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1934

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RADIO WORLD

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The First and Only National Radio Weekly

615th Consecutive Issue—Twelfth Year

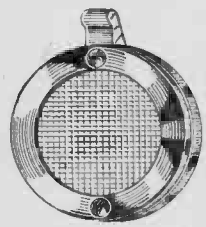
WHY TUBES OSCILLATE

(See page 6)

METAL-WORKING
LATHE

Precision equipment for the small shop. New designs and manufacturing processes make this amazing bargain possible. Complete metal-working lathe with compound slide-rest, combination face-plate and independent chuck and tail center: 6" swing: 24" length, 20 lbs. Send $1.00, Balance plus postage C.O.D. Lathe for wood-turning alone, $4. Attachments for milling, grinding, sanding, saw-table, etc., available at low prices. Order from ad at once and have a complete machine shop. American Machine & Tool Co., 200 Broadway, New York, Dept. R.8.

LAPEL MICROPHONE



A single-button carbon-granule lapel microphone, impedance 200 ohms, requiring 4.5-volt excitation, of good frequency characteristics, and both handy and inconspicuous. Outside diameter, 1⅝ inches. The case is chromium-plated brass. The excitation may be provided by introducing the microphone in a cathode circuit carrying around 20 to 25 milliamperes, or a 4.5-volt C biasing battery may be used. Net price, $2.95.

RELIABLE RADIO COMPANY
145 West 45th Street, New York, N. Y.

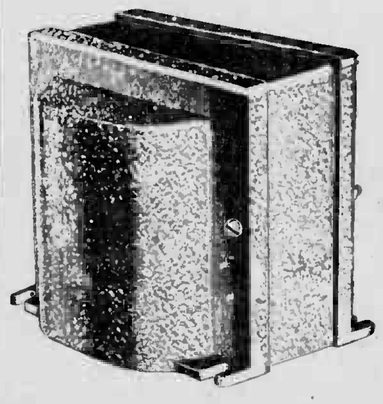
Beginner's Twin S. W. Receiver with Hammarlund Parts

Acclaimed by RADIO WORLD readers, who have purchased a "TWIN," as the finest short wave set to learn the mysteries of short waves. A letter to N.Y. Sun, May 20th, from one of our customers, states that he received stations in England, Germany, Italy, Africa, Geneva and Spain.

Economical—Uses two 2-volt 230 low current tubes.
KIT OF PARTS (blueprints, 4 coils, etc.) **7.95**
Wired, with 4 coils (15-200 meters) 8.95

RELIABLE RADIO CO., 145 W. 45th St., N. Y. City

Power Transformer for a BIG SET



INSTEAD of using undersized, overheating, inefficient power transformers for a big set, why not use a cool-running, efficient transformer and pay the little extra? The Reliable transformer, Model 104-SP, will work an 18-tube set. Provides for C bias supply through 25Z5 rectifier, for quality Class C or Class A.

Primary = 115 v., 60 cycles
Secondary X = 14 amp., 2½ v., ct.
Secondary Y = 6 amp., 2½ v., ct.
Secondary R = 5 v., ct.
Secondary HV = 400-0-400 v., 200 ma.
Secondary Z = 25 v., 0.6 ma.
Lug terminals at bottom
Price, $3.95
Shipping weight, 13 lbs.
Immediate Delivery

RELIABLE RADIO CO.
145 W. 45th St., New York, N. Y.

HENLEY'S "TWENTIETH CENTURY BOOK OF RECIPES, FORMULAS & PROCESSES." New 1933 Edition. Ten thousand processes, recipes, trade secrets and money-making formulas. For the laboratory, workshop, factory and home. Some subjects fully covered: Dyes, Inks, Waterproofing, Perfumes, Cement, Plating, Glass, Dentifrices, Varnishes, Soaps, Glues, Paints, Adhesives, Enamelling, Hairdressings, Cosmetics, Oils. Price, $4.00. Book Dept., Radio World, 145 W. 45th St., New York City.

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MACHINE WOUND COILS TO YOUR SPECIFICATIONS; reasonable prices; best materials. Box 82, San Clements, California.

RADIO SERVICEMAN, JUNIOR PARTNER WANTED. Reliable. Car desirable. No investment. Legitimate proposition. State qualifications, equipment, etc. Box 30, Radio World.

"AUTOMOBILE REFINISHING," by C. E. Packer, Member of S.A.E. For the car owner and professional refinisher. A practical handbook on the materials, methods and equipment used. 148 pages, 41 illustrations. Price $1.50. RADIO WORLD, 145 W. 45th St., New York City.

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Powertone Wallace Short Wave Receiver

The battery operated short-wave set which won the Hoover Cup for premier short-wave design and performance; well designed both electrically and mechanically. Built of the finest precision parts, each operating at maximum efficiency at all times; the Wallace has many features to recommend it to all interested in short-wave reception. Among these features are:

1. Band spread tuning for the crowded bands, controlled by a single panel switch. 2. Ultra Low-Loss coils wound with silver ribbon. 3. Each circuit individually controlled. 4. Highly efficient tuned antenna system. 5. Zero body capacity. 6. 15-200 meter tuning range.

The set is for earphone operation, using two 230 tubes, which require a 2-volt filament supply and 45-90 volts of "B" battery.

The receiver uses four plug-in coils whose tuning ranges are:
No. 1. coil—20-32 meters No. 3. coil—75-150 meters
No. 2. coil—40-60 meters No. 4. coil—150-200 meters

Complete kit of parts, with one coil $14.70
Each additional coil 1.18
Wiring and testing (if desired) extra 3.23

Guaranty Radio Goods Co., 145 W. 45th St., New York, N. Y.

PADDING CONDENSERS

Either capacity, 50c

A HIGH-CLASS padding condenser is required for a superheterodyne's oscillator, one that will hold its capacity setting and will not introduce losses in the circuit, for losses create frequency instability. The Hammarlund padding condensers are of single-condenser construction on Isolantite base, with set-screw easily accessible, and non-stripping thread. For 175 kc. intermediate frequency use the 850-1350 mmfd. model. For i.-f. from 460 to 365 kc., use the 350-450 mmfd.

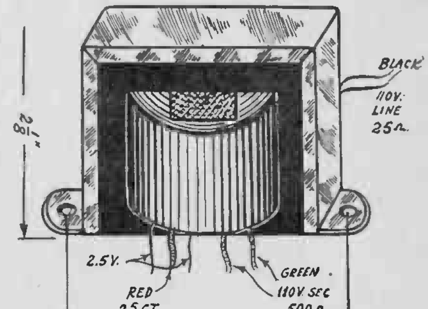
0.0005 HAMMARLUND S. F. L. at 59c.

A sturdy, precision straight frequency line condenser, no end stops. The removable shaft protrudes front and rear and permits ganging with coupling device, also use of clockwise or anti-clockwise dials, or two either side of drum dial. Front panel and chassis-top mounting facilities. True straight line. This rugged condenser has Hammarlund's high quality workmanship and is suitable for precision work. It is a most excellent condenser for calibrated radio frequency test oscillators, any frequency region, 100 to 60,000 kc., short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction, rigidity; Hammarlund's perfection throughout.

Order Cat. HO5 @ .... 59c net

Reliable Radio Co., 143 West 45th Street, New York, N. Y.

SPECIAL
SMALL POWER TRANSFORMER



Filament-plate transformer, for oscillators, 1 or 2-tube sets, etc.
Primary, 110 volts a-c.
Secondary A, 2.5 volts, center-tapped; stands up to 3 amperes.
Secondary B, 110 volts, not center-tapped.
Excellent for test oscillators with a-c in plate.

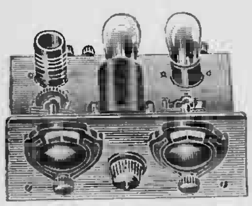
Price, $1.10
RADIO WORLD
145 West 45th Street New York, N. Y.

