brazilian beam, 4 to 10:30 pm
New York City	WRCA	9.670	Brazilian beam, 7 to 10:30 pm
New York City	WNRA	9.750	European beam, 1:45 to 6 pm
New York City	WCBN	11.145	European beam, 1 to 5:45 pm
New York City	WCRC	11.826	European beam, 6 to 10:30 am
New York City	WCRC	11.830	European beam, 10:45 am to 4:30 pm; South American beam, 5 to 11 pm
New York City	WNBI	11.870	South American beam, 6:30 to 11 pm
New York C.	WOOW	11.870	European beam, 6 am to 5:45 pm
New York City	WNBI	11.893	European beam, 1:15 to 4:45 pm
New York City	WNRI	13.050	European beam, 6 am to 6 pm
New York City	WNRX	14.560	European beam, 6 am to 3:45 pm
New York City	WRCA	15.150	European beam, 7:30 am to 3:30 pm; Brazilian beam, 4 to 6:45 pm
New York City	WOOC	15.200	European beam, 6 am to 3:15 pm
New York City	WCBX	15.270	European beam, 6 am to 3:45 pm
New York City	WNRE	15.280	European beam, 7:30 am to 4:15 pm
New York City	WNBI	17.780	South American beam, 5 to 6:15 pm; European beam, 7:30 am to 1 pm
New York City	WCBN	17.830	European beam, 6 am to 12:45 pm
New York City	WNRA	18.160	European beam, 6 am to 1:30 pm
San Francisco Calif.	KWID	7.230	Oriental beam, 6:45 to 11 am
San Francisco Calif.	KGEX	7.250	Philippine beam, 5 am to noon
San Francisco Calif.	KNBA	7.565	Oriental beam, 4 to 9:45 am
San Francisco Calif.	KCBA	7.575	East Indies beam, 4 to 9:45 am

(Continued on page 365)

REVAMPED TESTER

(Continued from page 322)

is possible because of the full-wave rectification of the meter.

If polarity indications are necessary, connections can be made to terminals Nos. 1 and 5 on the meter, in series with a suitable resistor, for any range needed, using 1000 ohms per volt.

The master switch offers the following ranges:

Pos.

1—0-2½ miliampere, D.C. and A.C.
2—0-25 " " " "
3—0-250 " " " "
4—0-2½ volts " " "
5—0-25 " " " "
6—0-100 " " " "
7—0-250 " " " "
8—0-1000 " " " "
9—0-500,000 ohms
10—0-5,000 ohms.
11—Low ohms.

The parts used are:

M—350 microampere meter.
R—Built-in rectifier
B—Self-contained battery.
Y—3150 ohm resistor, for compensating of the A.C. readings.
X—2000 ohm resistor, in series with meter.
VR1—10,000 ohm resistor, across the meter used for zero set.
SW1, 2, 3, 4—Gang switch, with eleven positions.
SW5—S.P.S.T. switch, to compensate for the A.C. readings.
Resistors—2K, 1K, 200, 100, 20, 13½ ohms, form the tapped shunt.
Resistors—500, 7,500, 15,000, 75,000, 150,000, 750,000 ohms, are the series resistors for the voltage readings.
Resistors—10,000, 96 ohms are the series resistors used for the resistance measurements.
Resistor—3.75 ohms is the shunt to increase meter current for low-ohm scale.

BINAURAL HEARING AID

A new British hearing aid employs two microphones and two earpieces to give the stereophonic effect of normal hearing. The average person's ability to distinguish direction from which a sound comes is upset by an ordinary hearing aid.

For frequencies below about 1,000 cycles per second, this directional effect is attributed to the time interval between "reception" of the sound in the ear nearer the source and in the one farther away, while for higher frequencies it is considered to be due to a difference in intensity because of the acoustic shadow cast by the head. The "cross-over" frequency at which the effects merge varies with different individuals, but both demand that each ear be used at approximately the same sensitivity.

The stereophonic hearing aid has two separate amplifying channels, each with its own tone and volume controls. In addition, there is an overall volume control. The individual controls are pre-set by an expert for the individual user, who then adjusts volume with the master control.

For best binaural results the microphones should be placed on the sides of the body, in a position corresponding to that of the ears.

LAWS OF THE ATOMS

Compiled by HELEN M. DAVIS*

1. A single ATOM is the tiniest particle of any chemical element that can exist by itself and retain the qualities that mark it as that element.

2. All material things in the universe known to our senses are composed of one or more CHEMICAL ELEMENTS.

3. Substances composed of more than one element are known as COMPOUNDS. Atoms of elements are held together in compounds by electrical forces in the outer parts of their structure.

4. The smallest unit of a compound, usually composed of two or more atoms, is known as a MOLECULE.

5. There used to be 92 chemical elements, from hydrogen ($_1H^1$) the lightest, to uranium ($_{92}U^{238}$), the heaviest. There are now two new elements, NEPTUNIUM ($_{93}Np^{239}$) and PLUTONIUM ($_{94}Pu^{239}$).

6. When elements are represented, as above, by their chemical SYMBOLS, the subscript number is the atomic number. This is different for each element. The superscript number represents the atomic weight.

7. One of the qualities characteristic of matter is weight or mass. ATOMIC WEIGHT is expressed on a relative scale, as compared with the weight of hydrogen which is taken as one.

8. ATOMIC NUMBER is the measure of the electric charge on the nucleus of the atom. Atomic weight is the measure of the atom's mass.

9. Different samples of the same element, when tested by chemists, are sometimes found to have different atomic weights. Lead which occurs with radium, for example, has a different atomic weight from ordinary lead.

10. In all other ways the two kinds of lead are chemical twins, exactly alike except for weight. Elements which differ in weight only are called ISOTOPES.

11. Uranium has several isotopes. The usual kind, whose atomic weight is 238, was used to produce the two new elements. U-235 was used to make the ATOMIC BOMB.

12. Each of the new elements, neptunium and plutonium, has two isotopes whose atomic weights are 238 and 239.

13. Different elements, quite distinct in chemical behavior, may have the same atomic weight. We have $_{92}$U-238, $_{93}$Np-238 and $_{94}$Pu-238, all with different properties. Such elements are now called ISOBARS.

14. All atoms are composed of standard interchangeable parts. These are PROTONS, NEUTRONS and ELECTRONS.

15. Protons and neutrons make up the NUCLEUS of the atom. The structure of the atom is much like that of the solar system. The nucleus corresponds to the sun at the center. The planets are electrons revolving in their orbits.

16. The proton and the neutron each have a mass about equal to that of a hydrogen atom, which is 1 on the chemist's scale. Each is about 1800 times heavier than the electron.

17. The ELECTRONS, light in weight and some distance away from the heart or nucleus of the atom, revolve around the nucleus much as planets revolve around the sun. They are held in their courses by electric attraction.

18. The proton has a POSITIVE charge of electricity, the electron has a NEGATIVE charge equal and opposite to the positive charge of the proton. The neutron has no charge at all.

19. The difference in chemical properties of the elements is caused by difference in the number of protons in the nucleus. This is the ATOMIC NUMBER.

20. Atomic weight is the SUM of the weights of the protons and neutrons in the nucleus.

21. It is the NEUTRON which figures in the transmutations which give atomic power. Neptunium and plutonium were formed by bombarding uranium 238 with neutrons.

22. Neutrons can PENETRATE to the nucleus of heavy atoms when charged particles would be repelled by charges in the atom.

23. The HYDROGEN atom is believed to have just one proton as its nucleus, with one electron circling around it. Hydrogen's atomic weight and atomic number are each one.

24. Hydrogen has one isotope which is just like ordinary hydrogen except that it is twice as heavy. It is known as "heavy hydrogen" and sometimes as DEUTERIUM. Its compound with oxygen is called "heavy water."

25. The nucleus of HEAVY HYDROGEN contains one proton and one neutron. The atomic number of heavy hydrogen is one, corresponding to one proton. The atomic weight is two, corresponding to the two heavy particles, proton and neutron.

26. HELIUM has two protons and two neutrons in its nucleus. The two protons correspond to helium's atomic number two. The combined weights of protons and neutrons in the nucleus give helium its atomic weight 4. Two electrons, held in their orbits by the two protons, revolve around the nucleus.

27. The VOLUME of an atom is determined by the orbits of its outermost revolving electrons. Only a small fraction of the size of an atom is actually occupied by the protons, neutrons and electrons, just as the space occupied by the sun, the earth and other planets is only a small part of our solar system.

28. In spite of all the unoccupied SPACE, an atom is quite IMPENETRABLE to other atoms and to larger bodies. The electrons revolve millions of times a second, and keep everything out of the space within quite as effectively as though they were everywhere at once.

29. The only things that can get inside an atom are smaller things, FRAGMENTS of other atoms, protons, neutrons or electrons. They must be shot with just the right speed. These fragments of atoms are observed as radiations given off by radio-active elements which are breaking up spontaneously.

30. RADIATION is wave motion, known to us as the electro-magnetic waves used for radio transmission, heat, light, X-rays and cosmic rays. Large numbers of extremely tiny particles in motion together act like waves.

31. Three types of radiation are given off by radio-active substances. ALPHA particles are high-speed nuclei of helium atoms. BETA particles are high-speed electrons. GAMMA rays are electro-magnetic radiations similar to X-rays and light.

32. Of these, only the gamma rays are properly called radiations, and even these act very much like particles because of their short wave-length. Such a "particle" or quantum of gamma radiation is called a PHOTON.

33. In general, the gamma rays are very penetrating, the alpha and beta rays less so. Even though the alpha and beta rays are not very penetrating, they have enormous SPEED.

34. The speed with which atom particles travel is the source of atomic energy. ENERGY is capacity to do work. It is work stored up for future use.

35. If you raise a weight to a height above the ground and suspend it there by some device, the WORK you put into raising it can be stored there indefinitely as POTENTIAL ENERGY. It will be there, ready, whenever you decide to release it.

36. The energy which a moving body has because it is in motion is called KINETIC ENERGY. The kinetic energy of any particle depends upon its mass and the square of its velocity. Energy is conserved by the moving

*SCIENCE NEWS, Washington.

particle until it strikes an object, then work is done.

37. All ENERGY is either potential or kinetic. Either one can be converted into the other. These two conversions are continually occurring.

38. Particles of atomic size have kinetic energy arising from several different kinds of MOTION. All atoms are constantly in motion.

39. If the atoms are so dispersed that the material constituting them is a GAS, that gas will exert pressure on all sides of the container that holds it. If the container is a balloon bag, the imprisoned gas can do work by lifting heavy weights into the air, as in the case of a dirigible.

40. Atoms which compose an element that will combine readily with another element, as hydrogen or carbon will combine with oxygen, have unsymmetrical arrangements of the outer electrons in their systems. These unsymmetrical arrangements tend to set up a sort of strain, which causes CHEMICAL COMBINATION to take place when elements with suitable combining powers are brought together.

41. These unsymmetrical arrangements give rise to FORCES which result in kinetic energy. This energy appears, for example, when carbon and oxygen burn to carbon dioxide, giving off heat, or hydrogen and oxygen explode to form water, again giving off heat.

42. Chemicals combining to form stable compounds give off energy in the process. These are known as EXOTHERMIC REACTIONS. Combinations which absorb energy, forming unstable compounds, are known as ENDOTHERMIC REACTIONS. Explosives, for example, which are highly unstable, are formed by endothermic reactions.

43. Chemical forces, electricity and heat are all forms of energy. Potential and kinetic energy may be distinguished in each case.

44. These energies all arise from motion of the atom as a whole, or motion resulting from attractions and repulsions between the outer PLANETARY ELECTRONS of the atoms' structure.

45. Energy resulting from motion of particles deep within the structure of the atom was unknown until the discovery of RADIOACTIVITY.

46. Radioactive elements undergo SPONTANEOUS breaking up of their atoms, giving off alpha and beta particles and gamma rays. Loss of these particles causes the radio-active elements to change into other elements.

47. The energies shown in these TRANSFORMATIONS are thousands of times greater than the kinetic energies which the molecules of a gas have by reason of their motion when heated. They are thousands of times greater than the energy changes per atom in chemical reactions.

48. The property of matter that connects it with motion is INERTIA. Inertia is opposition to change of motion.

49. One conclusion that appeared early in the development of the theory of RELATIVITY was that the mass due to inertia of a moving body increases as its speed is increased.

50. This increase implied an equivalence between an increase in energy of motion of a body (kinetic energy) and an increase in its MASS.

51. It was for this reason that Einstein suggested that studies of radioactivity might show the EQUIVALENCE of mass and energy.

52. Einstein's statement is that the amount of energy, E, equivalent to a mass, m, is given by the equation $E = mc^2$ where c is the VELOCITY OF LIGHT.

53. From this equation, one kilogram (2.2 pounds) of matter, if converted ENTIRELY into energy, would give 25 billion kilowatt hours of energy. This is equal to the energy that would be generated by the total electric power industry in the United States (as of 1939) running for approximately two months.

54. Compare this fantastic figure with the 8.5 kilowatt hours of heat energy which may be produced by BURNING an equal amount of coal.

55. Until the atomic power research program, no instance was known of matter being converted into energy without more energy being used to produce the transformation than was released by it.

56. Two axioms of physics stated: (1) MATTER can be neither created nor destroyed; (2) ENERGY can be neither created nor destroyed. For all practical purposes they were true and separate principles until about 1940.

57. It is now known that they are, in fact, two phases of a single principle, for we have discovered that energy may sometimes be CONVERTED into matter and matter into energy.

58. Such conversion is observed in the phenomenon of nuclear FISSION of uranium, a process in which atomic nuclei split into fragments with the release of an enormous amount of energy.

59. The extreme size of the CONVERSION FACTOR explains why the equivalence of mass and energy is never observed in ordinary chemical combustion.

60. We now believe that the heat given off in such COMBUSTION has mass associated with it, but this mass is so small that it cannot be detected by the most sensitive balances available.

61. Transformation of matter into energy is an entirely different sort of phenomenon than the usual chemical transformations, where the matter is changed into a different form but its MASS persists.

62. From the standpoint of the Laws of the Conservation of Matter and of Energy alone, transformation of matter into energy results in the DESTRUCTION of matter and CREATION of energy.

63. The OPPOSITE transformation, which astronomers believe may be going on in some of the stars, amounts to the destruction of energy and the simultaneous creation of matter.

64. It is difficult for us to imagine the reconciliation of two such different concepts as matter, with its characteristic mass or weight, and energy, which does not have this quality. We shall, perhaps, be forced to think of the stuff of the universe as some such combination of matter and energy as would be symbolized by the coined word "MATTERGY."

PPM—NEW TECHNIQUE

(Continued from page 315)

R284 depends on the amount of current flowing through the voice amplifier tube. If a positive signal is applied to the grid of that tube, current increases and so does voltage drop across R278, reducing the voltage available for application to the multivibrator grid. Hence the multivibrator's snap back to normal will be delayed. If a negative signal is being applied to the voice amplifier grid when the multivibrator is excited, plate current is reduced, voltage is higher and the snap-back and consequent pulse formation takes place at an earlier point than would otherwise be the case.

Variable resistor P8 sets conditions in the multivibrator so that with no modulation the pulse occurs exactly in the middle of its proper channel.

Thus simply is the apparently difficult feat of pulse position modulation performed. Between the pulse generator and the velocity-modulated oscillator which launches it on the ether, the pulse passes (with pulses 2, 4 and 6) through a clipper and a stage of video amplification. The odd pulses are similarly generated and pass through a similar clipper-amplifier. Then the common two-stage video amplifier further builds them up and passes them on to the transmitter unit up on the antenna mast, directly behind one of the parabolic reflectors.

Undergoing two more stages of amplification (through a 6AK5 and a 6V6-GT/G) the signals are applied to the grids of the modulator tube, a 3E29. This is a double beam-tube with both sections connected in parallel, which operates at a plate voltage of 1500. The plates of this tube are connected to the cathode of the U.H.F. velocity-modulated oscillator, driving it into oscillation during the period of each pulse. The U.H.F. signals (at frequencies between 4300 and 4800 megacycles) travel through a hollow waveguide to a plain reflector at the focal point of the transmitting parabolic reflector, from which they are reflected back against the face of the parabola and sent out in parallel rays to the receiving station, which may be from 30 to 50 miles away, depending on the terrain between the two towers.