Introducing - - -

NEW 1934 DIAMOND of the AIR

A-C OPERATED SHORT-WAVE RECEIVERS

12,500-Mile Reception

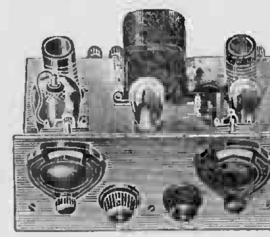


2-TUBE

Introducing the latest in short-wave receivers. The "Diamond of the Air" 2- and 3-tube battery receivers for many months have been acclaimed by owners to be the most remarkable short-wave receivers in their class. Now, for the first time, Reliable Radio Company introduces the 1934 A-C SHORT-WAVE "DIAMOND"—incorporating all the features of the battery-operated sets plus the convenience of a-c operation. The receivers have to be powered additionally and the power pack quotations will be found on this page.

IMPROVED RECEPTIVE QUALITIES

All 1934 features have been incorporated in the new "Diamond of the Air" a-c short-wave receiver and, besides, the popular battery-operated models have been improved in a new 1934 design. The lowest in price, yet these sets will log stations from all parts of the world regularly.



3-TUBE

The A-C "Diamond of the Air" Receivers

The a-c receivers have been developed for those who have the benefit of electric service. They use the latest type triple-grid tubes, resulting in more selective and sensitive reception.

The 2-tube model employs a 57 tube, resistance coupled to a 56 type output tube. For those desiring to use this receiver on batteries, simply replace the 57 type tube with a 77 and the 56 tube with a 37, for heater excitation from a 6-volt storage battery and use B batteries for plates. Loudspeaker reception on all local and many distant stations.

The 3-tube a-c receiver uses a 58 as an r-f amplifier, followed by a 57 detector and a 56 as an output tube. This receiver can be used on batteries by using 77, 78 and 37 tubes as detailed above. Capable of logging stations from all parts of the world.

Employs the Highest-Grade Materials

A receiver is only as good as the parts used in its construction. Only the finest parts are included. **Hammarlund** condensers, representing the finest, are used. The metal panel eliminates body capacity.

DIAMOND OF THE AIR

Battery-Operated Short-Wave Receivers

The battery-operated receivers employ the 2-volt low-current tubes, saving considerable expense to those living in districts where no a-c is available.

The two-tube model uses two 30 tubes. Especially designed for headphone reception, although loudspeaker reception may be obtained at ordinary room volume.

The 3-tube two-volt model employs one 34 and two 30 tubes. It will receive short-wave stations from all parts of the globe on a loudspeaker.

Electric Models

Cat. No. 5025-D. Two-tube A-C kit, with blueprint. Shipping weight, 5 lbs. $8.45

Cat. No. 5026-D. Above, wired and tested. Shipping weight, 5 lbs..... 9.45

Cat. No. 5027-D. Complete set of tubes for above, either one 57 and one 56 for a-c operation or one 77 and one 37 for battery operation. Specify which. Shipping weight, 2 lbs.......... 1.45

Cat. No. 5028-D. Three-tube a-c kit, with blueprint. Shipping weight, 7 lbs. 11.45

Cat. No. 5029-D. Above, wired and tested. Shipping weight, 7 lbs..... 13.45

Cat. No. 5030-D. Complete set of tubes, either one 58, one 57 and one 56 for a-c operation or one 78, one 77 and one 37 for battery operation. Specify which 2.45

Two-Volt Battery Models

Cat. No. 5019-D. Two-tube kit, with blueprint, less accessories listed below. Shipping weight, 5 lbs.......... $7.75

Cat. No. 5020-D. Above, wired and tested, less accessories listed below. Shipping weight, 5 lbs.......... 8.75

Cat. No. 5021-D. Complete accessories including two 230 tubes, one set of standard headphones, two No. 6 dry cells, two standard 45-volt B batteries. Shipping weight, 22 lbs.......... 4.50

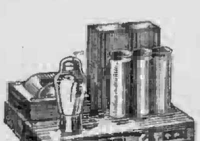
Cat. No. 5022-D. Three-tube kit, with blueprint, less accessories listed below. Shipping weight, 7 lbs.......... 9.95

Cat. No. 5023-D. Above, wired and tested, less accessories listed below. Shipping weight, 7 lbs.......... 10.95

Cat. No. 5024-D. Complete accessories, including two 30 tubes and one 34 tube, one set of standard headphones, two No. 6 dry cells, three standard 45-volt B batteries, one 6-inch magnetic speaker. Shipping weight, 32 lbs.......... 8.95

DIAMOND of the AIR SHORT-WAVE

POWER PACK



Supplies clear hum-free power regardless of circuit sensitivity. Especially designed for use with the "Diamond of the Air" Short-Wave receivers, but can be used on any short-wave battery-operated receiver for B supply.

Contains a brute-force filter, employing two heavy-duty 30-henry chokes, specially-designed power transformer, and three electrolytic condensers. These factors assure pure d.c.

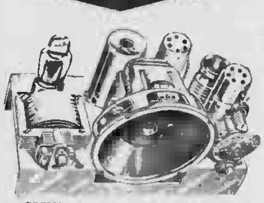
Will deliver 180 volts. Supply your own taps. 135, 90 and 45 volts. Supplies 2½ volts at 10 amperes for filament drain. All taps terminate at binding posts on the side of the pack. Employs an 80 rectifier. Will stand up to 75 ma. drain for B current.

All parts are mounted on a sturdy metal base finished in silver.

Cat. DAPP. Price, including 80 tube $5.95

Shipping Weight, 20 Lbs.

Reliable



Four-Tube A-C Short-Wave Receiver with Built-In Speaker

Will tune in short-wave stations from all parts of the world with ease. Uses four plug-in coils to cover the entire short-wave band from 15 to 200 meters. The built-in power supply is entirely free from hum or disturbing line noises. Uses an ultra-sensitive dynamic speaker which aids in tuning in the weaker signals.

Cat. 4TK. Kit of Parts, less cabinet, less tubes **$11.50**

Cat. 4TW. Above, completely wired and tested.......... **$13.75**

Cat. 4TCB. Cabinet only...**$1.50** extra

Cat. 4TTU. Complete set of licensed tubes.......... **$2.50** extra

Reliable Radio Company

145 West 45th Street
NEW YORK CITY

POWERTONE SHORT WAVE WORLD RECEIVER AC DC RECEIVERS

For A-C and D-C Operation

Will work anywhere that 110 volt A-C or D-C is available. U. S. amateur reception is assured on loudspeaker by the use of a 43 power tube in the output.

With headphones the entire world is at your finger-tips. Chassis is completely encased in a beautiful crystal finished cabinet. Covers the short wave, band from 15-200 meters. Uses one 78, one 25Z5 and one 43 tube.

Price Kit..........$8.95

Wired.....$2.00 extra. Tubes......$3.25

FREE

HANDY SERVICEMEN'S

MANUAL

WITH EACH PURCHASE OF A SHORT-WAVE RECEIVER

ALL SHIPMENTS MADE EXPRESS COLLECT UNLESS OTHERWISE DIRECTED BY PURCHASER

Roland Burke Hennessy
Editor

Herman Bernard
Managing Editor

RADIO WORLD
REG. U.S. PAT. OFF.

The First and Only National Radio Weekly
TWELFTH YEAR

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Technical Editor

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Advertising Manager

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AN ELECTRON-COUPLED TEST OSCILLATOR

CONSTANT MODULATION, CONSTANT-IMPEDANCE ATTENUATION, CONSTANT COUPLING AND UNIVERSAL OPERATION

By Herman Bernard

A SIMPLE test oscillator, that works on a. c., d. c., or batteries, has electron output coupling, and attenuator, is constantly modulated, and shielded, is diagramed herewith.

Assuming a tuning condenser rated at 0.00035 mfd., for a fundamental frequency coverage of 130 to 400 kc., the intermediate frequencies will be taken care of, except from 400 to 500 kc, which can be accommodated by second harmonics in the region between 200 and 250 kc, while the broadcast band is covered by the fourth harmonic, 520 to 1,600 kc.