PULSE RECEIVING SYSTEM

Arriving at the receiving parabola, the pulses are converged by it on the reflecting plate at the end of the receiving waveguide and sent down the guide. A frequency 60 Mc. lower than the transmission frequency is mixed with the incoming waves in a crystal detector, producing a modulated 60-Mc. beat-frequency signal, which is further amplified in a multi-stage I.F. amplifier, and detected. From here there is a video signal similar to that in the video stages of the transmitter. This signal is amplified and clipped to eliminate amplitude variations, again passing through a number of stages, and applied to a *marker selector.*

THE MARKER PULSE

The function of the selector stage is to select the marker pulse from the rest of the incoming signals and use it to operate a series of square-wave generators which supply "gate" pulses in the proper sequence to each of the *pulse converter* circuits, which convert the position-modulated pulses back to voice frequency.

The method of selecting the marker pulse is simple. The pulses, which at this point have an amplitude of about 10 volts (negative) are applied to the grid of the marker selector tube, V17A in Fig. 4. Its grid, normally held positive by the 3.3-megohm resistor R10 connecting it to the 300-volt line, is brought below cut-off potential and plate current stops flowing. Plate voltage starts to rise, charging C7 through the 270,000-ohm plate resistor, R15. Since the combination's charging time is relatively long, voltage rise is proportional to the length of the pulses, those of one microsecond producing a rise of about ten volts, while the four-microsecond marker pulse causes a rise of about 40 volts in the plate circuit.

These output pulses are applied to the grid of the *marker amplifier* tube, which is biased to a point 20 volts below cut-off. Because of this bias, the 10-volt signals from the one-microsecond channel pulses have no effect, while the 40-volt impact of the marker pulse is sufficient to cause plate current to flow and to send amplified pulses on to the *square-wave generator.* This is a 12L8-GT hooked up as a freely-oscillat-

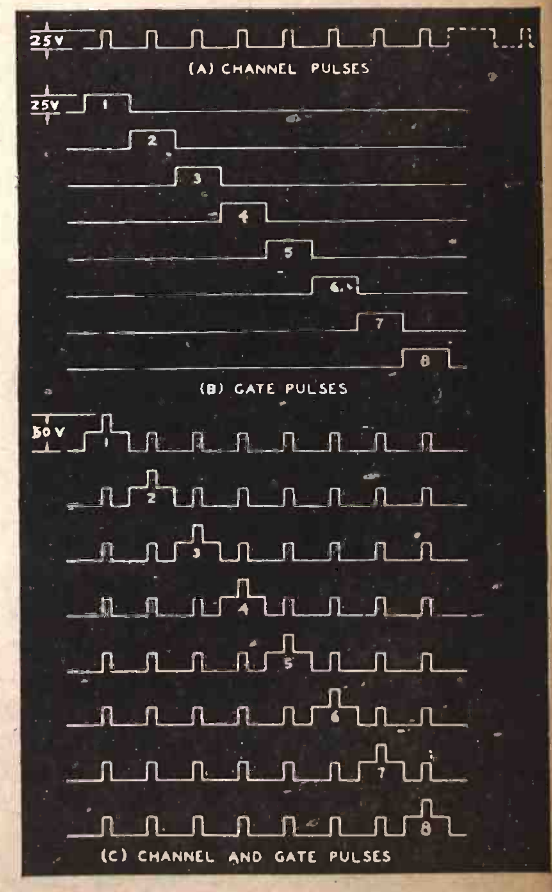


Fig. 5—Channel plus gate pulse waveforms.

ing multivibrator. The amplified marker pulses lock the multivibrator in precise synchronism. Its two plate circuits are connected directly—in the case of two of the eight channels—or through delaying circuits, to the eight *gate generators*. These produce pulses (called *gate* pulses) of about 25 volts, 13 microseconds long, so spaced that each one occupies the space alloted to a channel. (See Fig. 5).

THE PULSE CONVERTER

The gate pulses are applied to the eight *pulse converters* in the order shown in the figure. At the same time, all the channel pulses are applied to all the pulse converters in parallel. The pulse converters are multivibrators, hooked up somewhat like the pulse position modulators, whose work they are to reverse. The grid of the first tube V13A (Fig. 6), is connected directly to the plate of its gate generator, as well as to the output of the final pulse amplifier. Its cathode resistor is common to the second section of the tube, whose plate is connected to 300 volts through a 56,000-ohm resistor. The grid of this second section is also brought to the 300-volt positive lead through a 3.3-megohm resistor. The second section therefore conducts heavily, biasing the first section well below cut-off. Channel pulses from the final pulse amplifier are insufficient to overcome this bias. When the gate pulse is applied, the channel pulse added to it is sufficient to drive the first section's grid far enough positive to make the section conduct. Once the first section starts conducting, it continues to do so till the end of the gate pulse.

Thus the output of the pulse converter is a series of pulses of varying length, the rear edge of each pulse occurring at a fixed period, but the leading edge varying at the voice frequency. Thus we have a length-modulated pulse.

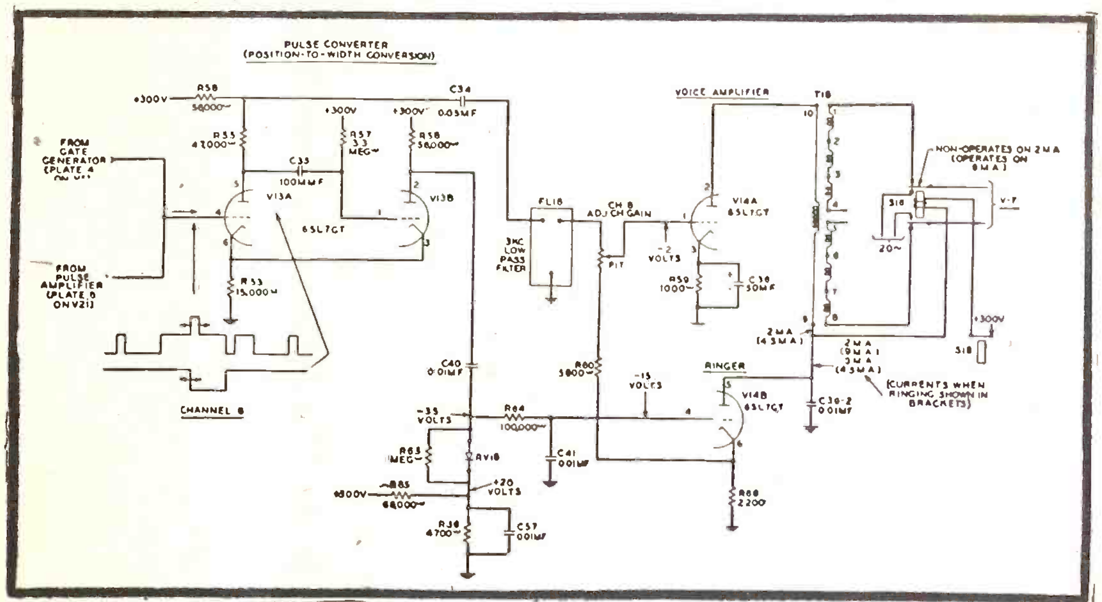


Fig. 6—Simplified schematic diagram of the pulse converter and voice frequency amplifier.

Since the voltage drop through the 56,000-ohm resistor, R56, and consequently the charge on C34, the output condenser, is dependent on the length of the pulses, it is easy to see that the voltage across C34 varies with the voice signals, rising above and falling below what it would be in the case of an unmodulated signal, as the pulses begin before or after the channel's mid-point.

The output of the pulse converter contains, besides the voice-frequency signal, a strong 8,000-cycle component and its harmonics, together with voice-frequency sidebands of the 8,000-cycle component and its harmonics. It is therefore passed through a low-pass filter, which removes frequencies above roughly 3,500 cycles, with its attenuation peak at the recurrence frequency of 8,000 cycles. The voice frequencies are then applied to the voice or audio amplifier, from which they go to the

(*Continued on page* 359)

ELECTRONIC TRANSIENTS

(Continued from page 310)

to consist of an infinite number of odd harmonics.

Omitting certain odd harmonics in the series and changing the amplitudes of others, results in a variant of the square wave—the *rectangular wave.*

Countless other periodic wave shapes are encountered in electronics. But their shape always depends on the harmonics that are present, their relative amplitudes, and their relative phase relations with each other. The steeper the sides of the final wave shape, the more harmonics it contains.

All of the wave shapes shown in Figure 2 have equal alternations. That is, the positive portion of each wave has mirror symmetry with the negative portion. Sometimes waves are encountered that do not have equal alternations but which are periodic. Again, these waves are the result of combining a fundamental and certain harmonics of given amplitude.

Thus, any shape of recurrent wave may be produced by the careful selection and combination of a fundamental and harmonics of the basic frequency. And, in like manner, any existing wave may be broken down into a fundamental and certain harmonics.

DISTORTION

This represents distortion of the original, fundamental wave. But it is desirable distortion. The large number of harmonics present in the wave generally is necessary to obtain specifically shaped waves, without which certain types of electronic circuits—such as timing relays, delay and control devices, or others—could not function.

Steep-front waves are widely used in practically all phases of radar, television, and electronics. As such, they represent a highly distorted wave consisting of a great number of harmonics.

For this reason it is impossible to pass such a wave through an ordinary audio or radio circuit. To do so would introduce *unwanted* distortion and loss of shape.

When amplification of such a complex wave is required, the fundamental and *all* harmonics must be amplified equally. In radar and television this led to the development of wide-band or *video* amplifiers, capable of equal amplification of all frequencies from a few cycles to several megacycles. Most coupling stages, also, are required to pass complex waves without discrimination as to frequency, phase, or amplitude of the component harmonics.

In some electronic applications, however, just the opposite is true. Circuits are designed to introduce the intentional distortion. Particularly in radar, this *controlled* distortion is necessary for shaping control waves prior to their application to the final stage of some other component. A typical example of this is the very steep-front, narrow, rectangular pulse required to modulate a radar transmitter during each "pulsing period" of the set's operation.

The behavior of these distortion circuits can best be understood as transient phenomena—or "transients." A measure of the introduced distortion is sometimes known as the *time constant.*

TIME CONSTANT

Ohm's law states that the voltage across a resistance is equal to the current through it times the value of the resistance. In other words, a voltage is developed across a resistor only when current flows through it. By controlling this flow of current the shape of the voltage wave (across the resistor) can be controlled.

Simplest method of current control is to utilize the charging and discharging properties of a condenser. In a simple

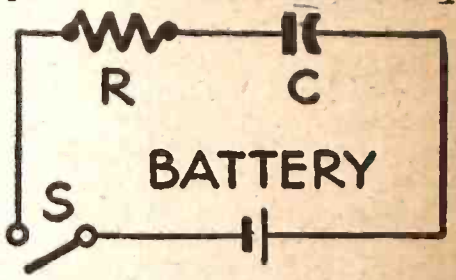


Fig. 3—The simplest wave-forming circuit.

R-C circuit [Figure 3], when the switch S is closed the rate of the condenser charge is limited by the amount of resistance R in the circuit. The charging of the condenser is not instantaneous, but of an exponential nature. It takes place within a measurable time, determined by the amount of resistance R and capacitance C.

The product of R and C is a measure of the time (in seconds) required for the condenser charge to reach 63 percent of its final or fully charged value. This product (RC) is known as the *time constant* where R is in ohms and C is in farads.

When the condenser [Figure 3] is discharged through the same resistance R, the discharge current will be limited by the resistance. The current decrease will again be exponential, the slope at any time depending upon the values of R and C. The time constant is again a measure of the time required to discharge the condenser.

When the time constant for a given

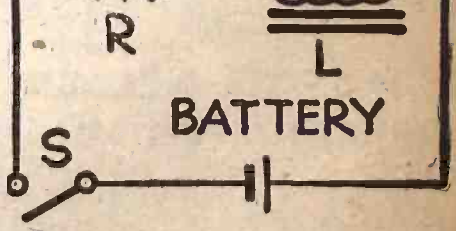


Fig. 4—An inductor changes the wave shape.

circuit equals 1 (or RC seconds), the charge on the condenser is considered to have reached 63 percent of its final value. When the time constant equals 5 (or 5RC seconds), the condenser is considered, for all practical purposes, to be fully charged.

Conversely, in discharging, when the time constant equals 1 (RC seconds), the amount of charge on the condenser is considered to be 37 percent of its final voltage. And when the time constant equals 5 (or 5RC seconds), the condenser is considered to be fully discharged.

Current flow through a resistance can also be controlled by means of inductance-retarding effects. In a simple R-L circuit [Figure 4], when the switch S is closed the battery forces a current through the inductance L. The reactance of the coil retards any change in the flow of current, and the current increases exponentially—the rate depending upon the values of R and L.

The quotient L/R is a measure of the time required for the current to rise to 63 percent of its full value. And this quotient is known as the time constant (in seconds), where R is in ohms and L is in henrys. There is a similar exponential fall of current when the circuit [Figure 4] is discharged through the resistance R, the time constant again being a measure of the time required for current decay.

By utilizing transient current effects of either R-C or R-L circuits, it is possible to influence the distortion and formation of voltage waves—to any desired shape. For instance, the common saw-tooth wave used for the time base of most types of cathode ray tubes is but the charge-discharge wave taken from across a condenser.

Resistance-inductance circuits are occasionally used in electronic delay, timing and counting circuits. But the resistance-capacitance or R-C circuit has wider general use in radar, television, and electronics.

TRANSIENT EFFECTS

In a given R-C circuit [such as Fig. 3], if the value of either resistance or capacitance is increased, or if both are increased, the circuit will have a longer time constant because the condenser will take longer to charge.

Thus, the value of either R or C, or both, can be varied to obtain any desired value of charging time.

The terms *long* time constant and *short* time constant are purely relative evaluations.

A *long* time constant means that the time (expressed in RC seconds) is long compared with the time necessary for the impressed or signal voltage to complete half a cycle. If the product of R and C is large enough there will be little or no introduced distortion.

A *short* time constant means that the time (expressed in RC seconds) is short in comparison with the frequency of the impressed or signal voltage. A circuit possessing a short time constant introduces a particularly desirable form of distortion known as *peaking*.

The input wave applied to either R-C or R-L circuits may be of any shape. But the greatest amount of distortion can be obtained in the output when the

(Continued on following page)

ELECTRONIC TRANSIENTS

(Continued from previous page)

input wave consists of abrupt changes, that is, when the input wave has very steep sides. Most ideal type of input wave is the *assymmetrical square wave.*

Figure 5 illustrates such a signal voltage applied to two kinds of R-C circuits. By earlier definition, the upper circuit has a short time constant (RC=0.001 seconds), the lower circuit has a long time constant (RC=0.1 seconds), both with respect to the frequency of the applied square-wave voltage.

When the voltage E is applied to the short time-constant circuit [upper Figure 5], the condenser is charged to E volts according to the rate of charge permitted by the values of R and C. Polarity of the condenser charge is determined by the polarity of the applied square wave.

As the input voltage changes, the voltage across the condenser, e_c, follows the rate of charge and discharge. This wave form is known as the *integrated portion* of the original impressed square wave. Should such a sloping wave, e_c, be desired to operate or control an electronic circuit, the voltage wave could be tapped off from across the condenser and fed to other stages or components. This circuit is referred to as an *integrator circuit.*

Of more practical use, however, is the *peaked wave* appearing across the resistance, e_r. Such a circuit is referred to as a *differentiator circuit.*

Peaking is an important form of distortion, finding wide use as a trigger impulse. The output voltage, e_r, is often applied to limiting or other types of pulse-forming circuits to obtain extremely narrow and precise rectangular impulses.