The inductance has to be selected for the low-frequency extreme, and 4 millihenries will be required. The coil can be wound on a ⅜-inch dowel with No. 30 enamel wire, by providing circular end pieces to hold in the winding. The number of turns is a little in excess of 500. The tickler need have only enough turns on another similar bobbin to insure oscillation, and this number depends somewhat on the closeness of coupling between the two inductances.

Recording Two Points

By using a broadcast receiver the coil can be tested. If one has a local station on 540 kc, as in Canada, a beat would be struck with that and the oscillator for 135 kc fundamental (fourth harmonic being 540 kc), at about 92 on the oscillator dial, if dial numbers increase with capacity (increase as frequency decreases). Also, 570 kc should strike a beat at about 82. Somewhere between any one of the other frequencies can be similarly located and by turning the oscillator dial to a much lower number the fifth harmonic registered, so for these low-frequency stations two points are recorded.

The object is to get your bearings, but the foregoing preliminary information enables you to do that. The method implies that a broadcast receiver be used, with antenna connected to it, and output of the oscillator consisting of a wire with no shield around the part coupled loosely to the antenna, as perhaps by wrapping two or three turns around the leadin near the set. Or unshielded wire may be added to the outlead for this coupling purpose.

Familiarity with the frequencies of local and semi-distant stations, in connection with the receiver tuning, will enable you to locate sufficient other frequencies. After you have a distribution of a dozen or more points, plotting paper may be used, and the missing frequencies identified by extrapolation.

Why Leads Are Shielded

Aside from the calibration purpose that requires part of the output wire lead to be unshielded, both the a-c cable and the output leads should be shielded and shield grounded, to prevent these wires from acting as transmitting aerials. Unless this prevention is accomplished the attenuation control does not work more than feebly.

The total oscillator should be contained in a metal box and the oscillator proper should be insulated from the box. This would require an insulating panel for the dial and tuning condenser, for the condenser is not directly grounded. In fact, its rotor is connected to the line, but this point is not within reach in the completed instrument.

A copper foil backing should be cemented to the insulated panel, and oversized holes drilled so that there will be positively no danger of contact of condenser with the metal box, since the box is independently grounded, and unless this insulation precaution is taken the fuse may be blown.

Grounding the Box

At one point on the metal box any paint or other finish should be cleared so that connection is made between the copper foil and the box so the conductive ground post makes the desired contact, both to foil and shield box.

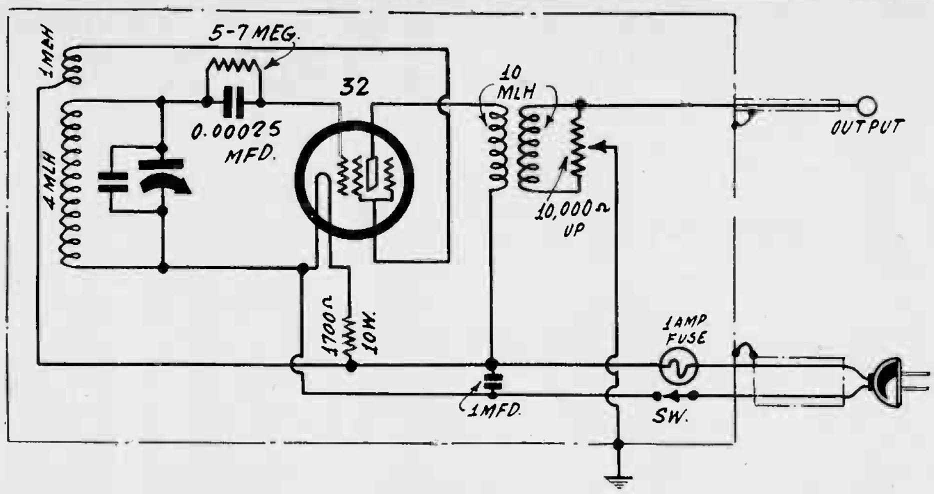
The attenuation control might be subject to body capacity were not the slider grounded, and the only ready way of using a grounded slider, without resorting to rheostat action, which is a shorting device hence frequency-shifting, is to follow the method diagramed. A transformer is used in the output, primary in the plate circuit, secondary having the potentiometer across it.

The point on the box represented by the ground symbol is the conductive connection to binding post, and may be read also as the grounded connection of the a-c cable and of the output lead. That is, the sheath covering of these wire leads is grounded. In the one instance, output, a single-wire conductor is used, in the other, a-c cable, a double-wire conductor is used.

Tickler Connections

Oscillation is obtained from correct polarity of the feedback winding, so if oscillation fails, reverse the direction of connections to this winding, putting to line the connection formerly at plate, and to plate the connection formerly at line.

The tickler is in the screen circuit, and



A modulated test oscillator for use on a.c., d.c. or batteries, that has attenuator and electron output coupling. The accuracy of such an oscillator may be 1 per cent., by use of accurate inductance and by careful setting of the trimmer at the high frequency end, through beating with a broadcasting station somewhere at or between 1,400 and 1,500 kc.

this usually means tighter coupling is required than if the tickler were in the plate circuit. In point of fact the screen is used as the plate, and the usual plate is simply a positively-voltaged element for the attraction of electrons for output. Hence the coupling is emission coupling, or electron coupling, because there is a common unison of electrons of the generated frequency in both circuits. This type of coupling is substantially constant, independent of the frequency, and moreover conditions of the tested load or work circuit do not materially change the frequency generated by the oscillator.

Around a couple of hundred turns may be needed for the tickler, so this transformer may be wound by the constructor. Such is not true of the output transformer, which consists of two tightly-coupled honeycomb coils of some thousand or so turns, inductance 10 millihenries. Usually these are on wooden dowels, and it will be necessary in some instances to saw down the dowels so that the coils may be tightly coupled. The dowel pieces may be glued together.

Constant Impedance

An advantage of the potentiometer method used is that there is a relatively constant impedance, a precaution taken even though the effect of various impedances on the frequency of the oscillator is slight.

The oscillator is of the grid-leak condenser type, and that means grid current flows. The oscillation amplitude will be very steady from the low-frequency limit, say 130 kc, to about 300 kc. This may be verified by connecting a small 110-volt neon lamp across the tuned circuit and noting that the illumination is constant until about 300 kc, when the lamp starts to flicker as higher frequencies are generated. and finally may go out, although the oscillation persists. The extinction simply means that the amplitude of the oscillation is lower than the ignition voltage required by the lamp, and moreover the wave form is then not so good.

Grid Leak Action

The grid leak develops a voltage drop due to the grid current, and since the leak is high in resistance, and the amplitude of oscillation is high, the drop in this resistance, though not measurable with ordinary meters, is considerable. This is d.c., as the grid condenser removes most of the oscillation voltage from the resistor.

The polarity is such that the grid is more negative, the higher the voltage drop in the leak. This is because the negative electrons accumulate faster at the grid, due to the 0.00025 mfd. condenser, than the leak can discharge them. If this accumulation of electrons is sufficient there will be a second oscillation frequency, in the audio region. This is exactly what is intended and is the reason why the leak prescription is so high. The grid blocking, taking place at an audio frequency, provides the modulation when the device is used on batteries or on d.c. Otherwise the a-c hum provides the predominating oscillation, and the sound due to grid blocking is hidden by comparison.

The line voltage may be from 90 to 120 volts, for the resistance value of 1,700 ohms, 10 watts. If the line voltage is 180 to 240 volts, use around 3,500 ohms, 20 watts.

Works Practically Anywhere

The test oscillator will work, as stated, on any source, so that any place where a set is to be serviced there will be power to run the oscillator, since the set will use a.c., d.c. or batteries. There is one exception—the crystal set. But any one with a crystal set would not want to go very far in having it serviced.