Thus there are two principal types of distortion in the R-C circuit: integration and differentiation.

Distortion of the input square wave by a short time constant R-C circuit is due to the poor low frequency response of the stage. The square wave has steep sides, and therefore a large number of *odd* harmonics. The highest frequency harmonics cause the impressed wave to be even further removed from the shape of the fundamental sine wave. Reactance of the condenser is greatest for low frequency harmonics, causing an exaggeration of the high frequency harmonics in the resistor output wave, e_r.

Although both waveforms, e_r and e_c, are available for use, either but only one of the two are ever utilized because of loading effects on the stage. And of the two types of output waves, the voltage, e_r, is more generally used.

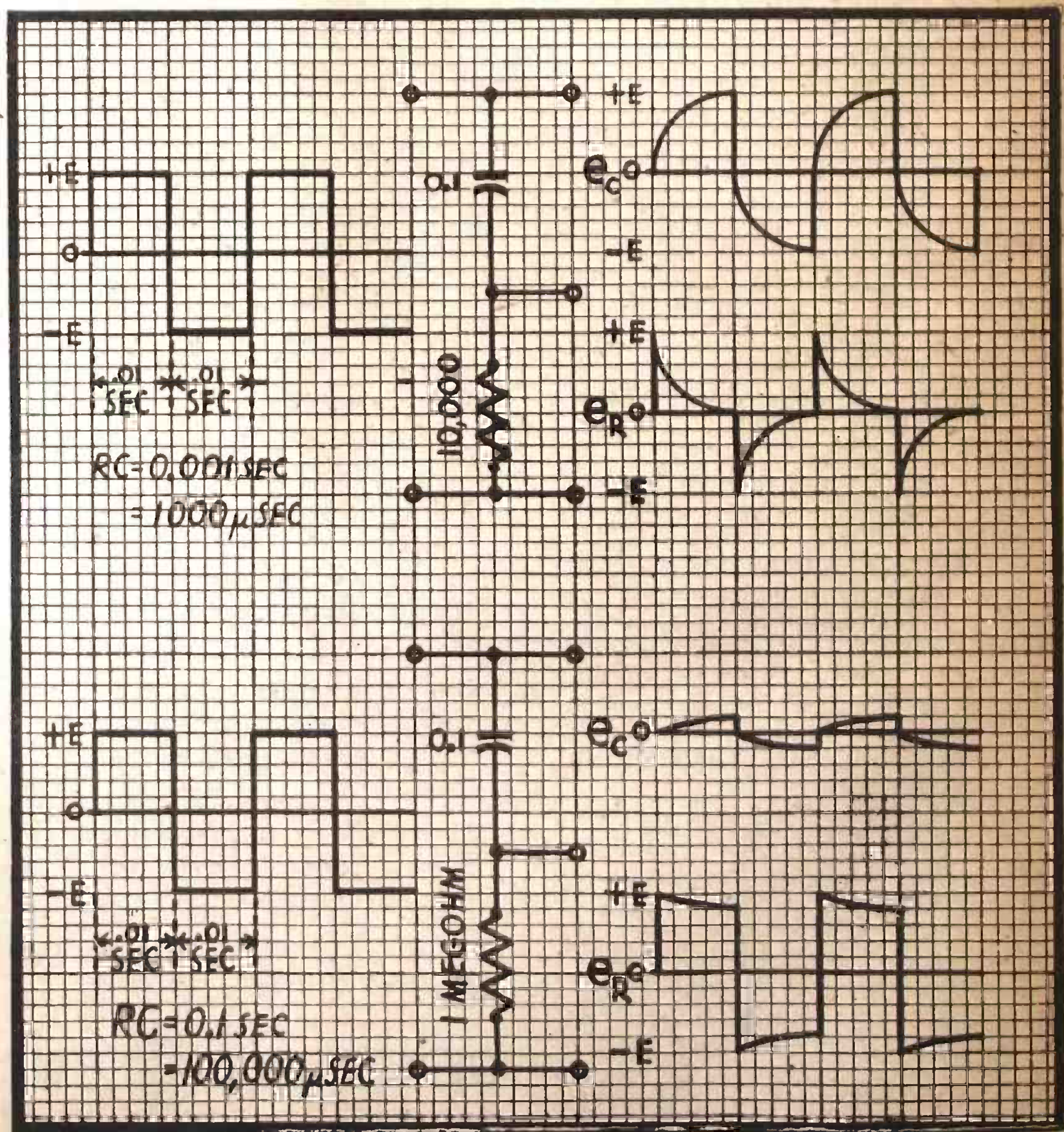


Fig. 5—Distorting circuits for shaping waves and the forms that may be produced by them.

A long time-constant circuit [lower Fig. 5] also provides two waveforms, but of somewhat different nature. In this circuit the time constant is ten times the required time for a half cycle of the impressed square-wave voltage. When this voltage E is applied to the circuit, the condenser does not charge to its full value during an alternation. Before it has time to charge fully, the polarity of the impressed voltage is reversed.

The wave across the condenser, e_c, is of little use because of its diminished amplitude.

The integrated voltage across the resistance, e_r, is almost a duplicate of the impressed square wave. If the time constant for this particular circuit were 40 or 50 times that of the signal frequency, the voltage across the resistor would be almost identical with the input voltage. And the condenser voltage, e_c, would have no perceptible change.

Since practically the entire voltage drop of the R-C circuit [lower Fig. 5] is across the resistance, this explains the wide use of long time-constant circuits as coupling devices between stages of resistance-coupled amplifiers. Careful selection of R and C values is necessary, since improper selection might result in a short time-constant circuit introducing unwanted distortion.

Wave shapes other than square waves may be applied to either long or short time-constant circuits, resulting in various wave forms in the differentiated or integrated output. For instance, a rectangular wave may be integrated to obtain a saw-tooth voltage wave.

However, a pure sine wave suffers *no* distortion when passing through either a long or short time-constant circuit, since one of the important mathematical properties of a sine wave is that it may be differentiated any number of times without changing its shape.

Besides the important distortion effects of R-C and R-L circuits, the time constant of such simple circuits is the basis for all electronic delay and timing circuits. The delay action depends upon the R-C or R-L values, and the time required for a current to build up or decrease. The retarding action of these circuits can be utilized to achieve either postponed control actions or to measure required time intervals.

These circuits permit delayed action of both electrical and mechanical devices, control of circuits during prescheduled intervals of time, and other electronic functions.

In radar and television applications, selected impulses containing very high-order harmonics are used to synchronize the operating of many components.

CORRECTION

An error occurred in the article "Elements of Radar" on page 169 of the December issue. In the 24th line, second column, the time for a pulse to travel 3270 yards should have been 10, not 50 microseconds. The time for the full circuit would of course be 20 microseconds instead of 100 as stated.

British amateurs were permitted to return to the air on a limited number of frequencies, by an order dated January 8, 1946. Power up to 100 watts is permitted. Equipment taken into custody in 1939 will be returned to the hams of Great Britain within the next few weeks.

SOME FM FACTORS

(Continued from page 324)

that using four doubler stages permits a frequency change of 4 squared or 4 x 4 equals 16.

The limit frequencies of 5059.12 and 5008.11 will also be stepped up to:

$f_1 = 16\ (5059.12) = 80{,}945.92$ Kc

$f_2 = 16\ (5008.11) = 80.129.76$ Kc

The bandwidth at the higher range is 80,945.92 Kc minus 80,129.76 Kc or 816.16 Kc.

IMPROVING THE LINEARITY

Since a bandspread of 816.16 Kc is far too wide for our purpose, decreasing this final bandwidth will result in decreasing the oscillator frequency shift and improve linearity. If a bandwidth of 150 Kc is used, the oscillator frequency shift should be (with four doublers) equal to 150 Kc./16 or 9.375 Kc.

Thus, the frequency shift for both positive and negative modulation peaks, at the oscillator, may be made very nearly the same to secure linear modulation conditions. In this example, an FM oscillator shift of only 9.375/2 or 4.6875 Kc above and below the resting value of 5035.11 Kc gives us a high-frequency final doubler output range of 16 times 9.375 or 150 Kc. The 150 Kc figure may be used on the basis of selecting a deviation ratio of 5 times the highest modulating frequency, which we may assume to be—in this example—equal to 15,000 cycles per second.

As the carrier frequency is shifted from 5035.11 to 5059.12, numerous sideband FM frequencies are produced. The bandwidth is 5059.12 minus 5035.11 or 24.01 Kc. Let us split this up into 100 parts. Then,

$$f_a = f_c + \left(\frac{f_b}{100}\right)$$

where f_a = the first sideband frequency in a positive direction (going higher in frequency)

f_c = the original carrier frequency (of 5035.11 in this example)

f_b = the bandwidth, equal to 24.01 kc in this case. Note this is for ½ the total band and is the upper frequency half of the complete band.

In this case, 24.01 divided by 100 gives 0.2401 and the first sideband frequency would be,

$f_a = 5035.11 + 0.2401 = 5035.3501$ Kc.

The interval that we have selected is 0.2401 and the tenth sideband frequency would be, simply,

$$f_{10} = 10\left(\frac{f_b}{100}\right) + f_c = 10 \times 0.2401 + 5035.11 = 5037.511$$

Other sideband frequencies could be calculated for analysis purposes. Actually an infinite number of such frequencies are produced both above and below the unmodulated FM carrier frequency. As the oscillator deviation is increased, the side frequencies, which are developed by the carrier shifting through a frequency range, are increased in number. Using a lower carrier frequency, and small shift, the sideband frequencies are reduced in comparison with the number of frequencies produced at a higher FM carrier frequency level.

The carrier frequency in this case is 5035.11 Kc, which means that 5035.11 x 1,000 complete waves are produced per second. Since t equals 1/f, a 1,000 Kc wave equal to 1,000,000 complete vibrations per second would have a time duration of 1/106 or 0.000,001 second. 5035.11 × 1000 equals 5,035,110 cycles per second. Thus for one complete wave of R.F. there would be required a time duration of 1/5,035,110 second or 0.000,000,1787 second, equal to 0.17 microseconds.

AUDIO COMPENSATION NEEDED

When a 40-cycle audio signal modulates the transmitter, the high frequency carrier is moved from 5035.11 Kc to 5059.12 Kc, back to 5035.11, then to 5008.11 Kc and back to 5035.11 Kc, the starting point. This change is made at the rate of 40 cycles per second. The time required for the modulating signal to go through one cycle is 40 divided into 1 or 0.025 second. This is the time of one complete 40 cycle wave, and during the positive half of that wave, assuming positive peaks cause a rise in the carrier frequency, the carrier is shifted from 5035.11 to 5059.12.

Let's start from zero for the modulating signal and assume that we are rising from zero to the maximum positive value or peak. The time required to reach the peak will be ½ that of the 40-cycle duration time or 0.125 second. For a time duration of 0.125 second, assuming no modulation of the carrier, 0.025/0.000,000,1787 waves of R.F. would be produced each ½ cycle of 40 cycle modulating signal. This would be 139,898 waves per second. (It must be remembered that the above example is given for simplicity's sake.)

When the modulating frequency is 15,000 cycles per second, the time duration of the modulating signal is equal to 15,000 divided into 1 or 0.000,066 second. This is equal to 66 microseconds. The positive and negative half of the wave each require 33 microseconds for completion. As the time is now much shorter than it was for the 40-cycle signal, during a given half of the high audio frequency cycle a fewer number of R.F. waves will be transmitted. That is, 33 microseconds divided by 0.17 microseconds gives 194.11 R.F. waves during the positive half of a single cycle of the 15,000-cycle audio signal. The duration of the 5035.11 Kc carrier is 0.17 microseconds.

We may expect a greater output at the lower audio modulating frequencies than at the higher audio modulating frequencies, and can compensate for the effect by increasing equalization in the audio modulator of the transmitter, so that the higher frequency sounds produce greater deviations.

HUM ELIMINATION

(Continued from page 313)

may be caused by emission from the heater to the cathode, or emission from the cathode to the heater. This condition may be reduced or eliminated, in the first instance by applying a positive voltage on the heater, sufficient to make it as positive as the cathode. In the second instance, the application of a negative voltage on the heater sufficient to make the heater-cathode voltage difference small is the remedy.

It must be remembered that although a tube is supposedly cut off by the application of bias to the cathode, the cathode does not always cover the heater completely, and that emission can occur from the heater to the plate. If this emission takes place from one exposed heater wire, said emission will not be from an equipotential surface and will vary as the heater supply frequency.

It is best, in audio amplifier design, not to rely on multiple grounds to the chassis. It is better to carry the ground circuit from point to point with a heavy copper wire, and this ground, insulated from the chassis, should be grounded in one spot only. This spot will have to be found by trial and error. This is particularly effective in high-gain amplifiers. A spot will be found at which the hum will drop appreciably and even reduce to the vanishing point.

RESISTANCE-CAPACITY FILTERS

It sometimes becomes impractical from an economic standpoint to use brute force methods, such as complicated filters and regulators, to effectively filter the entire power supply, when the addition of an RC network, in one or more circuits, will accomplish the desired result. This may be either keeping the supply ripple from this stage, or isolating the plate excursions of this stage from the power supply RC filter networks are usually figured on the basis of T = RC (see Fig. 3) where T is the time in seconds, R is the resistance in ohms and C is the capacity in farads.

It might be pointed out that a lot of time can be saved and time-constant problems can be worked in the head, if you remember that microseconds equals ohms times microfarads or that microseconds equals megohms times micro-microfarads. One of these formulas puts the parameter you want in the terms that you want it and eliminates converting farads, for instance, to microfarads or micro-microfarads, or ohms to megohms. This will also eliminate the possibility of error in adding and subtracting negative and positive exponents.

This formula states the time, T, it takes the voltage across the Condenser, C, to charge to 2/3 of its full value or to discharge to 1/3 of its original value. These fractions are approximate, as the exact amount that the value C charges to is equal to $1 - \frac{1}{\varepsilon}$ and the value it discharges to is $\frac{1}{\varepsilon}$.

The condenser charges or discharges according to an exponential function so that it takes a much longer time to change even a much smaller additional amount in the direction we are considering. (See Fig. 4.) It is interesting to note that C may charge to 95% of its maximum in 3RC (seconds) or it will discharge to 5% of its total

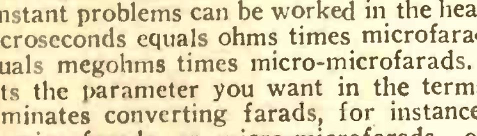


Fig. 3—Charging time is set by R and C.

value in the same time, as the case may be. This figure is accurate to about three decimal places.

If we compute our RC value on the basis of T = RC in an isolation filter, we will still have 1/3 of the original amount of ripple left, which in most cases is not reducing it to a sufficiently low value. We could compute the necessary RC to reduce the ripple to any premeditated value but

(Continued on following page)

Spell radar backward and you get confusion, says Frederick C. Othman, newspaper columnist. He refers to the confusion surrounding both the early censorship of the subject and the subsequent "revelation," which was not entirely revealing.

Possibly to illustrate the confusion, the distinguished columnist goes on to declare: "My professor says that radar some day will become television, without scanning discs, synchronous motors and all the other complicated innards now in use."

The ghost of Nipkow will be pleased to hear that in this day of cathode-ray tube television, the scanning disc is still referred to, even if the reference *is* due to confusion caused by publicity on radar.

HUM ELIMINATION

(Continued from page 355)

for a reasonably close estimate we may use the formula $T = \frac{RC}{25D}$ where D is the duty cycle expressed in a fraction of one. This will yield an RC filter which will reduce the ripple to approximately 1% of its unfiltered value. The duty cycle is the ratio of time of duration of a wave form to the period of successive wave forms. In the case of a sine wave these values are equal, so D will equal .5.

Remember when using RC filters that the choice of R is limited to the largest value that will give the required filtering but which will not drop the average DC potential on the tube plate to a value lower than the value which was used in designing the components for that stage.