If a printed dial is used, the frequencies may be recorded in pencil, in reference to 0-100 division, and when the curve is plotted the whole dial may be calibrated accordingly, and frequencies written in, in such even jumps as convenient, including the broadcast band. For that band 10 kc separation would be convenient from 520 to 800 kc and 20 kc from 800 to 1,600 kc,

The Ratios

The frequency coverage stated, 130 to 400 kc, is a frequency ratio of about 3.08, requiring a capacity ratio of approximately 9.5, since if the total maximum capacity is the condenser maximum (0.00035 mfd.) plus circuit capacities (0.000025 mfd.) or 0.000375 mfd., the minimum capacity could even be more, but we have allowed for 25 mmfd. However, the trimmer must not be jammed all the way in, otherwise the frequency ratio would become about 2.8 to 1, which is too small.

A good many constructors are handy at building oscillators but need some help either as to coils or calibration. Fortunately, information about coils and calibration may be obtained by addressing Trade Editor, RADIO WORLD, 145 West Forty-fifth Street, New York, N. Y.

The oscillator can be built compactly, so that it occupies a total of not more than 50 square inches. By use of accurate coils the frequency accuracy can be better than 1 per cent., even when the line voltage is anywhere within the prescribed limits. The attainment of such percentage accuracy in relation to the coil-condenser system, however, is a semi-precision job, and therefore the convenience of a calibrating laboratory may be preferable.

LIST OF PARTS

Coils

One oscillation transformer, secondary inductance 4 millihenries, tickler inductance, 1 millihenry.

Two 10-millihenry radio-frequency choke coils, constituting tightly-coupled output transformer.

Condensers

One 0.00035. mfd. tuning condenser with trimmer built in.

One 0.00025 mfd. pigtail grid condenser.

One 1.0 mfd. pigtail condenser.

Resistors

One 1,700-ohm 10-watt resistor.

One grid leak, 5 to 7 meg.

One potentiometer, 10,000 ohms up.

Other Requirements

One shield box.

One dial.

One knob.

One shielded double-wire a-c cable and plug.

One shielded single-wire conductor outlead.

One insulated binding post (output).

One conductive binding post (ground).

One 1-ampere fuse with insulating holder.

One panel and copper foil same size.

One UX socket.

One grid clip.

One 32 tube.

Settle - Fordney Hear Records of 'Phone Talk

Lieut. Commander T. G. W. Settle and Major Chester L. Fordney, stratosphere balloonists who recently set a new official world's altitude record in the first American ascent, had the thrill of listening to the conversations that they carried on from the highest point ever reached in the Western hemisphere and the earth by means of NBC radio facilities, when they visited the NBC studios in Chicago.

Recordings had been made of the conversations between the service officers and land points during the flight. Taken from the air during the broadcasts, the records are unique in that they preserve for posterity the first conversations ever held by man between earth and the stratosphere and, of course, the first radio voice transmission from those heights.

The stratosphere ascension was sponsored jointly by the National Broadcasting Company and the Chicago "Daily News."

WHY TUBES OSCILLATE

PRINCIPLE IS THE SAME FOR ALL THERMIONIC GENERATORS AND FOR MECHANICAL SYSTEMS, TOO

By J. E. Anderson

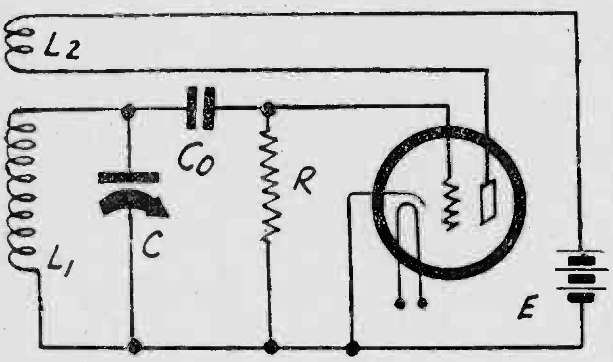


FIG. 1
The circuit of a tuned grid oscillator illustrating how oscillation is maintained by a battery. The tube and tickler act in the same manner as the escapement mechanism in the clock.

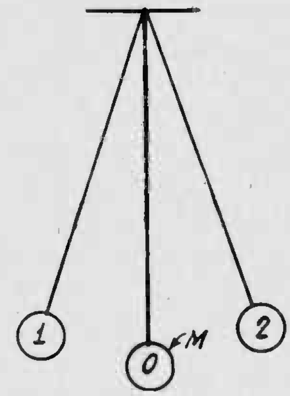


FIG. 2
The ordinary pendulum is an oscillator which is kept moving by occasional impulses, either by a person moving a swing or by the escapement in a clock.

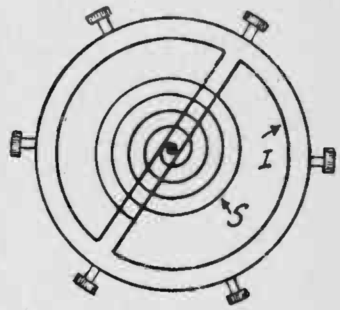


FIG. 3
The balance wheel and hair spring in the watch constitute an exact analog of an oscillating circuit, the spring being the condenser and the wheel the inductance.

HOW DOES an oscillator work? Why should it be possible to convert direct-current power in a battery into alternating-current power in the form of rapid oscillation? What determines the frequency or the rate at which the current chances direction? What keeps the alternating current going? These are just a few of the questions that are often asked concerning vacuum-tube oscillators.

The questions can be answered by analogies, for all oscillators work on the same principle. In Fig. 1 we have a typical tuned grid oscillator having a source of power E, and inductance L1, and a capacity C. In Fig. 2 we have a mechanical oscillator with which everybody is familiar, the pendulum as exemplified in the clock. In Fig. 3 we have a mechanical oscillator that is nearly as familiar as the pendulum, namely, the balance wheel and spring of a watch or alarm clock.

The sources of power in Figs. 2 and 3 are not shown because they are difficult to represent, and, moreover, they may be different. In the pendulum clock the source of power is the weight that has to be pulled up once a day or so. In the watch the source of power is the mainspring which has to be wound up once a day. But the source of power keeping the pendulum going may be a person standing by and giving a pendulum a push once in a while.

An Occasional Push

That occasional push is the secret of the maintenance of the oscillation in every type of oscillator. Every child knows how to keep the swing going by giving it an occasional push in the right direction and at the proper time, and the swing is only an oscillator of the pendulum type.

But every child learns how to start a pendulum and keep it going without the aid of a second person. He makes an effort, apparently mostly mental, to urge the swing to go faster when it is on the downward swing, and the pendulum responds to the urge. This seems to be contrary to Newton's third law of motion, about which the child knows nothing, but actually it is an application of it. Due to a slight shift in position there is a reaction on the support of the pendulum, and some of the energy stored in the child is used for increasing the motion. The effort, therefore, is physical as well as mental. This shows that energy stored in a part of the moving object can be used for the purpose of maintaining the motion.

Now what determines the frequency of the pendulum, that is, the rate at which a pendulum clock runs or the rate at which the child swings? It is mostly the length of the pendulum between the support and the center mass of the weight. In this respect the pendulum is not a typical oscillator. Here is what happens. When the bob M is given a push in the direction of position (1) it starts moving in that direction. It does not stop the instant the push or impulse, is over, because of the inertia. It keeps going. But the earth pulls it back, as it pulls everything down. That is, the pull of the earth tends to bring the bob back to the position (0). After the bob has moved up a certain distance the earth has succeeded in stopping it, and then it begins to fall back. But it does not stop at the lowest point because of the inertia. It keeps on moving toward position (2). But the instant the bob is past the lowest position the earth begins to pull it back again. As a result the pendulum keeps swinging back and forth and at a rate depending on the length of the pendulum.

Necessity for Energy Supply

If left to itself the pendulum would soon stop because of energy losses which occur as soon as there is any motion. It gradually stops. But if an occasional push is given in the direction of motion it will keep on swinging.

In the pendulum clock a little push is given the system once every cycle by the escapement mechanism which allows a little of the energy stored in the weight to be released and transferred to the pendulum. If the energy supply is not to affect the rate of the pendulum, the push must be given exactly at the instant the pendulum is at its lowest point, and in a very high grade clock the pushes are not only timed correctly but they are only applied once every few cycles.

The essential thing in the pendulum oscillator is that we have a bob having inertia and a force which tends to pull the pendulum back home as soon as it leaves the neutral position.

The Watch as an Oscillator

When we examine the watch or alarm clock we come to an oscillator which is exactly analogous to a vacuum tube oscillator. In this case we have a balance wheel and a hair spring. The moment of inertia of the wheel is the inductance in the case, and the hair spring is the condenser. A large heavy wheel and one having its mass concentrated near the rim is equivalent to a large inductance. A stiff spring is equivalent to a small condenser. A weak spring is equivalent to a large condenser. In order to make the frequency of oscillation, that is, the rate at which the balance wheel moves back and forth, high, the spring must be stiff and the wheel light. Conversely, if the rate is to be slow, the wheel must be large and heavy and the spring weak.

By examining the balance wheel we find that a large number of tiny screws with large heads are fastened to the periphery of the wheel. When they are turned so that they move from the center, the moment of inertia increases, that is, the equivalent inductance increases. There is also a device for regulating the stiffness of the hair spring, the usual regulator marked F and S. When this device is moved toward F, the spring is stiffened; when it is moved toward S the spring is weakened. In other words, the regulator on the watch is a tuner varying the frequency of the oscillator by varying the effective capacity.

Power Supply in Watch

The energy that keeps the balance wheel going is contained in the mainspring, which takes the place of the plate battery. The energy in the mainspring is potential, while that in the battery is electro-chemical, also a form of potential energy. In either case it is unidirectional, yet it produces alternating motion.

As in the case of the pendulum clock, there is an escapement mechanism in the watch which releases a little energy each time the balance wheel gets into a certain position, and this not only keeps the balance wheel oscillating but it also keeps the wheels turning.

The Gasoline Engine

Even the gasoline engine is a special type of oscillator, but in this it is difficult to locate the condenser and the inductance, except indirectly. The oscillating portion, of course, is the piston. The push that keeps it going is the explosion, and the escapement mechanism is the distributor and the valves. The inductance in this case is the flywheel. This does not take part in the oscillation but just the same it is the moment of inertia of the wheel that keeps the engine going between explosions. We have to look to the compression chamber for the condenser. Energy is not released every cycle in this case, but only once in every two complete cycles. The gasoline engine is not mentioned as a typical oscillator but only as an illustration of the manner in which energy is supplied periodically to keep it going.

The Vacuum Tube Oscillator

In the vacuum tube oscillator as exemplified in Fig. 1 we have an exact electrical counterpart of the balance wheel. We have the inertia in the coil L1 and the resilience in the condenser C. Suppose an alternating current is flowing in the L1C circuit. A certain amount of energy is stored in the magnetic field of the coil. As the current flows this magnetic energy is transformed into potential energy of electric charge on the condenser. The greater the charge on the condenser the more difficult it is for any more current to flow into it. Indeed, the difficulty is directly proportional to the charge already on it, or more accurately, to the potential difference across it. This proportionality is the essence of the matter. A time comes when no more current can flow into it, and then the current stops in the circuit, both in the coil and in the condenser. Immediately it stops, that is, when all the energy in the coil has been transferred to the condenser, the current starts flowing out of the condenser, in the opposite direction, of course, from that it flowed in. The energy is once more gradually transferred to the coil, and it is all there at the moment the current is greatest. The condenser is then completely discharged and the magnetic field of the coil is greatest.

The current does not stop flowing when it is maximum, although the condenser is completely discharged, for the coil keeps it flowing in the same direction, just as the pendulum keeps moving past the lowest point, where the velocity (current) of the bob is maximum. It keeps on flowing until all the energy has been transferred once more to the condenser, which then is charged in the opposite direction to its original charge. The oscillation consists of an endless transfer of a certain amount of energy from the coil to the condenser and back again, first in one direction then in the other.

Maintenance of Oscillation

The amount of energy tossed about in this manner between the coil and condenser is considerable, but the energy lost during each cycle is extremely minute. Yet there is a loss, and if energy were not continuously or periodically supplied, the oscillation would soon stop, just as a pendulum stops if impulses are not given it occasionally. How is the energy supplied to the L1C circuit? The source is the battery E, but what is the escapement mechanism that transfers the energy from the battery to the tuned circuit?

The escapement is the vacuum tube amplifier, in addition to the coupling devices. The grid is connected to the tuned circuit, so that the grid voltage is practically the same as the voltage across the tuned circuit. This voltage produces a current in the plate circuit, which flows through the tickler coil L2. This coil is coupled to the coil in the tuned circuit and the current in the tickler induces a voltage in the tuned coil. This is the push required to maintain the oscillation. It takes virtually no power from the tuned circuit by coupling the grid to it, only voltage, yet that voltage will produce a current in the plate circuit, which in turn aids the current in the tuned coil to flow by the induced voltage. The timing of the pushes is automatic and very nearly correct. In so far as the impulses are not correct, the frequency changes a little. The same change in frequency occurs in the pendulum when the timing of the impulses is not just right.

Other Types of Tube Oscillators

What applies to the tuned grid oscillator applies to all other types of vacuum tube oscillators. In the tuned plate oscillator the only difference is that the tuning condenser is put on the tickler, but that is a detail. In the Hartley circuit the condenser is put across both windings, another detail which does not change the principle.

In the Colpitts oscillator there is no inductive feedback, for the cathode of the tube is connected to the junction of two condensers placed across the coil. The impulses that keep the oscillation going are applied therefore, to the condensers. We can find a mechanical analog for this also. Let us consider the balance wheel. Instead of giving the wheel a push in the right direction at the right time, we could give the hair spring the impulses. That would work just as well. In the gasoline engine, in so far as it can be considered as oscillator, the impulses are actually applied to the condenser, for the explosion increases the pressure. The explosion does not give the flywheel the urge to move, at least not directly.

The Dynatron

The simplest of all oscillators is the dynatron. This oscillates by virtue of the negative resistance characteristic in the plate circuit, where the tuned circuit is placed. When a screen grid tube is used as oscillator the control grid is usually connected to the cathode, as shown in Fig. 4, and the plate is connected to a positive voltage of a lower value than the positive voltage applied to the screen.

The real oscillator is the LC circuit. The rest is nothing but the power supply and the escapement. Just how the negative resistance releases enough energy to maintain oscillation is not easily seen, and merely to say that the product of the plate resistance and the plate current is equivalent to an electromotive force begs the question. But that is nearly all that can be said. However, as the voltage across the tuned circuit rises, the plate current falls, and vice versa. The plate current is the line current, or the sum of the currents into the condenser and coil. Therefore as the resonant current increases, the difference between the coil and condenser currents, which is the plate current, tends to decrease. In order to keep it constant there is a supply of energy from the battery to enable it to retain its value. And this energy is the push required.

The Neon Tube Oscillator

The neon tube oscillator is interesting because of its simplicity and its principle of operation. It does not work by virtue of a negative resistance characteristic or any definite escapement mechanism, yet it must have an escapement because a battery maintains the oscillation and supplies the energy necessary to offset losses. One feature is that it does not have any inductance. In this respect it does not differ from the multivibrator, for it does not have any inductance, and yet it oscillates.