The importance of this factor "D" will be more evident when a non-sinusoidal circuit is to be decoupled. For instance, a multivibrator which produces a square wave ten microseconds wide and then rests for ten thousand microseconds will draw current for 10 µsec., whereas one which produces a square wave three thousand µsec. wide and rests for seven thousand µsec. will draw current for 3000 µsec. and will, therefore, discharge our C to a much lower voltage, indicating the necessity for a bigger C or a larger R.

In any event, when unequal wave forms are considered, it is more convenient to consider time constants rather than impedances and reactances.

MISCELLANEOUS METHODS

Decoupling is necessary where several stages are to be cascaded, as oscillation can result. It is conventional, therefore, to isolate several or all the stages, not only in the interest of hum reduction, but to eliminate the unwanted regeneration introduced by common coupling in the power supply.

Hum which cannot be eliminated in any other manner can be reduced by the application of degeneration which will reduce the hum, within the loop, proportional to the amount of feedback. In several cases, this feedback loop could be resonant at the hum frequency only, so that a maximum of degeneration is introduced at the hum frequency.

In cases where the low-frequency response is not important, it is feasible to reduce the coupling time constants by reducing the coupling condensers and grid resistors, reducing the gain at the hum frequencies. When all other means fail or when economy dictates, hum may be balanced out by applying to the circuit in question a hum voltage of proper amplitude and 180° out of phase. This voltage may be applied to any of the tube elements in a number of ways.

Remember that the field of a dynamic speaker, when used as choke in the power supply, has a very strong hum field surrounding it and an input transformer should not be located close thereto. A velocity microphone will pick up a strong hum voltage when located as far as 8 or 9 feet from such a speaker field. Microphone orientation will reduce this pickup to a minimum.

When connecting a self-powered tuner to an amplifier, remember to reverse the line connections if undue hum results. If both units have by-pass condensers from one side of the line to ground, it is possible to plug the units into the supply mains in such a way as to place some, or all, of the 110 V A.C. 60 cycle power source in series with the common ground between the units.

Consider, when using a cathode follower, that the cathode is swinging with the signal, and, at some parts of the cycle, it may well be a hundred volts above the filament, which may give rise to cathode-filament emission, or capacitive hum coupling.

Electrolytic condensers are a potential hum source. Their capacity reduces with age and their impedance increases, which can also give rise to oscillation. They should not be depended upon for R.F. by-passing and, in such instances, should be paralleled with a good paper or mica condenser.

Don't forget to by-pass to ground all the cathodes in which degeneration is not desired. The value of the condenser should be large so that its impedance at 60 cycles will be much lower than that of the cathode resistor, so that any hum developed between the heater and the cathode will be by-passed to ground. It is important that this condenser be grounded to the same place as the grid and cathode resistors, so that an AC circulating current in the chassis is not connected in series with the cathode by-pass condenser. (See Fig. 2.) Electrolytics used for by-passing sometimes give rise to tunable hums in radio tuners. Tunable hums have also been known to be caused by unwanted 60 cycles introduced into the oscillator of a superheterodyne receiver, due either to faulty by-passing or a faulty tube.

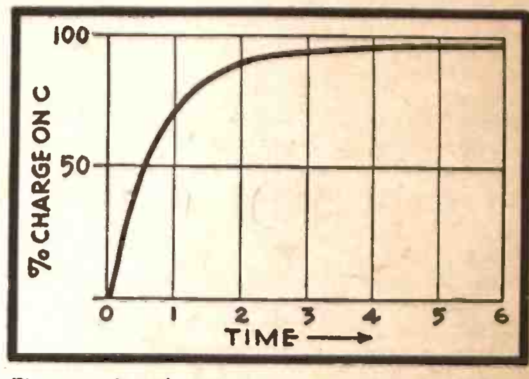


Fig. 4—Graph of condenser charging time.

Hum can be caused by induction from a phonograph motor to a magnetic pickup. This can be reduced by magnetically shielding the pick-up and using an iron turntable. Of course, the leads from the pick-up should be run through shielded wire and, in low-level pickups or microphones, the shield braid should not be relied upon for the ground return. Rather, use double wire shielded cable, connecting shield braid to the amplifier chassis and the ground wire to the amplifier ground. In this instance, do NOT connect the braid to the ground at the microphone or pickup but only to its frame. In connection with phonographs, it may be noted that what appears to be a hum only when records are played, may be turntable rumble. This may be-duced by replacing the rubber drive wheel on the rim drive models or by reducing the low frequency response of the amplifier.

Last, but not least, mechanical vibration can be responsible for hum. In such cases mechanical isolation is indicated. Mounting on rubber or removal of the source is the answer.

There are very few cases where the annoying hums cannot be eliminated or reduced to the point where they are no longer objectionable and the full capabilities of the unit under consideration can be realized.

A "PORTABLE SHOP"

(Continued from page 311)

tron stream flowing through the other elements to the plate. The plate is electrostatically shielded from the oscillating portion by the screen, which is at R.F. ground potential. It is also stable in respect to voltage variations. Any variable condenser which was or could be used to cover the broadcast band with standard coils may be used here. Standard 4-prong plug-in coil forms are used. The coil is wound continuously but is tapped for the cathode connection. Complete information on coil data is given in the table. The 6SK7 is a perfect tube for the job; being single ended wiring is easy, and one can be assured of complete shielding. Grid condenser and grid leak should be of the smallest physical size procurable and should be fitted with a metal shield. The value of the resistor supplying voltage to the potentiometer is given as 50,000. Actually it should be determined after the voltage from the power-pack is known. For the 6SK7 the voltage at X should be 100 volts, which is the screen voltage given in the tube manual. B-plus and filament voltages are supplied from the power-pack below by two wires plugging into male receptacle situated at the back of the panel.

As an R.F. and I.F. signal-tracing unit the tester compares not unfavorably with elaborate 3-stage TRF analysts. For signal tracing the output jack is connected to the input of the audio channel by a short connection. Signals can then be picked up with a shielded test probe.

A word of warning is needed for anyone who thinks that all that is necessary is to pick out the right sized condensers and stick them together. There is a world of difference between an ordinary regenerative set and one that is carefully designed. When used as a service tool one wants no worries as to whether that birdie, whistle, hum or howl is coming from the defective radio or from one's test instrument. Here are a few pointers. 1.—Plate and grid wires must be very short, yet parts must not be crowded. 2.—Half the battle is in constructing strong, neat shields. 3.—Build rigidly and solder carefully. 4.—Three factors influence the smoothness of going into and out of oscillation; the amount of feedback, grid leak, and antenna coupling. The final setting of the cathode tap on a coil should be such that the detector breaks into oscillation at the recommended screen grid value as given in the tube manual. If it oscillates only at a higher voltage too little feedback is present and the cathode tap should be moved higher on the coil. A low enough value of feedback should be used to ensure smooth regeneration from an almost noiseless condition to slight hiss, loud hiss, whistle (when passing station). If it comes into oscillation with a plop and is not stable (starts squealing if you shake your fist in its face) adjustment of the grid-leak or antenna coupling is indicated. If, however, smooth regeneration cannot be obtained with at least a one-megohm leak, the antenna coupling should be loosened; that is, use a smaller condenser. A tiny trimmer condenser works well in this position.

5.—Another disease from which regenerative sets suffer is fringe howl, noticed when tuning through a station. This is more than a matter of too much regeneration. It means that R.F. signal is getting through into the audio section. The remedy lies in better R.F. filtering.

6.—A good regenerative set should have little or no hum. Methods of elimination are: 1.—More careful shielding, not just of wires but of parts and sections. 2.—Grounding of chassis. 3.—Better power supply. 4.—Ground one side of heaters and by-pass other side through an .01 mfd condenser.

To obtain an audio signal for test purposes, plug in broadcast coil, attach antenna to input jack (a small built-in antenna in the top of the cabinet brings in all local stations). Connect output jack to input of audio channel. Tune in a station.

MODULATED R.F. OR I.F. SIGNAL

As anyone who was ever bothered by interference from a neighbor's radio in the old days knows, a regenerative set can be made to give out a self-modulated R.F. signal. This is done by turning up the regeneration control until the tube breaks into audio oscillation. If the tube merely oscillates smoothly the result is an unmodulated signal. If the regeneration is increased still more the grid becomes more negative until the plate current has been reduced to so low a level that the tube stops oscillating. The grid then becomes less negative and oscillations can again begin, so an audio cycle is repeated and is superimposed upon the fundamental R.F. wave.

It is unnecessary to tell how one uses an R.F. or I.F. signal in locating a fault in a radio. Nor is it necessary to outline the alternative method of signal tracing. Many good articles have appeared in *Radio-Craft* on both of these methods. It hardly needs to be mentioned that when the test instrument is used for signal tracing the apparatus is not used in an oscillating condition. The regeneration control is merely advanced to a position where the apparatus is sufficiently sensitive to pick up a signal, detect and amplify it and pass it on to be registered by the audio channel. Always use a shielded test probe when picking up an R.F. or I.F. signal from a radio.

DIODE VACUUM-TUBE VOLTMETER

To use, the D.C. pocket voltmeter, seen at the right in the photo, is connected to the Diode. Refer to the circuit diagram for connections and note that the two ground terminals on the lower part of the panel are used along with the two pin jacks in the upper left corner. This circuit reads peak A.C. volts and while it is not as sensitive as more complicated V.T.V.M.'s it is a distinct improvement over ordinary A.C. voltmeters. The RMS value of the A.C. voltage under measurement can be determined by multiplying the peak value as read on the meter by 0.71. Most common measurements are peak voltages across filter condensers; to check turns ratios of transformers, and as an audio-frequency output meter across the voice coil of a speaker. The condenser must be a *high quality* paper 2.0 mfd. It should be noted that this circuit has certain limitations. It is no more sensitive than the meter with which it is used and loads the circuit. As here constructed it has too high losses to measure R.F. frequencies.

Many possible uses occur to one who has an idle evening with the apparatus. The audio-amplifier becomes a record player, a music booster, or a miniature P.A. system. The broadcast band may be covered, and short-wave coils can easily be wound for foreign reception.

You can also try modulating the suppressor-grid of the 6SK7 with a strong audio signal from a record player or a carbon microphone. The broadcast can be picked up by the kitchen radio. (But not by the neighbor's radio or the federal authorities won't like it.)

TECHNOTES

ATTENTION, SERVICEMEN!

Do you have any servicing notes available which you would like to bring to the attention of the readers of *Radio-Craft?* If so, send them along. If they are publishable a six-month subscription to *Radio-Craft* will be awarded you. If your notes are illustrated you will be given a one-year subscription.

. . . . BROADCAST TECHNOTES

Here are a few tips regarding console equipment for use in broadcast studios:

1—Use of soldering lugs can result in erratic performance. To eliminate, skin back the shielded portion of the shielded conductor, then scrape off the insulation near the wire ends and clean the wire. Make loops in the ends and sweat solder around them. These "lugs" make perfect contact at all times.

2—Where shielded wire has a tendency to short, due to shielding braid touching terminals, push the braid back and wrap Scotch tape around the exposed portions of the shielding.

3—In servicing the potentiometers used for level controls, first clean with carbon tetrachloride, then apply a thin layer of graphite grease and a relatively thick layer of vaseline.

4—Put a little graphite grease on the ends of cord tips and push in and out of each tip jack several times. The graphite grease creates a better electrical bond.

5—Preamps should be mounted on sponge rubber if any microphonic noise is present.

6—When making connections to lug-type terminals on the patch panel, twist as much exposed wire through the eyelets as possible, to make area of soldering surface between the wire and terminals.

7—Put a little graphite grease on microphone connectors to prevent corrosion of contact surfaces.

BURR JAMISON,
Chief Engineer, WROX

. . . . SUPREME GENERATOR 571

I was continually having trouble with the output plug on this model signal generator. Solved the problem by replacing the existing jack with a four-circuit Amphenol mike connector, using terminals 2-3 as the internal generator ground connection. Terminals 1-4 were used as the output feed jacks.

This gives excellent results; it is easier to connect and disconnect the plug for transporting, and is the perfect plug connection after the plug ring is screwed into the jack. A shielded mike cable was used as the output leads.

JACK BORITZ,
Bronx, N. Y.

. . . . TUBE SUBSTITUTE

With some older types of tubes still short and liable to be so for the next few months, this idea may prove useful. I needed a 1V tube for a Silvertone radio, and not having one, I substituted an OZ4 gas-filled tube. I made an adapter out of an old 1V base and an octal socket.

CASELLA RADIO SERVICE,
New Orleans, La.

. . . . GRUNOW 1101

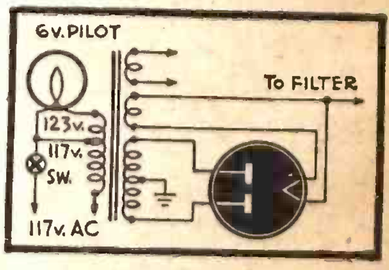
The owner complained that he had practically no control over the volume of the set. I found that he disconnected the aerial at the window strip in an attempt to lower the volume to comfortable listening standards. The set used a 2-megohm volume control.

After considerable testing, I found leakage between the volume control wire and another wire in the remote control cable. I ran another wire to the volume control as a temporary repair until a new cable could be obtained, and all was O. K.

CLAUDE M. PREW,
New London, N. H.

. . . . PILOT LIGHT

Some transformers have several taps on the primary side. If the line voltage is 115 volts and a tap at 120 volts is provided, a pilot light can be connected



across this 5-volt potential. The leads from the pilot light to the transformer should be twisted to prevent tunable hum.

This is particularly useful on certain old-time receivers, where there are primary taps and the filaments run at lower voltages than the ordinary pilot lamps. Of course it is also possible to connect up a 2.5-volt lamp across any filament circuit which includes a type 27 or 56 tube.

NORMAN H. KENT,
Moose Jaw, Sask.

. . . . WESTINGHOUSE 42X5

Three sets of this particular model came in with a shorted by-pass condenser on the plate of the 6K6. Only one of these by-pass condensers shorts out, but since the third set came in, I made it a routine part of my job to remove the bypass on both 6K6 plates, and replace them. The original condensers were .0035 mfd., and I use an .002 mfd. in replacing them.

F. A. CLIFFORD,
Shamokin, Pa.

PPM—NEW TECHNIQUE
(Continued from page 349)

common frame of the system, where they may be put on telephone lines or otherwise routed as desired.

OTHER RECEIVER ELEMENTS

The actual receiver circuit is not as simple as has been described. A number of necessary circuits have not been mentioned. One of these is the automatic frequency control circuit, which is hooked in after the eighth I.F. stage. This applies to the high-frequency oscillator a voltage which keeps it exactly 60 Mc. below the received signal, correcting for slight frequency variations in either transmitter or local oscillator. Operation is along standard a.f.c. lines. When no signal is being received, a *searcher* circuit is activated, causing the local oscillator to travel over the tuning range till a signal is found, when it locks in on the signal frequency.

An a.v.c. circuit is also provided after the first video amplifier, control voltages being applied to the I.F. stages. Two clipper stages also assure uniformity of received pulses.

The gating circuits are also more complex than appears in the simplified discussion. While two gate generators work directly off the square-wave generator, each of the other six channels requires its own sweep generator and gate starter to properly delay gate action so that the eight-gate circuits operate in turn, each occupying its proper portion of the 125-microsecond period.

(All photos and drawings courtesy Bell Telephone Laboratories.)

ANTI-RADAR DEVICES
(Continued from page 309)

the vertical, and broad in the horizontal, plane. The superstructure is a reflector excited by the horn at bottom.

Photo 5 is a portrayal of the feelings which German radar operators might have been expected to feel when their apparatus was rendered useless by "window." It was posed with a captured German radar at Foggia, Italy.

●

Radio defense against the atom bomb is unlikely to be of great value, in the opinion of many of the scientists who helped develop it. Many different methods can be used to detonate the bomb; just how many is probably not yet known. Because of the possibility of employing many different detonating mechanisms, the defense against the atomic bomb is complicated. Radio might detonate it, but to do so one would have to know the type of detonating mechanism used in the bomb. Just as there is no defense against conventional explosive, per se, so there is no defense against atomic-energy explosive.

Atomic explosives would without doubt be launched against an enemy country in an atom-powered rocket, atomic power itself rendering other means obsolete for war use. Thus any other than radio means would be too slow to detonate the destructive charge at a safe distance from its objective.

Civilian RADIO JOBS Wanted
FREE WANT-AD SERVICE

LABORATORY TECHNICIAN; 23 yrs. 4 years experience in audio, and research Labs. Seeking position with Electrical or Electronic Laboratory. David M. Lisbin, 77 Rodney St., Brooklyn 11, N. Y. EVergreen 8-8354.

RADIO MECHANIC—Operator 3½ years Army experience; desires position with radio company; ambitious, conscientious; interested servicing, television, electronics. Solomon Posner, 654 Williams Ave., Bklyn 7; CL7-2072.

RADIO TECHNICIAN: 4½ years Maint. Inst. and Repair. 1 yr. Radio eng. night. Electronic Lab assistant or trouble shooter. Future Primary. Salary secondary. I. Weinberg, 1563 Hoe Ave., Bx. 60.

FUTURE IN RADIO, electrical, selling, any field desired; 24, married; 4½ years AAF radio mechanic, operator. Restricted radio telephone license. Ritzer, 2020 76th St., Brooklyn 14, N. Y.

RADIO OPERATOR—2nd phone, res. tel. licenses; eager and quick to learn, married, 24, will accept most anything in the operating field; New York only. Michael O'Connor, 55 Mt. Hope Place, Bronx 53.

RADIO TECHNICIAN, 3 yrs. exp. Army Signal Corps A.M.—F.M. Repair. Good selling ability. Salary secondary providing there is advancement. S. Jacobowitz, 299 Atkins Ave., Brooklyn 8, N. Y. AP7-6864.

VETERAN—Former D/F Station Chief with 4 years of Comm. experience desires a job of FM or VHF Install. and maint. Prefers work in middle-west. Will furnish references. Age 25. Write P. O. Box 14, Springfield, Mo.

RADIO TECHNICIAN, 25, married. Graduate of Air Force radio and radar schools. Two years of practical experience in a Signal Corps Depot and with the Air Transport Command. Familiar with all test instruments. Vicinity of New York City. Moderate salary to start. Morris Landsberg, 937 E. 181st St., Bronx 60, N. Y.

RADIO TECHNICIAN, 3 years exp. on low and medium power HF and VHF transmitters and receivers. Radiotelephone 1st class license. Desire position with good opportunity with broadcast station anywhere in U.S.A. Robert A. Boyle, 31-33 80th St., Jackson Heights, N. Y.

YOUNG MAN 29, married. 3 years experience AAF Radar. Maintenance, installation, and operating. Desires position in above. Anthony Urban, 412 W. 57th St., New York City (19). CI7-2539.

RADIO INSTRUCTOR, Air Force trouble shooting, maintenance, 3 yrs.; 15 yrs. commercial exp., service, sales; broadcast and "ham" licenses. Brody, 1057 Bryant Ave., Bronx 57.

RADIO REPAIRMAN; semi-skilled, 2½ yrs. army; 1 yr. civilian, experience in pulling sets, giving estimates; desires work in store. Sam Brounstein, 1248 St. Marks Ave., Brooklyn 13; PR 4-5315.

RADIO AND RADAR TECHNICIAN; 3 yrs. exp., aircraft communications and navigation equipment. Azuz, 415 Claremont Pkwy., Bronx 57.

PREVIOUS 4 yrs. electrical exp., indoor and outdoor work; also thorough radio, radar trouble shooter and tester. E. Rothenberg, 2939 Brighton 5 St., B'klyn 24; DE 2-4075.

YOUNG MAN; 23; radio tech., 3 yrs. army exp., desires pos. with future; willing to sell—mod sal. Harry Garten, 2233 81st St., Brooklyn 14.

RADAR MECHANIC—3 yrs. Army exp. installations, repairs, will take any position with future; salary within reason. Sid Edelstein, 1059 53d St., Brooklyn 19.

AAA for alertness, ambition and ability; 23; some college; radio and sales office exp., speak French; will go anywhere. Ephraim Schwartz, 186 Clymer St., Brooklyn 11.

RADIO—2d class telegraph and amtr.; License M.O.S. 766; opprty. cmcl. or mfg. operator; transmitter maintenance; 24, single. Nemoyten, 446 Georgia Ave., Brooklyn 7.

MAN; 27, married; ambitious, experienced business administration radio and sound equipment field. Eliot Schwartzman, 141 E. 19th St., Brooklyn 26; BU 4-2672.

AMBITIOUS: 23; 1 year army radio; radar repair training; seeks future in radio field; willing to learn; 1 year college. Stanley Klein, 9205 Flatlands Ave., Brooklyn, N. Y.

EXTREMELY MECHANICALLY INCLINED. Licensed amateur; 3 yrs. army operating and maintenance. Code speed 30. Prefer Radio or Mechanical Work with future. Joseph Tartas, 320 Sterling St., Brooklyn 25, N. Y.

RADIO TECHNICIAN: 3 years exp. installation, testing, modification and repair aircraft, radio. Exp. also repair and conversion commercial receivers. Familiar all test equipment. Can type, drive; seeks servicing or laboratory position with future. Single, age 33. Murray Cohen, 132 Penn St., Brooklyn 11, N. Y.

TECHNICIAN RADIO, Electrical 10 years Civilian. Army exp. Maintenance, Construction, Installations including Amplifiers. Intercommunication. FM. Radio. Possess complete test equip. N. A. Zuloff, 303 So. 1st St., Brooklyn 11, N. Y.

RADIO REPAIRMAN, 23; 4 yrs. Army, civ. exp.; full or part time; interested in position with oppor. for advancement; willing worker. Anthony Palumbo, 93 Adam St., Hoboken, N. J.

RADIO TECHNICIAN, Navy chief, married, exp. radio, radar, electronic tester, radio telephone, 1st class license. Edward Chesnik, 61-03 Maspeth Ave., Maspeth, L. I., HA 8-0642.

COMMUNICATIONS; inter-office telephone, automatic or common battery; 5 yrs. wire chief; willing, living wage. Bernard Levine, 1000 E 173d St., Bronx 60.

RADIO ENGINEER: int. broadcasting, 18 mos. exp. upstate station as transmitter engineer, hold 1st class commercial. Milton Meinwald, 7207 18th Ave., Brooklyn 4; BE 2-8044.

YOUNG; 21; ambitious; mechanically inclined; 3 yrs. radar work; seeks any pos. with future; willing to learn. Paul Rubin, 1068 Ward Ave., Bronx 59.

RADIO-OPERATOR, MECHANIC; 3 yrs. Army exp.; seek pos. with radio company; interested television, electronics; married. Paul Pushinsky, 579 Saratoga Ave., Brooklyn 12; DI 2-0797.

RADIO TECHNICIAN, 23, married; mathematics, radio design background; exp. radio, radar, control ckts.; construction, lab., research. S. Granat, 1717 Carroll St., Brooklyn 13; PR 4-3405.

RADIO, Loran, UHF Technician; 8 yrs. exp. in radio repair and design; repaired and designed all type electronic equipment; 23. Jerome Kass, 1124 43d St., Brooklyn 19.

RADIO OPERATOR—4 years Army experience, ambitious, quick to learn, 28, married, good at selling, accept position with future. Jack H. Glusky, 1150 Vyse Ave., Bronx 59.

TECHNICIAN; desires day job, tester or lab. asst.; 8 yrs. exp.; married; willing take test; prefer New York. Wm. Pendergrass, 104 Central Ave., Jersey City, N. J.

TELETYPIST, 23, 2½ years army experience operation news transmission; preferably news bureau or communication work; worked staff P.R.D. of S.H.A.E.F., scribe, Paris; some radio-teletype work; steady position. Isidore Heiss, 40 Bristol St., Brooklyn, N. Y.

RADIO TECHNICIAN, 3 years Army, 9 yrs. civ. exp. seeks pos. as lab. techn., engr. aid. Coll, drifting bckyrd. Frank Platt, 19 West 82 St., N.Y.C. 24.

EX-JASCO CAPTAIN: 29, civilian investigator, intelligence officer, staff communication air liaison, administrative executive ability, knowledge communications, radar, vaudeville, operations, production. Married, child; salary and future. A. Silverstadt, 410 Eastern Parkway, Brooklyn 25, N. Y. NEVINS 8-9825.

VETERAN 27, ambitious, easily adaptable. Attending Radio school evenings. Modest salary as radio apprentice. Harry Rothenberg, 3325 Park Ave., Bronx 67, N. Y.

RADIO MECHANIC: desires pos. with mfr. firm of electronic equipment; 3 yrs. army maintenance exp.; 24, married. Sol Katz, 1680 Vyse Ave., Bronx 60.

BLIND SERVICEMEN

(Continued from page 321)

in a radio shop that a man with sight could do. In 1937, he opened his shop doors to customers. He was a success. He sold new radios as well as repaired old ones. In general, he carried on his business as any sighted person could have done.

When he had proved to himself that a blind man could do radio work successfully, he began to dream of passing his knowledge on to other blind men. He knew from experience that independence is the thing the blind man desires above almost anything else. He knew that if he could teach them to be radio experts, they could be independent.

But problems beset him. Where would the money come from for such a school? Where would he get students? Who would pay for their training and the equipment they would have to have?

Then, one day in 1942, while he was still dreaming his dream, a telephone call came from the Army Signal Corps and Marine Materiel School in Omaha. A story about him in *Radio-Craft* had caught the eye of the school's owner. Could he come and teach servicemen to repair wounded radios in the dark?

He could and he did. He taught soldiers and Marines to repair and service their equipment in total darkness under the conditions they would find on a battlefield. So successful was he that in the 30 days allotted for each class, he not only taught them to service their equipment but to build simple radio circuits in a darkened room.

His wartime experiences further proved to him that his dream of teaching other blind men could be a reality. If persons with sight, naturally clumsy in the dark, could be taught this work, he knew that the average blind man could learn it far more easily. For the blind learn great manual dexterity, and their sense of hearing is developed beyond that of their sighted fellow men. And, after all, radio is concerned with the science of sound.

First he went to a few friends for financial backing. Then he got in touch with agencies for the blind all over the country. When he told them of his plan, some were skeptical. Many were enthusiastic.

But the blind themselves seized upon the plan. Inquiries about the proposed institute flooded in from all corners of the nation. They came from broom makers, piano tuners, rug weavers, men with popcorn stands. They came from men in all sorts of occupations, but they had one thing in common. Each of the letters was from a man with a burning desire to do radio work, to become an economically independent business man.

Now came the job of convincing the rehabilitation agencies of the states that radio work is suited to the blind man and that he can make a financial success of it. And be convinced they must, for almost all blind persons are forced to rely upon the agencies for their educations.

There was proof ready and waiting for them in Mr. Peterson. After successfully operating his shop in Preston, Idaho, and after his tenure as teacher for the Army and Marine Corps, he had opened his own shop in Omaha.

In little more than a year he had built his business to the point where he had one of the largest, if not the largest, in the area.

A traveling representative was appointed to explain the institute to the rehabilitation agencies, which are continually on the lookout for new opportunities for the blind. The representative already has covered some 20 states in the east, northeast and north. Convinced, agencies are now sending students.

The states pay for a student's training with the help of the Federal government. After his graduation, each blind person may have up to $250 to set himself up in business. It is not a great deal to equip a radio repair shop. But radio men agree that "it's more than the usual shoestring" on which radio men often start.

The training takes a year—a little more or a little less as the student needs it. The first half of the course is spent in learning theory, practicing on models, and attending classes. The last half is devoted to actual work on radios and similar equipment.

In other words, the blind student will have a chance to serve his apprenticeship under the direction of the school with all the help he needs available.

An unusual feature of this last half

Suggested by: J. F. Dunnett, Vancouver, B. C., Canada

"Yeah! Well if you're not here in a couple of minutes, it's all off!"

year's work is that the student works on actual radios in need of repairs, not just laboratory models deliberately thrown "out of gear."

And so the blind are learning to recognize tubes and parts, not through endless trial-and-error methods; but quickly and surely under methods developed by Mr. Peterson. Using his technique, they are learning to solder without burning themselves. "I have enough burns for all of them," comments Mr. Peterson.

The project is so strikingly successful that Mr. Peterson is already faced with the problem of finding new quarters for the school because of its rapid growth. The letters ,cards and telegrams which pour in daily from blind men are eloquent testimony to their desire for independence. Letters have been received from as far as England.

They are learning all about radio. In short, they are learning to become useful, important members of their communities. They are learning to be independent.

Radio-Craft will print in an early issue an article showing how to construct a Braille-type multitester. This instrument was designed and constructed by a blind radio amateur in New York.

ELECTRONIC STETHOSCOPE

THE value of electronic instruments in medical work has long been recognized. Among the most important of these is the electro-cardiograph. Now we have an instrument for study of the heart which combines the advantages of electronic amplification obtained in the electro-cardiograph with almost the lightness and portability of the ordinary stethoscope.

The new instrument, produced by Maico, leading manufacturer of electronic medical apparatus, is called the Stethetron. It consists of a microphone, a 3-stage amplifier, a special transducer and regular stethoscope earpieces.

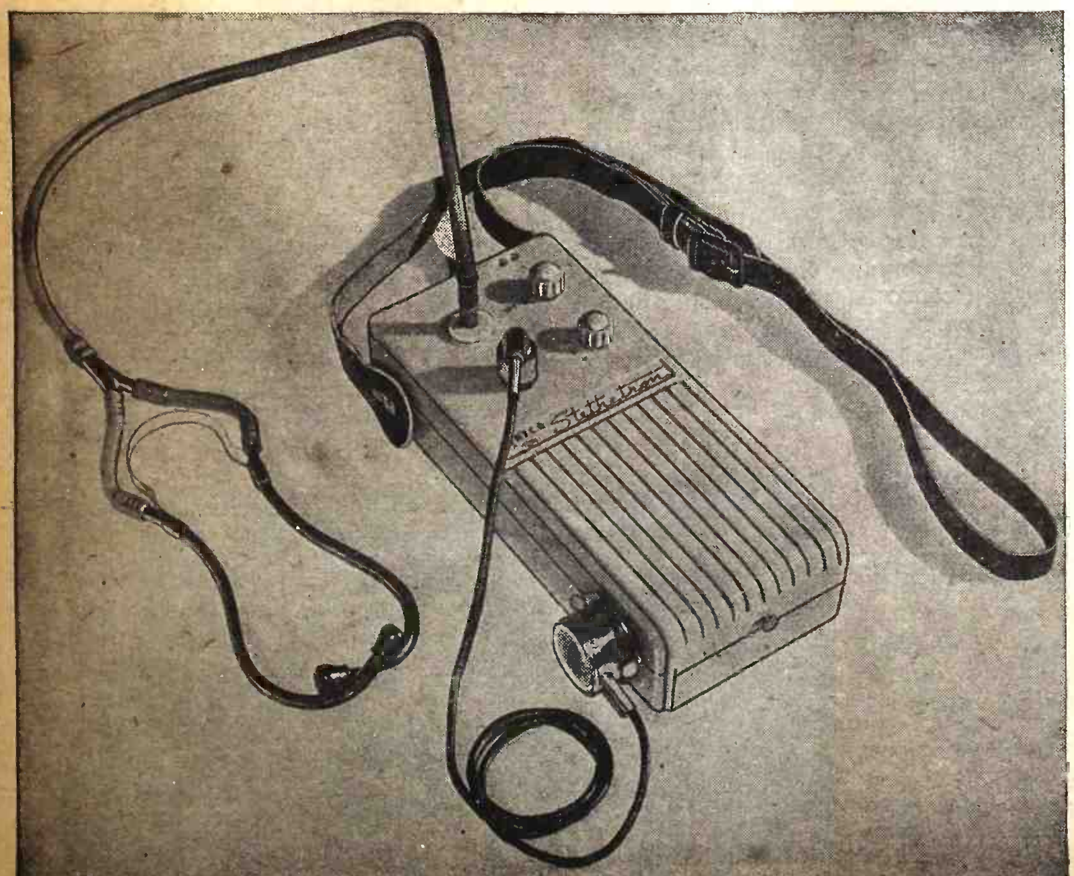
One of the difficulties in the use of electronic amplifying apparatus for listening to the heart has been that louder low-frequency sounds masked the high-frequency sounds which are most important from a diagnostic point of view. The normal thump of the heart prevented hearing faint, high-pitched heart murmurs. By use of a special tone-emphasizing circuit, which Maico calls "Inverted Tonal Emphasis" it is possible to subdue the normal, low-pitched heart sounds at will and listen to those which might indicate abnormal conditions.