There is no ready analogy for this oscillator in mechanics. The nearest to it, apperently, is the geyser. Perhaps most of us have not seen any geysers, and if we had we would not know just why they are like a neon tube oscillator. This writer, at least, has seen many imitations, both huge ones and midgets, and has a fair idea how they work. Here is how, according to a spectacular professor in physics. There is a conical container of water with the small end up. At the upper end is a large pan into which the water can flow when there is no room for it in the container. Below the bottom is a

(Continued on next page)

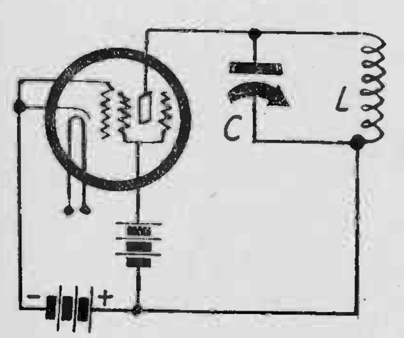


FIG. 4

The circuit of a dynatron oscillator, which is a circuit that oscillates by virtue of the negative resistance in the plate circuit. The screen must be more positive than the plate.

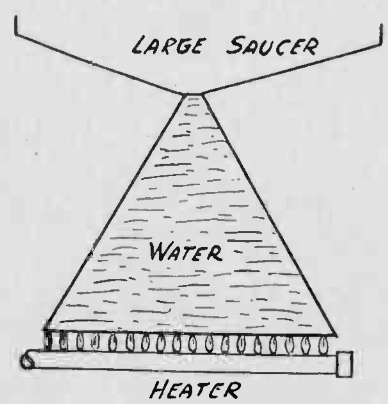


FIG. 5

A cross section of an artificial geyser, which is the nearest ready analog of the neon oscillator. There is a gradual accumulation of a charge and a sudden burst.

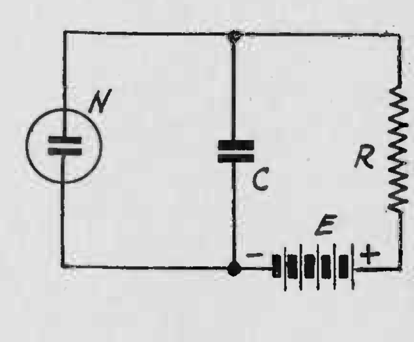


FIG. 6

The circuit of a neon oscillator which operates because there is a difference between the striking and extinguishing voltages of the tube and because the condenser charges slowly through the resistance.

SAW-TOOTH WAVE FORM OF NEON TUBE OSCILLATOR

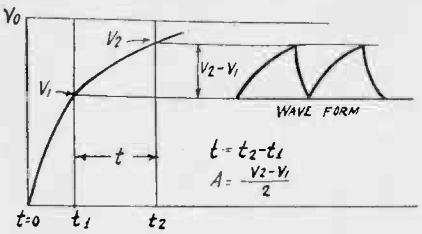


FIG. 7.

The frequency of a neon tube oscillator depends on the capacity of the condenser across the tube, the resistance through which the condenser charges, the applied voltage, and the striking and extinction voltages. This figure shows the manner of charging and discharging and also wave form.

(*Continued from preceding page*)

heater, the rate of heating being regulable. Gradually the water heats, and expands in doing so. Gradually it runs over the rim into the saucer-like flare at the top. Then something happens. The water throughout was at the boiling point just before the run-over. Just after that occurrence every drop of water is above boiling point. In consequence there is an explosion, and most of the water goes up in steam and spray. The main object of the saucer is to collect as much of the hot water as possible and send it back into the boiler, so that the geyser can repeat its performance. The time for the next display depends on the rate of heating of the water.

The Neon Tube Geyser

Now in what way does the neon tube oscillator resemble a geyser? Well, we have a condenser C, Fig. 6, which represents a tank, and indeed, is often called that. It is being charged by the battery E through the resistance R. The length of time it takes the condenser to charge up to a voltage equal to that of the battery depends on the capacity of the condenser and the value of the resistance. But it never gets fully charged, because of the neon tube.

At first the neon tube plays no part, but stands by ready to explode, so to speak. When the voltage across the condenser, and hence across the neon tube, reaches a certain value, the tube suddenly begins to draw current, that is, it begins to glow. This is equivalent to the eruption of the geyser. The tube draws current so rapidly that all of it cannot come from the battery through the resistance. Instead, the greater part of the current comes from the condenser, which is rapidly discharged. In other words, the tank discharges its stored up energy through the tube, and does it with practically explosive rapidity. The glow does not cease immediately, for it will not go out at the same voltage as it goes on. And this is the secret of the neon tube as an oscillator—the difference between the striking voltage and the extinguishing voltage. Ultimately the condenser is discharged to the point where the voltage is no longer able to keep the neon tube conductive. The glow stops, and the condenser begins to charge slowly through the resistance. This process goes on indefinitely at a rate depending on the time it takes the battery to charge the condenser from the extinguishing voltage to the striking voltage and the time it takes the neon tube to discharge.

The time it takes the neon tube to discharge the condenser is so short that it can be neglected in comparison with the time it takes the battery to charge it through the resistance R. Hence the frequency of oscillation depends on the values of C and R, and not to a very large extent on the tube. The resulting wave form is what is called the saw-tooth shape.

Estimating Frequency

It is possible to estimate the frequency quite closely if R, C, and the striking and extinguishing voltages are known. If V_0 is the voltage of the battery and the voltage to which the condenser would be charged if the charging process were not stopped, V_1 the voltage at the instant the glow stops, and V_2 the voltage the instant the glow begins, the time required for the voltage across the condenser to go from one value to the other is $t = RC \log (V_0 - V_1)/(V_0 - V_2)$, where the logarithm is natural. Suppose that we have a battery of 90 volts. Then V_0 is 90. A certain cell has a striking voltage of 85 volts and an extinguishing voltage of 47 volts. The $V_1 = 47$ volts and $V_2 = 85$ volts. Therefore we have $t = RC \log 8.6$. Expressed in common logarithms we have $t = 2.303\ RC—\log 8.6$, or $t = 2.15RC$. The frequency is the reciprocal of t. Hence $f = 0.465/RC$. If $R = 100{,}000$ ohms and $C = 500$ mmfd., the frequency would be 9,300 cycles. However, due to the fact that it does take some time for the condenser to discharge, the actual frequency would be a little less than this.

Effect of Battery Voltage

It appears that the battery voltage affects the frequency of oscillation considerably. In the case just solved the battery voltage was only five volts greater than the striking voltage. Suppose we make the battery voltage 135 volts, retaining the other voltages. Then $f = 6.9/RC$, or 138,000 cycles per second. The frequency is just 1/RC when $(V_0 - V_1)/(V_0 - V_2) = 2.7183$, which for the values of V_1 and V_2 used would make $V_0 = 107$ volts. The frequency is then 20,000 cycles per second for the values of R and C used.

Amplitude in Neon Oscillator

The amplitude of oscillation in the neon tube oscillator is determined, not by the applied voltage or the frequency, but the difference between the striking and extinguishing voltages. In the case illustrated the striking voltage was 85 volts and the extinguishing voltage 47 volts. The difference of 38 volts is the double amplitude, and therefore the amplitude is 19 volts.

The harmonics generated by the neon tube oscillator are very strong, as can be imagined from the wave shape, which is indicated in Fig. 7. The saw-tooth shape is clearly indicated. The harmonics are stronger the more rapidly the discharge takes place.

Use for Scanning

One of the applications of the neon tube oscillator is to scanning in television. When it is used for this purpose, an endeavor is made to have the discharge period last as short a time as possible and to have the charge take place as nearly linearly as possible. The scanning beam moves across the frame in the direction of scanning while the condenser is charging and it moves back while it is discharging.

Jabs Is New Member of ARRL Directors

HARTFORD, CONN.