Because the normal heart-beat is composed largely of low-frequency notes, the tonal emphasis modifier can also be adjusted to increase these at the expense of the higher portion of the spectrum, in the fashion of a radio's "tone control." The special transducer is also built to respond to low-pitched sounds. The microphone is a special unit, a contact type being necessary to pick up sounds from the patient's body without being affected by extraneous, airborne sounds.

A certain type of heart murmur is inaudible to a physician with normal hearing, using an acoustic stethoscope, unless the patient is rolled on his side. In actual experiments, the Stethetron has revealed this murmur instantly while the patient was flat on his back.

The 3-stage amplifier provides electrical amplification up to 100 decibels. Acoustical amplification is very difficult to measure accurately because of the peculiar nature of the body as a source of sound, but subjective tests indicate acoustical amplification in the Stethetron of up to 60 decibels for the important higher pitched sounds.

The new electronic stethoscope is housed in a plastic case, measuring only eight and three-eighths inches by three and seven-eighths in length and width and being but one and three-fourth inches deep. The whole instrument can be slipped into an overcoat pocket. Instead of requiring a heavy extra case, it can be carried easily in the case with a physician's other instruments where it may be conveniently on hand on private calls.



A leading British radar expert proposes that radar be used for mapping the moon.

144-MC TRANSMITTER

(Continued from page 319)

vides a maximum of 14 watts output for an input of about 27 watts at 2 meters. We use long-lines (¼-inch copper tubing) in a shunt-fed ultra-audion circuit. This design keeps high voltage off the lines and was adopted after a number of accidental contacts with the copper tubing while using other circuits. The shape of the tubing saves much space.

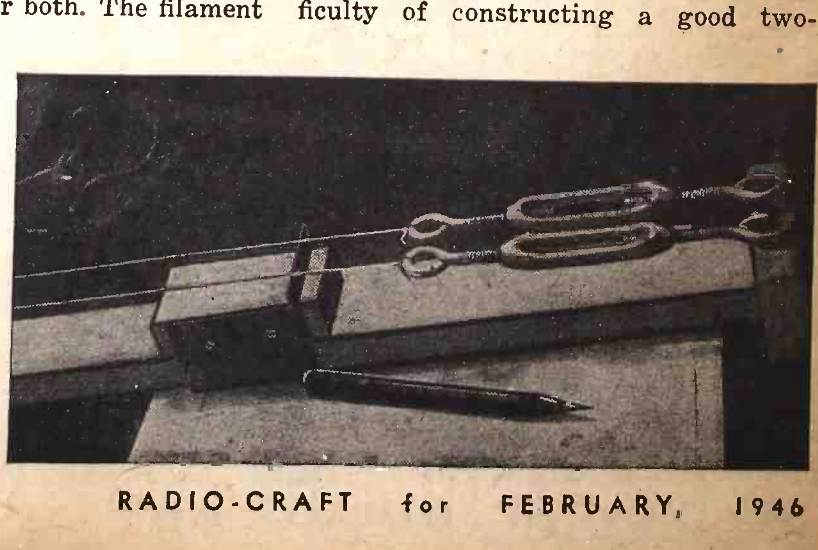
The length of each line is 8¾ inches and their separation is 1 inch (center-to-center). One line conects to the tube plate cap through a 50 mmf. mica condenser. The other connects to the grid cap through a short length of twisted pair No. 18 wires (for rigidity). Connections to both tube caps and copper tubing are made by means of National grid caps (No. 8). The other ends of the lines terminate in banana plugs which fit into stand-off insulators. The plug-in feature is used because it provides good line rigidity and good electrical connection. A piece of lucite, drilled to accommodate the tubing, aids in keeping them in proper position.

We use a plate voltage of 380 on the HY75. The current with no load is 38 Ma. This rises to 56 Ma. when the antenna or a dummy load is added. The input is then approximately 22 watts. If the circuit has low efficiency, such as is caused by poor VHF chokes or insulation, it will be found that the no-load current will be higher and the tube may be overloaded. The plate should show no bright color even after the longest "rag chews." Since the filament is of the instantaneous heating type, it can be turned off between transmissions. (This is a good feature for mobile work.)

The photograph shows the transmitter adjusted for 146 mc. Frequency is controlled by changing the position of the shorting bar which consists of a twisted pair of No. 18 wires terminated in grid caps. A displacement of less than an inch is sufficient to tune from one end the band to the other. It is well to check frequency whenever a major change is made in the circuit.

Four home-made chokes are used. The grid return is made of 20 turns, 1-inch diameter, 1½-inch length. The plate return uses 25 turns, ¼-inch diameter, 2¼-inch length. No. 24 enameled wire is used for both. The filament chokes use 8 turns of No. 18 wire, ½-inch in diameter, ½-inch length.

When using plate modulation it is a good idea to keep an eye on the modulating equipment necessary for good results.



One end of Lecher-wire wavemeter, showing slider and turnbuckles to tighten wires.

For an R.F. input of approximately 25 watts, a single 6L6 with 350 and 250 volts on the plate and screen, respectively, is sufficient. Such a convenient set-up eliminates expensive and complicated apparatus at the modulating end of the transmitter.

Most amateurs use a relatively high-gain mike of the crystal or carbon variety for very-high-frequency operation, since very good fidelity is seldom necessary. However, we are equipped with a very low-level velocity mike at W1HCO/2. This requires a high-gain amplifier to bring up the voice.

The amplifier uses a 6J7, 6SJ7 and a 6L6 in that order. The audio stages are conventional except for the addition of a .4 megohm resistor directly between the plates of the last two stages. This degenerative circuit permits higher output with less distortion

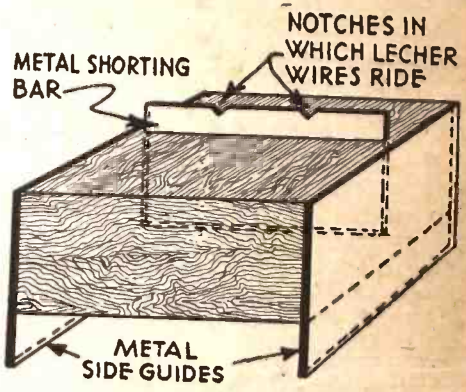


Fig. 3—Sliding block to short Lecher wires.

because it minimizes grid current. The 6L6 can provide approximately 11 watts with relatively low distortion with such a connection.

The modulation transformer here is a UTC universal type. Primary and secondary connections are so made as to present an impedance of 4200 ohms at the primary and 6900 ohms at the secondary, thus matching impedances properly.

THE ANTENNA

Our location is not the best for 2-meter work. The roof is not easily accessible for readjustments and the feeder is approximately 4 wavelengths long. Height—so important at these frequencies—is very disappointing here. Use of a long coaxial cable is not recommended because it introduces excessive losses at VHF. Because of the difficulty of constructing a good two-feeder system of great length we have used a single wire system, which has worked well.

The radiator is a half-wave dipole 40 inches long, made of ¼-inch brass tubing. It is held at its center by a block of lucite to minimize loss, although this point is a voltage node and special precautions are not required. The feeder connects to a point 12 inches from an end. The other end of the feeder is soldered to a National No. 8 grid cap which slides along the plate line.

To determine the exact point where the feeder connects, it is moved along the copper tubing, starting from the shorting bar end. As it advances, the plate milliammeter will rise from the unloaded value. It should not be moved beyond the point at which the meter indicates maximum plate input. We find that in our rig a point about 2 inches from the shorted end is correct.

POWER MEASUREMENT

A simple and effective means of measuring power output is the use of an ordinary 120-volt incandescent bulb.

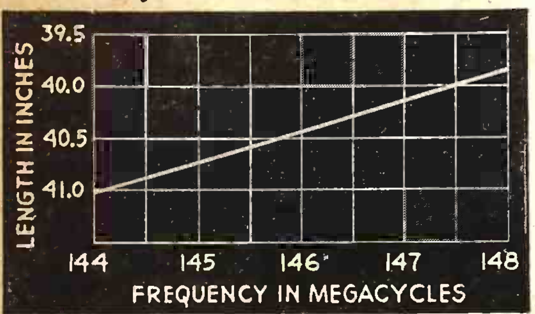


Fig. 4—Frequency may be determined by distance between nodes on the Lecher-wire system.

A 15-watt bulb has an impedance of about 900 ohms at full brilliance, a value not too far from that of usual single or double feeder systems.

To measure power output from the transmitter, disconnect the antenna. Hold the glass bulb so that one base connection is in contact with each line. As the lamp is moved away from the shorted end, it becomes brighter and reaches maximum intensity about three inches away. Its intensity can be compared with that obtained when it is screwed into a line socket. We estimate that 11 or 12 watts are obtained with our set-up.

As the bulb is moved toward the high impedance end of the lines, the plate current will increase. The meter should be watched and should not be permitted to exceed maximum tube rating. It is even possible to light the bulb by holding it so that only one contact is made, for example, on the plate cap or the grid cap. The return circuit, of course, is made through capacitance.

A small pilot bulb connected in series with the feeders can be used to indicate relative power output while adjustments are made.

It is advisable to use a plate current meter at all times. This allows a continuous check on power input and shows if unusual conditions occur, such as upward or downward modulation, sudden circuit changes, or improper loading.

FREQUENCY DETERMINATION

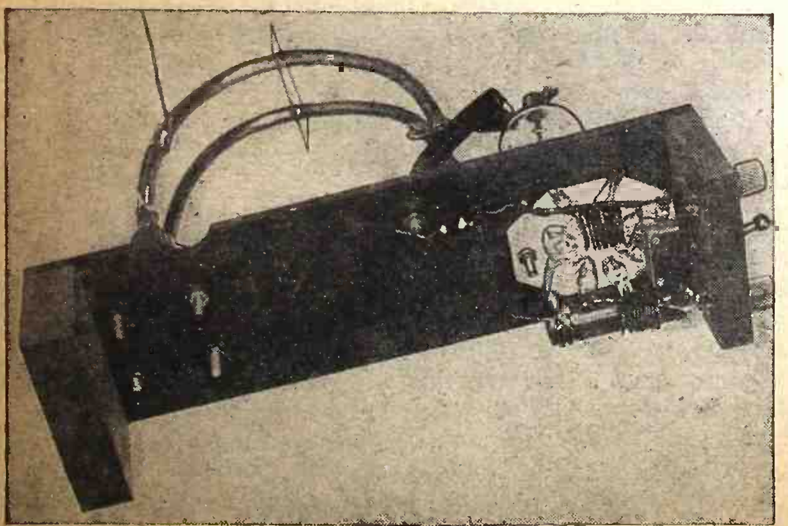
Exact frequency measurement is essential for any radio transmission service. Fortunately this is simplicity itself at very short wavelengths. We use a Lecher wire system constructed on a 7-foot length of 1x2-inch white pine. Bare wires, one-inch apart, are stretched the length of the baseboard.

At one end the wires are insulated by stand-offs and at the other end small turnbuckles (the ten-cent variety) are used to maintain tension. No insulation is needed at the latter end. A loop of wire made up of a total length of about 18 inches is connected to the insulated end for coupling to the transmitter.

First it is necessary to couple to the transmitter lines or tank a small loop of wire in series with a pilot bulb so that the bulb lights to reasonable brilliancy. Now the Lecher wires are coupled to the transmitter through the 18-inch loop.

A runner made of 1x2-inch wood with a metal shorting strip slides along the base board. As this portable shorting bar is moved along the wires a resonant point is reached where the pilot lamp becomes very dim and possibly goes out. This point is noted. The shorting bar is now moved out to the next resonant point. The distance between these two points determines the operating frequency (Fig. 4).

For convenience we have marked off the wooden base in foot lengths. Then it is only necessary to measure from a resonant point to the nearest mark and subtract or add as called for. The Lecher wire board may be screwed down to a table at each end while it is being used.



A bottom view of the transmitter unit. The chokes in the filament circuit may be seen at right, under the socket. Grid leak is just below.

True space ships travelling 3,000 miles per hour are all but practicable today, according to General H. H. Arnold, commander of the Army Air Forces. He believes that "research will unquestionably bring them into being within the foreseeable future."

Sixty per cent of all radios manufactured for the postwar market should include FM, it was revealed last month by Frank Mansfield, director of sales research for Sylvania Electric Products. Basing his figures on a survey just completed by his staff, he stated that out of a potential market of 17,400,000 receivers, 10,700,000 prospective owners wanted FM.

Prospects were willing to pay enough above the cost of an AM unit to assure their getting a true high-fidelity type of FM set. Of those queried, 56% stated they would pay $100 to $150 extra for a good FM receiver; 27% would add $30 to $50; and 13% were undetermined.

COMMUNICATIONS

WE CAN LEARN A LITTLE FROM THE PAST

Dear Editor:

In the minds of the general public, the words radio, television, and to some extent FM, and the ideas they convey, are more or less fixed and clear. How many of these people, though, have ever heard of a crystal set? How many of those who have heard of a crystal receiver, know what it will do or what its limitations are?

Often, in the course of my daily rounds, I take along a little crystal unit complete with an eight-inch magnetic speaker. I ask the householders if they ever saw a crystal set, and most of them reply: "A crystal set? What's that?"

Then, after I demonstrate the set to them, using their antenna, they all marvel and express amazement that such a simple thing, without tubes, without batteries, without current, can do so much. The usual response is:

"Amazing!" or "It's unbelievable" or "When was this invented, and how soon will I be able to get one of these gadgets?"

It is hard to believe that people who have been using radios for twenty years, do not know what a crystal set is, but that's been my experience. It brings to mind the thought that while people are being educated to the many good NEW things, it might be a good idea to educate or "re-educate" them to some of the many good OLD things that have gone by the board. This is an age of "new gadgets" and I have never succeeded in evoking much interest in crystal sets until I have set up my little pip-squeak radio and shown them what the results were.

JOSEPH D. AMOROSE
Richmond, Va.

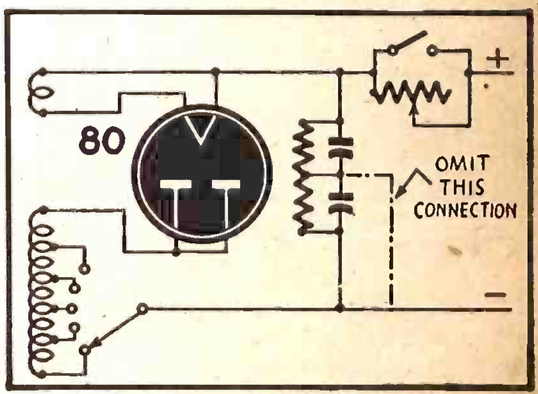
ERROR IN 10-TUBE TEST PANEL DRAWING

Dear Editor:

Regarding my article "A Combination 10 Test Panel" printed in the October issue of *Radio-Craft*, I would like to advise you of an error that I made in the drawing of the blueprint pertaining to units No. 8 and 9. I would appreciate it very much if you could spare a little space in your valuable magazine to print this correction.

CHARLES H. McELROY,
Los Angeles, Calif.

The correction is shown in the drawing which appears in the right-hand column opposite.—*Editor*



THIS READER JUST DOESN'T BELIEVE US!

Dear Editor:

I have just found time to read your editorial in the November issue of *Radio-Craft*. I am a disabled veteran of World War II and back in the radio business. In your editorial, you seem to think that all a veteran needs will be fulfilled by a neat letterhead. I am afraid you do not grasp our problems at all. First, the printers take care of their old customers first and take as long as a month to print our material. Second, a typewriter has been almost impossible to get. Third, ALL the distributors and manufacturers give us the runaround. They are catering to their old big customers. They don't give a damn if we are veterans and did not have a chance to build up our business during the war to double and triple prewar levels.

The veterans are the poor slobs that went out to win the war while all the draft dodgers stayed home and built up a big business. Now that we are back and have to start from scratch, we get promises of everything, but when you go to see a distributor, they are either out or they frankly tell you that they have already signed up all the dealers they intend to. How the hell will a letterhead cure the selfishness of these people?

Let's see you put this in an editorial (without finding excuses for your advertisers).

ROBERT RUBANE
Rubane Radio Service
Baltimore, Maryland

(*Radio-Craft* has made it a point, since 1929, never to excuse anyone, whether reader or advertiser if the truth was at stake. The above letter is printed to point out that frequently men fail because they do not put enough effort behind their work. World War II could not have been won if the generals, officers, and GI's had not had sufficient resourcefulness to overcome *all* obstacles.

While some printers take care only of their old customers, we visited at random two printing shops in busy New York, which we had never seen before. Our identity unknown, we had little trouble to get a quotation. Delivery of letterheads was promised in one week, if we wanted them. *Typewriters can be obtained.* Second-hand machines, reconditioned ones, are available in most cities, or can be rented if necessary. It is true that distributors and manufacturers frequently do give runarounds. This is a country-wide condition, much of which will be rectified by the time this letter appears in print.

If veterans present their case in a business-like manner, they are more likely to be taken care of *if there is merchandise to be had.* It is no doubt true that some manufacturers have signed up all the dealers they need—we doubt that *all* of them have done so. The very real difficulties pointed out in the letter above are all the more reason why the serviceman must make a business-like approach. These difficulties can and must be surmounted—there is no reason why you should add further handicaps to those that already exist.—*Editor)*

THIS RADIOMAN WANTS 'EM HARD TO FIX

Dear Editor:

Having come across a copy of *Radio-Craft,* August issue, I was struck by the childish attitude some "service engineers" adopt towards their chosen profession. According to them, coils, resistors, and condensers, etc., ought to have indicators to show whether they are faulty or not; then the engineer checking such a set just looks at a dial, removes the faulty component, and plugs in a new one. Do you call this repairing a radio?

Why do these people call themselves engineers, if all they have to do is read a dial and remove a plug in a new part? What are analyzers, oscillators, etc., for? If they don't know how to use these instruments, let them chuck the radio trade and do something where brains aren't needed. If these people want to earn money, they'll have to use their heads, and they should remember that "there's nowt for nowt in this world."

O. NEUMANN
London, England

(Strangely enough, industrial electricity and commercial communications do just what our correspondent objects to. There is a growing trend toward fuses that indicate when they are blown out, and components that are "repaired" by simply removing the whole unit and installing a new one.—*Editor)*

WORLD-WIDE STATION LIST

(Continued from page 344)

San Francisco Calif.	KNBX	7.805	Oriental beam, 5 to 11 am
San Francisco Calif.	KNBX	9.490	Oriental beam, 11:15 am to 3:30 pm
San Francisco Calif.	KNBI	9.490	Oriental beam, midnight to 3:45 am; Hawaiian beam, 4 to 9:45 am
San Francisco Calif.	KGEI	9.550	East Indies beam, 4 to 10:45 am; Alaska beam, 11 am to 12:45 pm
San Francisco Calif.	KWID	9.570	Oriental beam, 11:15 am to 1 pm; South American beam, 7:45 to 11:15 pm; Alaska beam, 11:30 pm to 1:45 am
San Francisco Calif.	KWIX	9.570	Oriental beam, 2 to 11 am
San Francisco Calif.	KCBF	9.700	Oriental beam, 1 to 4:45 pm
San Francisco Calif.	KWID	9.855	South Pacific beam, 2:30 to 6:30 am
San Francisco Calif.	KGEX	11.730	Southwest Pacific beam, 2 to 4:45 am
San Francisco Calif.	KGEI	11.730	Southwest Pacific beam, 1 to 4:45 pm
San Francisco Calif.	KCBA	11.770	South American beam, 11 pm to 1 am; 5 to 10:45 pm; Oriental beam, 1 to 4:45 pm
San Francisco Calif.	KNBA	11.790	Philippine beam, midnight to 3:45 am; South American beam, 5 to 11:45 pm
San Francisco Calif.	KWIX	11.890	Hawaiian beam, 4 pm to midnight; 12:15 to 1:45 am
San Francisco Calif.	KCBR	13.050	Oriental beam, 10:15 pm to 1 am
San Francisco Calif.	KGEI	15.130	Alaska - Oriental beam, 5 to 7:45 pm; Southwest Pacific beam, 8 pm to midnight
San Francisco Calif.	KNBX	15.150	Oriental beam, 9 to 11:45 pm
San Francisco Calif.	KGEX	15.210	Philippine beam, 4 pm to 1:45 am
San Francisco Calif.	KNBX	15.240	Oriental beam, 3:45 to 8:45 pm
San Francisco Calif.	KNBI	15.340	South American beam, 5 to 11:45 pm; Oriental beam, 2 to 4:45 pm
San Francisco Calif.	KWID	17.760	South American beam, 5 to 7:30 pm
San Francisco Calif.	KNBA	17.780	South Pacific beam, 2 to 4:45 pm
Schenectady New York	WGEO	9.530	South American beam, 5 to 11 pm
Schenectady New York	WGEA	11.847	European beam, 6 am to 3:45 pm; Brazilian beam, 4 to 10:30 pm
Schenectady New York	WGEQ	15.330	European beam, 6 am to 4:30 pm
Washington D.C.	WWV	2.500	U.S. Bureau of Standards; 6 pm to 8 am
Washington D.C.	WWV	5.000	U.S. Bureau of Standards; frequency, time and musical pitch; continuous day and night
Washington D.C.	WWV	10.000	U.S. Bureau of Standards; frequency, time and musical pitch; continuous day and night
Washington D.C.	WWV	15.000	U.S. Bureau of Standards; frequency, time and musical pitch; continuous day and night
U.S.S.R.			
Moscow		5.440	8 am to 6 pm
Moscow		5.815	11 am to 6 pm
Moscow		5.960	11 am to 6 pm
Moscow		6.028	5:45 to 9:30 pm
Moscow		6.230	noon to 6:25 pm; 7 to 9:45 pm
Moscow		6.230	noon to 6:25 pm; 7 to 9:45 pm
Moscow		6.980	5:45 to 6:25 pm; 7 to 9 pm; 11:15 to 11:45 pm
Moscow		7.300	noon to 5 pm; 6:15 to 11:30 pm
Moscow		9.480	6 to 8 am; 11 to 11:30 am; midnight to 1 am
Moscow		9.650	4:30 to 9:15 pm
Moscow		9.715	6:30 to 7:30 am
Moscow		10.450	midnight to 2 am; 9:30 to 10 am
Moscow		11.780	9 to 10 am
Moscow		11.830	10 pm to 2 am; 6 to 8 am; 11 to 11:30 am; 6 to 7 pm
Moscow		11.885	6:45 to 8 am; 6:30 to 7:30 pm
Moscow		12.080	8 to 11 am
Moscow		12.175	6:45 to 7:45 am; 8:30 to 10:30 am; noon to 1 pm; 7 pm to 1 am
Moscow		12.265	4 to 5:30 pm; 8 to 9:30 pm; 10 pm to 6 am; 7 am to 1 pm
Moscow		15.320	5 to 11:30 am
Moscow		15.340	5:30 to 9:30 am
		15.230	5:45 to 6:25 pm; 6:45 to 8:15 am; 3 to 3:45 pm
URUGUAY			
Montevideo	CXA6	9.623	3:30 to 8 pm
Montevideo	CXA15	9.735	
Montevideo	CXA19	11.705	7 to 8 pm
Montevideo	CXA19	11.835	6 am to 10 pm
Montevideo	CXA10	11.900	3:30 to 9 pm
VATICAN CITY			
	HVJ	5.968	11 am to noon; 1 to 3 pm
	HVJ	9.660	noon to 1:30 pm; 1:45 to 2:30 pm
	HVJ	11.740	noon to 1 pm
	HVJ	15.120	Wednesdays, midnight to 12:30 am
	HVJ	17.445	Wednesdays and Saturdays, 8:45 to 9:15 am
VENEZUELA			
Trujillo	YV1RO	3.310	5 to 9:30 pm
Maracaibo	YV1RT	3.370	5:30 to 10:30 pm
Caracas	YV5RY	3.380	9:30 am to 10:30 pm
Maracay	YV4RK	3.390	6 to 10:30 pm
Merida	YV2RC	3.420	6 to 9:30 pm
Maracaibo	YV1RV	3.440	7 to 9:30 pm
Barquisimeto	YV3RS	3.490	4:30 to 9:30 pm
Barquisimeto	YV6RC	3.510	6 to 9:30 pm
Caracas	YV5RS	3.530	5:30 am to 10:30 pm
Maracaibo	YV1RV	4.750	6 to 9:30 pm
La Guaira	YV5RV	4.760	5 to 9:30 pm
Coro	YV1RY	4.770	4 to 10 pm
Valencia	YV4RO	4.780	4:30 to 9:30 pm
Maracaibo	YV1RL	4.810	6:30 am to 11 pm
Volera	YV1RZ	4.840	4:30 to 9:45 pm
Barquisimeto	YV3RN	4.990	6:30 am to 10:30 pm
Ciudad Bolivar	YV6RD	6.200	5 to 9:30 pm
Caracas	YV5RW	3.400	5:30 am to 10.30 pm
Caracas	YV5RX	3.500	6:30 am to 10:30 pm
Caracas	YV5RM	4.890	5:30 to 10:30 pm
Caracas	YV5RN	4.920	6 am to 10:30 pm
Puerto Caballo	YV4RQ	3.480	5 to 9:30 pm
San Christobal	YV2RN	4.830	11 am to 9 pm
Valencia	YV4RP	3.460	8 to 9:30 pm
YUGOSLOVIA			
Belgrade		6.150	1 to 6 pm
Cetinje		9.360	1:30 to 3 pm
Belgrade		9.420	midnight to 2 am; 10 to 10:45 am

INDEX TO ADVERTISERS

RADIO SCHOOL DIRECTORY
(See Page 368)
American Radio Institute
Candler System
Commercial Radio Institute
Lincoln Engineering School
Melville Radio School
RCA Institutes, Inc.
Western Radio Institute
YMCA

Latest claimant for the title of "America's oldest broadcast station (until now in dispute between KDKA and WWJ) is KQW, San Jose, California. According to evidence submitted by the present station manager, KQW, established in 1909 by Dr. Charles D. Herrold, began broadcasting on a regular schedule in 1912.

The pioneer station has been consistently on the air since then, with the exception of the time it was compelled to remain closed during the first World War.

SWISS RADIO RENTAL

(Continued from page 312)

pairs. However, the majority are leased to subscribers desiring a low-cost lease service.

The used-set subscriber makes a down payment of about $5.75. His total monthly rental fee is about $1.40. There is no insurance and repair fee. If the subscriber breaks the contract on one month's notice he is given a credit note for rent paid minus $11.50 which he can use toward the purchase of a new set from Steiner. This plan is attractive to a customer and at the same time guarantees the firm at least $17.75 to cover the cost of the exchange, in addition to the profit on the sale of a new set.

Another service is offered by the firm for those who already own a receiver and don't wish to trade it in. This is called a *Tube and Repair Subscription* service. The subscriber signs a 20-month contract and pays about $1.40 a month. In return Steiner keeps his set in repair and replaces necessary parts and tubes at no extra cost. The unusual feature of the plan is this: Over a 20-month period the customer will have paid a total of about $27.60. Against this is charged $11.50 for repairs made during the period. The remaining $16 paid in is given back to the subscriber in the form of a credit which can be applied to the purchase of a new set from the firm. The customer participates in a savings plan and the firm is assured a new set sale. Over 20,000 subscribers participate in this plan.

Before the war all repair work in outlying regions was done by a small fleet of well-equipped mobile repair shops. Each of these glass-panelled repair trucks carried a crew of three repairmen and seven salesmen.

Radio Steiner is now going ahead with its postwar plans which include the introduction of television to Swiss audiences. The company plans to purchase a television transmitter and 50 receivers for demonstration purposes. The transmitter will be installed in one of the mobile repair trucks. The other repair trucks will be converted to a television demonstration caravan.

BOOK REVIEWS

ELECTRICAL MEASURING INSTRUMENTS, Measurement and Surveys, by E. S. Lincoln, Consulting Engineer, Fellow A.I.E.E. Published by Essential Books. Stiff cloth covers, 5½ x 8½ inches, 284 pages. Price $3.00.

This book deals with electric systems and electrical surveys as well as with electrical measuring instruments. Since the whole electric field is covered, only one chapter is of direct interest to the radioman—that on portable instruments.

All types of industrial measuring instruments are covered, including power factor meters, wattmeters and various types of recording meters. Useful information on connections to various types of meters, on accuracy, damping, scales, etc., is also included.

THE ELECTROLYTIC CAPACITOR, by Alexander M. Georgiev. Published by Murray-Hill Books, Inc. Stiff cloth covers, 6 x 9½ inches, 191 pages, Price $3.00.

A thoroughly modern book on the subject. The author's approach is from the industrial point of view, and much of his space is devoted to discussion of electrolytic capacitor design and manufacturing processes.

Four chapters discuss electrodes and electrolyte from both the theoretical and practical viewpoints. Discussion of the dielectric film is divided into two chapters—one theoretical and one practical. Such subjects as spacers, impregnation of dry and liquid capacitors, the container and its vent, measurements, routine and special tests and the causes and detection of troubles in electrolytic capacitors, are discussed.

Advantages and disadvantages of electrolytic in comparison with non-electrolytic capacitors, and of dry versus wet capacitors, are given a chapter each. Another is devoted to semi-electrolytic capacitors (types with a dry electrolyte which permits greatly increased working voltages at the expense of very high internal resistance).

Design also receives a chapter, and the one following it, "Trends in the Development of Electrolytic Capacitors," indicates possible future improvements.

TRANSMISSION LINES, ANTENNAS AND WAVE GUIDES, by Alexander H. Wing, Lecturer on Electronics, Harvard University; Ronold W. P. King and Harry Rowe Mimno, Associate Professors of Physics and Communication Engineering, Harvard University. Published by McGraw-Hill Book Co. Stiff cloth covers, 6 x 9 inches, 347 pages. Price $3.50.

The section on transmission lines, which occupies seventy pages, is possibly the most interesting part of the book. A combination of mathematical treatment and physical application is used, equations and schematic drawings often appearing together in the text. Such items as standing-wave ratios, impedance matching by various methods, measurements, efficiency and harmonic suppression are covered with great thoroughness in a mathematical manner.

The section on antennas also combines the physical and mathematical approach. Electromagnetic theory is considered from the viewpoint of retarded action and special divisions are made for the "near zone" (where action may be considered instantaneous) and "far zone" in which the antenna is considered as being coupled to the universe as a whole.

Wave guides are dealt with in the section headed, "Ultra-High-Frequency Circuits," and are treated in standard fashion. A further section covers wave propagation, treatment of this subject also being standard.

A number of problems based on the work of the first three chapters appears at the back of the book.

SCIENCE YEAR BOOK OF 1945, edited and with an introduction by John D. Ratcliff. Published by Doubleday, Doran & Company, Inc. Stiff cloth covers, 5½ x 8 inches, 224 pages. Price $2.50.