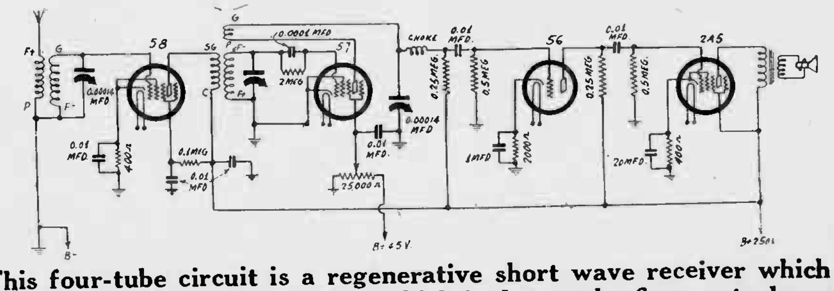
Annual elections in the American Radio Relay League, national organization of transmitting radio amateurs, resulted in the election of one new director and the re-election of five incumbents. The new director is Carl L. Jabs, of St. Paul, Minn., elected director of the Dakota division, by defeating the present director, Lawrence E. Lindesmith, of Duluth.

Reelected were Dr. Eugene C. Woodruff, of Pennsylvania State College, in the Atlantic Division; M. M. Hill, of Natchitoches, La., in the Delta division; Harry Wallas Kerr, of Little Sioux, Iowa, in the Midwest division; J. C. Hagler, Jr., of Augusta, Ga., in the Southeastern division; and Alex Reid, of St. Lambert, Quebec, as Canadian General Manager.

S. G. Culver, of Berkeley, Cal., incumbent director of the Pacific division, was declared reelected without opposition, no candidate having appeared against him.

Mr. Jabs has been a radio amateur for the past twelve years, although his profession is automotive engineering. He operates station W9BVH at 1822 James St., St. Paul.

SHORT-WAVE REGENERATOR



This four-tube circuit is a regenerative short wave receiver which has an exceptionally high sensitivity, which is due to the fine control possible over the regeneration. The diagram corrects an error in the December 9th issue. See page 17, column 3, this week.

TELEVISION IS NEARER

RECEIVERS FOR ULTRA FREQUENCIES DEVELOPED, CATHODE RAY SCANNING IMPROVED, 240-LINE PICTURES ADVOCATED, WITH MORE THAN 24 FRAMES PER SECOND

By Einar Andrews

A FEW years ago there was a great deal of talk about television, but very little worth-while action, as judged by results. At present there is more action than talk. But there is some talk, too, just to let the world know that there is action. The RCA Victor Company, Camden, N. J., has done a great deal of research on the subject during the last few years and some of what has been accomplished was described in the December issue of "Proceedings" of the Institute of Radio Engineers.

The developmental work has been done in a thorough and systematic manner by several engineers. Thus the relation between the number of scanning lines per frame and the clearness of the image has been examined, ranging from 60 lines per frame to 480 lines. It has been shown that a scanning detail of only 60 lines is worthless while a scanning detail of 240 lines gives satisfactory detail even for such difficult subjects as outdoor athletic games.

Another phase investigated is the transmission band width required for the various scanning details. Thus for a system using 60 lines per picture and 24 pictures per second, a communication band of 127,900 cycles is necessary, while a system using 240 scanning lines and 24 pictures per second requires 2.048 megacycles. It will be recalled in this connection that the entire broadcast band is only about 1 megacycle wide and that on this band there are about 100 transmission channels. Thus we could only have one television channel in this band if it were technically feasible to place television in that band.

Assumptions Made

The required channel widths just mentioned were obtained on certain assumptions and not on experimental evidence. It was assumed that the picture had an aspect ratio of 4/3, that is, it was in the proportion of 4 inches left to right and 3 inches top to bottom. It was further assumed, as stated above, that the rate of repetition was 24 pictures per second. Incidentally, it has been found experimentally that this is not quite satisfactory, as it results in quite annoying flicker. It was further assumed that the picture resolution along the scanning line was about the same as the width of the line. This assumption really imposes greater requirements than necessary because the picture does not consist of a checker board. Therefore the required width is less than that obtained. However, there are other factors which work in just the opposite way. Another assumption made was that the picture occupied 90 per cent of the time and that the other 10 per cent was required for control functions, for example, synchronizing.

The wide communication bands required for acceptable television impose severe requirements on the electrical circuits involved. Obviously, it will not do to use an ordinary radio receiver suitable for broadcast reception, for if it is satisfactory for use in the crowded broadcast band it would be entirely too selective for television. The great difficulty in the construction of television receivers and transmitters is to get them broad enough. They must amplify all essential frequencies in the communication band used in the same degree, and to design a receiver or transmitter that will do that is a great task. But this phase of the subject has been investigated experimentally and satisfactory circuits have been developed.

High Frequencies Essential

It has been established quite definitely by many investigators that only the ultra-high frequencies are suitable for television, for at these frequencies it becomes possible to construct circuits that are broad enough. This broadness has been one of the faults with ultra-high frequencies for broadcast use, but for television it becomes a virtue.

V. K. Zworykin has described an experimental television system, showing the general layout of the various components of both the receiver and the transmitter. The kinescope, a specially developed cathode ray tube, forms the basis of the receiver. This device is described in considerable detail, showing exactly how the electron beam is formed and focused and how it is modulated to vary the intensity of the light on the target, or viewing screen.

Scanning of the scene to be transmitted is done in this experimental system by means of a Nipkow disk by the flying spot method. That is, an intense beam of light is made to fly back and forth across the area to be scanned and the light reflected is picked up by the photoelectric cells.

Transmission of moving picture film is also done, in which case the scanning disk has a circular row of holes instead of a spiral of holes, for when a picture is sent the motion from top to bottom is provided by the motion of the film. In this case the flying spot method is not used but the light beam is sent directly through the film into the photoelectric cell. Variation in the intensity of the light beam entering the cell is done by the the gradations in the film. It is generally admitted that results from televised films are superior to those of televised original scenes.

Circuits for electrical scanning of the received picture are also shown in some detail. The scanning waveform is of the saw-tooth type, that is, the current rises slowly in a linear manner and then falls back very quickly. Examples are shown in which the linear rise in the current occupied 41,000 microseconds and the fall 700 microseconds and also when the rise occurred in 312 microseconds and the fall in 35 microseconds. Thus in one case the total time of scanning was 1/24 second while in the other it was 1/2,880 second. The 1/24 rate is for moving the lines from top to bottom and back up again and the more rapid rate for drawing the lines across the frame. The ratio of the two total times is 120, hence the system uses 120 lines per frame.

The circuit used for producing the saw-tooth wave is also shown. The method consists of charging a condenser through a current-limiting device such as a saturated vacuum tube and discharging it through a thermionic or gas-discharge tube.

Synchronization

Synchronizing is done by sending an auxiliary impulse at the end of each line and one at the end of each frame. A separate photocell is used for this purpose. These impulses are produced by slits cut in the scanning disk in proper relation to the positions of the holes producing the picture signal. The synchronizing signals are sent during the time that the scanning beam returns so that virtually no time is lost by synchronizing. The two synchronizing signals, that is, the one occurring at the end of each line and the one at the end of each frame are different in quality and frequency and therefore they can be received separately so that the picture can not only be held in frame but can also be timed correctly in each line. Shifting of the picture due to hunting is avoided by this double synchronizing signal.

R. D. Kell, also of RCA Victor Company, describes an experimental television transmitting system, which is the one that was installed in the Empire State Building in New York for making practical tests. He not only shows the circuits employed for producing the television signals but also photographs of the actual apparatuses used.

Receivers

Naturally, reception of television signals has also received attention, and concrete evidence of this is contained in an article on the subject by G. L. Beers. Superheterodynes operating at ultra-high frequencies are shown for the reception of the sound accompaniment, the picture signal, and the two synchronizing signals. The oscillator used in the frequency changer, it is noticed, is of the Colpitts type, for this was found to oscillate satisfactorily at very high frequencies.

The type and location of the receiving antenna was given attention. It was found that in some homes signals of sufficient strength satisfactorily to operate the receiver could not be obtained with indoor antennas. In such cases the antenna was erected on the roof and the signal led in through a shielded transmission line. It was also found that the signal strength varied considerably in an apartment. An interesting field map of an apartment is shown, giving the signal field strength at different points. It is interesting to note how the strength varies with the position in respect to metal objects in the rooms. The measurements were made at a frequency of 50 megacycles, the transmitter being located 100 feet from the front of the house.