This fourth annual edition is a compilation of the twenty-eight best science articles published during the past year. The articles are culled from national magazines and were chosen for their readability and reliability as well as for their interest to the greatest number of people. The entire volume is divided into four parts, covering the most beneficial discoveries and developments in the fields of medicine, physics, chemistry, aviation, electronics and other fields of science.

One article of particular interest to radiomen and radio technicians is "Electrons in Medicine," which describes such electro-medicinal aids as the pygmy phototube earring worn by pilots as an automatic oxygen control, and which measures the change in capacity in the ear lobe, turning on and shutting off the oxygen supply automatically; an electronic surgical knife which, while it cuts, sterilizes and coagulates the blood and seals the capillaries to prevent bleeding; a new type of metal detector for locating steel splinters in a person's eye; a balloon-equipped device that is lowered into the stomach to determine the presence and position of ulcers; and cyclotron treatments by which simple salts are activated to give them the properties of radium.

The chapter, "The Electron in Industry," is from an article by Waldemar Kaempfert in *The New York Times Magazine*, "Electrons in Medicine" from one by A. G. Mererik in *Hygeia*.

J. R. Poppele, chief engineer of WOR, New York, was re-elected president of Television Broadcasters Association at their annual meeting of the Board of Directors in New York.

All the other officers of the organization were also re-elected, as follows: Vice-President, F. J. Bingley, Philco Radio & Television Corp.; Secretary-Treasurer, Will Baltin, Assistant Secretary-Treasurer, O. B. Hanson, NBC. Ernest H. Vogel, Farnsworth Television & Radio Corp., was elected a director of TBA to succeed Lewis Allen Weiss, Don Lee Broadcasting System. Mr. Poppele and G. Emerson Markham, General Electric Co., were re-elected as directors.

RADIO SCHOOL DIRECTORY

PREPARE NOW FOR SKILLED JOBS IN RADIO AND ELECTRONICS

MAKE a place for yourself in a new world of radio and electronics—a world in which revolutionary electronic developments will require highly specialized technical knowledge. Take a good course now to fit yourself for a good paying job. The training you need can be supplied by one of the schools advertised in this publication.

TELEVISION RECORDING

(Continued from page 305)

consideration: when we speak of television recording we not only refer to video impulses alone, but to audio impulses as well.

Today, nearly all television broadcasts are made on a single channel. For instance, one station in New York City uses a video channel from 60-65.7: the audio band is 65.7-66. If a broadcast using such a channel is to be recorded it can be seen that the problem becomes more complex due to the great differences of frequencies between the audio and the video parts. Besides *both* must be recorded simultaneously.

Nevertheless, it can be accomplished if we use the circular film-disk, as mentioned above, or if recording can be done by magnetic means, say on a thin, narrow band of iron, then simultaneous video and audio recording becomes possible. (The Germans before the war had an interesting plastic film, impregnated with an exceedingly thin deposit of pure iron, for recording purposes.) If some electro-chemical means of recording can be developed, that also becomes a future possibility.

Some interesting possibilities of television recording become possible once the problem has been solved. We give but one example.

At the present time there is already on the market a machine now used in hospitals. This appliance is placed on the floor, or on a table; book pages are projected on the ceiling, enabling the patient to read a book without moving a hand, or moving a muscle. Once we have television recording it then becomes feasible to record the pages of an entire book and project them on your home television screen. As the pages are turned at the rate of 1¼ to 1½ minutes per page, you can then sit in front of your television receiver and read a book from your easy chair without the necessity of holding the volume and turning the pages. There is a real demand for appliances of this type.

RARER RADIO TROUBLES

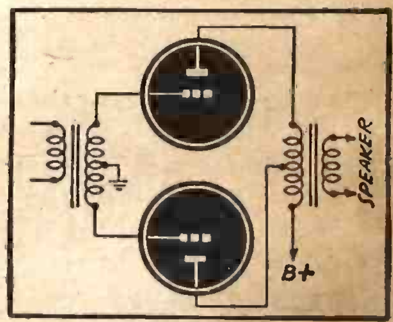
THE Philco 19 chassis often developes two troubles, especially when put in use after long disuse because of the radio shortage due to the war. These are a leakage in the 75-42 coupling condenser and decreased gain in the R.F. coil. The coupling condenser trouble can be easily overlooked since the grid may still be negative despite the leakage. This is a result of the fixed bias circuit which grounds the 42 cathode. The check must be made across the grid leak only, especially since bias increases with grid voltage, though not fast enough to prevent distortion. (As a result of this leakage the 42 usually becomes very weak and should of course be replaced also.) The 75 bias also increases, which causes added distortion (75 is also fixed-biased). The coupling condenser between volume control and 75 should be checked *after* the 75-42 coupling condenser is replaced.

The RF coil sometimes is open, sometimes still passes a little current, causing plate voltage to be low by 100 or more volts. Gain is then negligible, and the 1st stage actually attenuates even with 150 volts nominal plate supply.

On the Montgomery Ward 93WG603—I often find a hum of the sort caused by a shorted tube, but very elusive indeed. The trouble is caused by the pilot light socket developing leakage to chassis, which is off ground potential for A.C. It is originally mounted on a bakelite bracket, which breaks off, so that the metal frame is used directly as support. One may cure the trouble by replacing bracket or socket.

Also, on this set, the volume control is mounted "aloft," with a rubber twisted pair extending from switch. The rubber soon deteriorates and a short occurs from wire to wire, or wire to chassis, so that the owner is no longer Lord and Master of the "offs and ons" of his set. Customers remark on the quaint habit these sets develop of coming on during the night, with high volume since the volume contact is often back on the high volume side of the resistance when the switch is off, a situation of little consequence in the normal set.

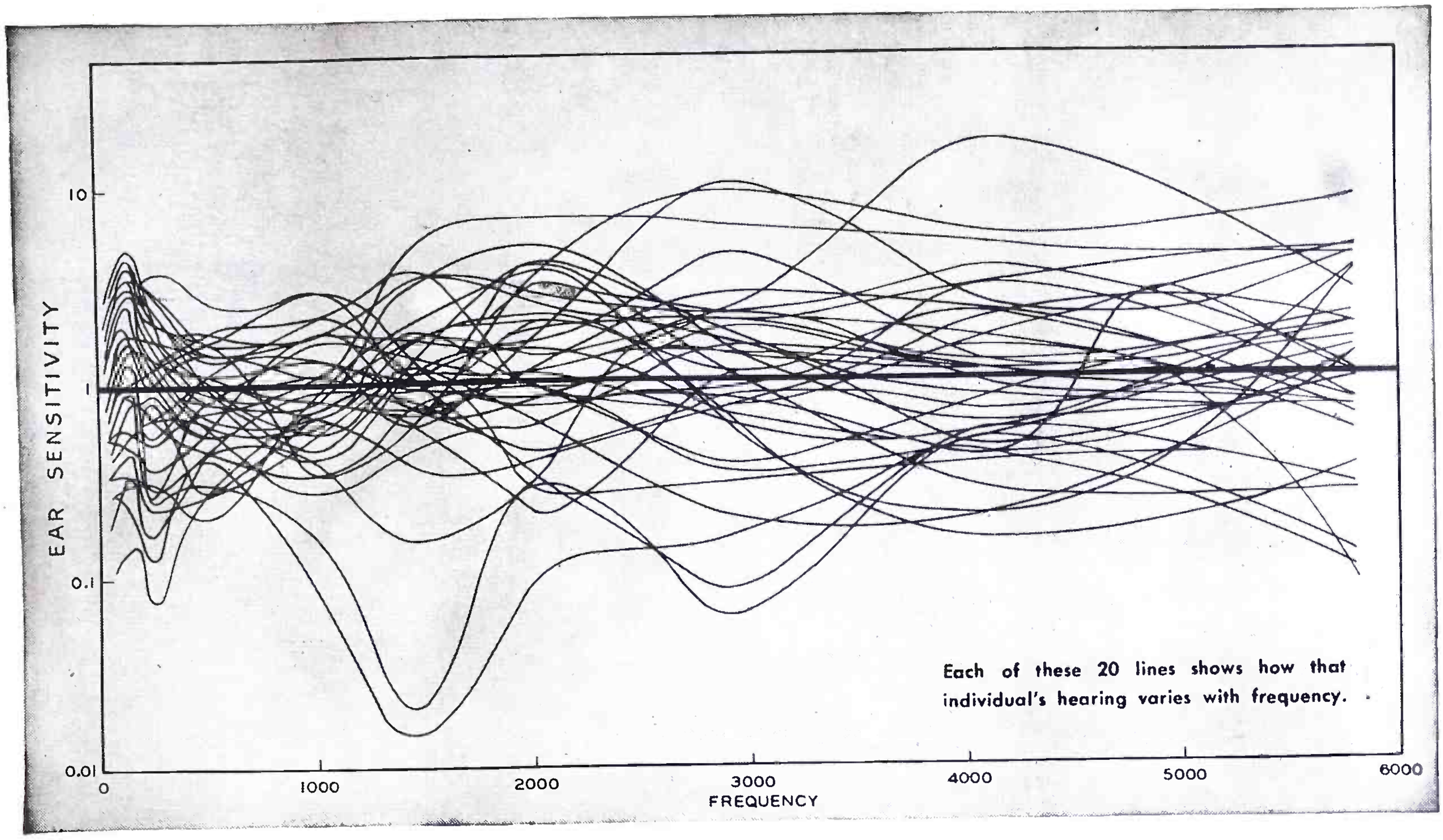
Here is a trouble I find occasionally on any model set with push-pull output. Distortion increases with volume, and disappears when either output tube is removed. The trouble is that the replacement output transformer is incorrectly connected, as shown in the figure.



The trouble could be traced no doubt to unusually coded outputs and faded coding on long cables from chassis to speaker. Also parts with unlabeled lugs may have been used with this slip resulting.

You can usually sell a couple of new tubes with the job, since only mismatched (usually from age) tubes sound at all good in the wrong connection.

RCA T-10-1 and similar sets have a metal cased coupling condenser which often shorts, diode-biasing the 6F5 to cutoff on strong signals on high volume settings. Due to high grid leak, this is almost impossible to check without a VTVM.



To measure is to know

Twenty-five years ago, one standard of sound power was the ticking of a watch, another was the clicking of two coins; and the measure was how far away the tick or the click could be heard. That test was made in measuring people's hearing, a field of interest to the Bell System scientists because the ear is the end-point of every talking circuit.

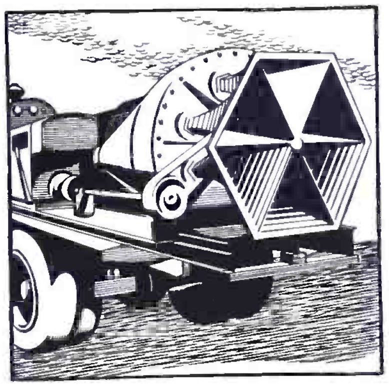
Accustomed to exact measurements, Bell scientists proceeded to develop a method of measuring hearing-sensitivity in terms which could be precisely defined and reproduced. After plotting hundreds of runs like those above, they decided on a particular sound intensity, representing an average "threshold of hearing," as a starting point.

The sounds delivered by a telephone line had previously been evaluated by listeners who compared their loudness with that of a standard source. There were wide variations in ears, as the chart shows, so the engineers replaced them by electrical instruments. When later their associates developed the Western Electric radio and public address systems, the necessary measuring circuits were promptly forthcoming. Addition of a standard microphone made a noise meter, widely used in quieting airplanes and automobiles.

"Through measurement to knowledge," said a famous Netherlands scientist. The principle finds wide application in Bell Laboratories, whether the quest be for a way to measure sound, a new kind of insulation, or more economical telephone service.

Hearing was first measured reliably by engineers in the Bell Telephone Laboratories

For good reception, program loudness must stay within certain limits. Volume-meters help to hold it there

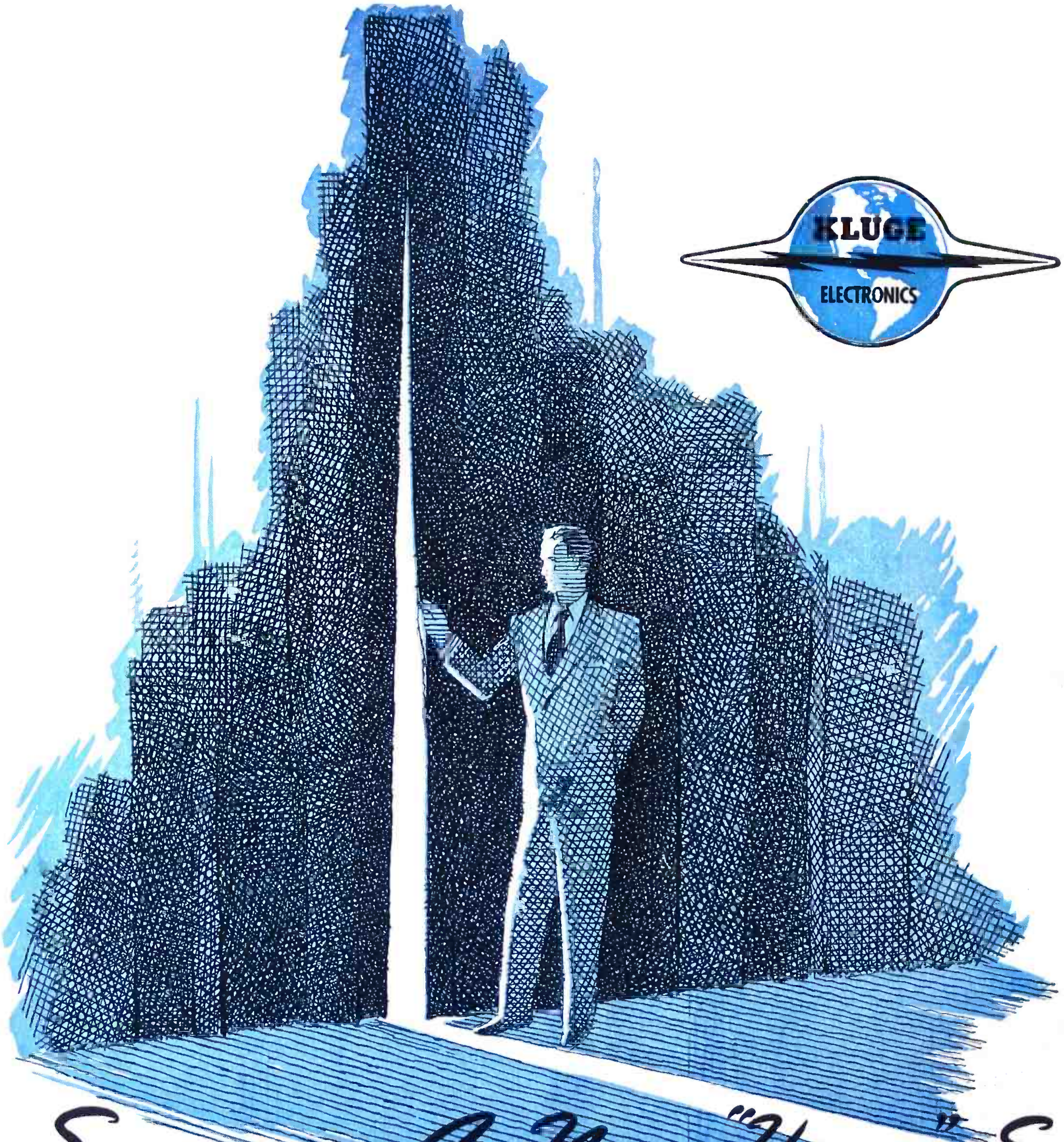


From the throat of this mighty air-raid siren comes the loudest sustained sound ever produced

Visible Speech, result of telephone research, turns sound into "pictures" that the deaf can read

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service



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The curtain is rising on a remarkable "new era" development for the "hams" and *potential* hams of the world! It's so logical . . . so ingenious, in its use of advanced electronics and ultra-modern principles of design that we have kept the secret for showings in *all parts of the country,* at the same time. Dealers will be ready soon. Don't miss their KLUGE "Premieres" . . . It won't be long!

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