Methods for getting a broad transmission channel are also described. Resonance curves in which the transmission is practically constant from 5.7 to 6.3 megacycles are shown.

After having read these articles on television one is convinced that real progress is being made in this difficult field, and one is encouraged to hope that in the near future we shall have practical television in the home.

PICK-UP AND MICROPHONE

Connections for Various Types of Receivers

By R. Burns

Chief Engineer, Capitol Radio Research Laboratories

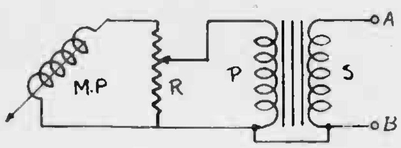


FIG. 1
In circuits with manual volume control at the audio level no external control is needed. M. P. is the microphone pickup, or phonograph pickup, R the control, P and S the primary and secondary of the matching transformer.

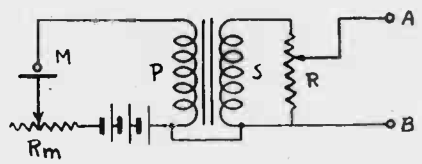


FIG. 2
Most microphones work much better with an energizing e. m. f. This is usually a battery of 4.5 or 6 volts. Rm is a 1,000-ohm rheostat. It is preferable to shut off the microphone by gradually increasing the resistance (to left) to infinity.

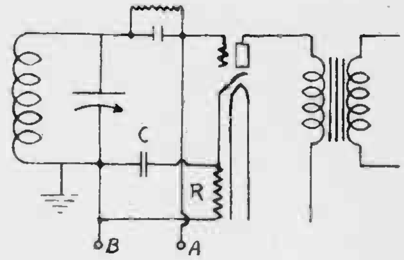


FIG. 3
For a grid leak type detector, especially where there is not much audio following, the pickup (mike or phone) may be connected between A and B. In the diagrams A is high potential and B is ground for the acoustic device.

THE audio amplifier which is a part of ever receiver provides a suitable means for entertainment with microphones and pickup apparatus. To make such adaptations of the amplifier it is necessary only to provide a means of breaking the regular signal circuit so that signals from the detector will not be directed into the audio amplifier, and to provide suitable apparatus to connect the pickup device to the input of the audio amplifier.

Audio amplifiers vary somewhat in the amount of gain or amplification which they provide. This makes it necessary to give some thought as to how much amplification is needed for a pickup or a microphone.

Before the midget receiver became so popular, and in general before the wide use of the pentode output tube, audio amplifiers almost invariably had two stages, that is, one audio stage following the detector and an additional stage either with a single tube or two tubes in push-pull or parallel driving a speaker. The application of a pickup or microphone either to the detector input, its output or the first audio amplifier input is possible with this setup.

The Volume Control

With the later designs having the detector followed by one pentode it is necessary to apply the pickup to the detector input. Although the detector amplifies somewhat, its main function is to convert high frequency modulated energy into energy at audio frequency. It is therefore not suitable as an audio amplifier until its circuit is adapted for that purpose.

Many present-day receivers employ some radio-frequency method of volume control, hence from the input of the detector to the speaker there is no means of controlling volume. When a pickup or microphone is attached to such a receiver there must be some means of controlling the volume. Since addition of a volume control to some point in the signal circuit of the detector or audio amplifier system would affect the received signals as well as the signals picked up by a microphone or pickup, it is best to include volume control apparatus with the microphone or pickup circuit.

Because of the special operation of r-f and i-f circuits of receivers equipped with automatic volume control the manual volume control (operated from a knob) is connected in the audio system, usually immediately following the detector. For this type of receiver the separate volume control is not necessary in conjunction with the pickup apparatus, whether a magnetic pickup or microphone be used. The pickup circuits are all shown equipped with volume controls as in Figs. 1 and 2, and if desired they may be removed and connections may be made straight through.

Same Connections to Set

It is not generally worth while to remove the volume control from apparatus already equipped with it. Always it is convenient to be able to control the volume at the point of pickup which is at the turntable for the magnetic pickup.

Both the pickup and the microphone at-

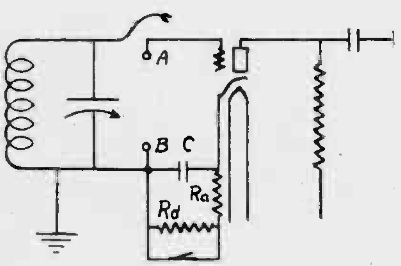


FIG. 4
The power detecter is treated as shown. The high side of the grid circuit is opened so that the acoustic device may be connected between A (grid) and B (ground). Ra is the amplifier bias resistor, Ra + Rd the detecting bias resistance.

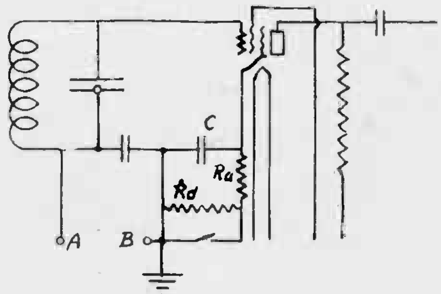


FIG. 5
In the case of a superheterodyne the pickup or microphone may be left between A and B, the extra resistance Rd for detection shorted out by the switch to allow Ra alone, for amplification, when the sound device is to be used.

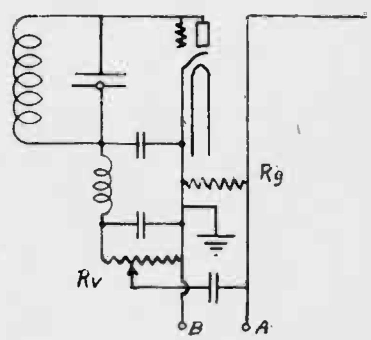


FIG. 6
The earlier type diode circuit is illustrated. The sound device is connected across the load resistor in the succeeding grid circuit. The diode itself is out of circuit for the use of phonograph pickup or microphone.

tachments produce voice currents, which term of course includes music and currents representing sounds of all kinds. As far as this application is concerned the pickup and the microphone have approximately the same output energy and for this reason they are both connected to any receiver in exactly the same manner.

A transformer is necessary for both the pickup and microphone in order that the energy which they produce can be suitably applied to the audio amplifier at reasonable efficiency. Without such transformation the energy is practically useless. The transformer changes the energy from high-current, low-voltage to low-current, high-voltage, ordinarily called "impedance matching."

A pickup with its transformer and volume control apparatus is shown in Fig. 1 and a microphone with same in Fig. 2. The additional apparatus in Fig. 2 is simply a microphone battery and a current-regulating resistance. The battery should be a 4½ or 6-volt battery of storage cells or dry cells. The rheostat Rm should have 1,000 ohms resistance. Regular telephone microphones operate best at 150 milliamperes and when a microphone is purchased its recommended current should be ascertained.

Prevention of Granule Flashing

It is not necessary to keep a meter in the microphone circuit but it will be well to measure this current when the instrument is installed. Instead of using a switch to cut off the microphone current it is better to use a 1,000-ohm rheostat with an open position at the maximum end so that the microphone current can be reduced to a safe minimum before it is cut completely off. This will prevent "flashing" of the granules in the microphone.

The grid-leak-condenser type of detector has a grounded cathode and consequently no bias from the B supply. When applying a bias to the tube for the purpose of audio amplification simply insert a resistor R in the cathode lead as in Fig. 3. Its value will depend on the tube and its plate current as well as the bias voltage desired. This resistance value may be determined by multiplying the bias voltage by 1,000 and dividing the result by the plate current in milliammeters.

The grid leak and condenser may be left as shown as they do not bypass or short the audio signals. For all of the circuits shown terminal A on either of the pickups is connected to terminal A on any of the circuits. Terminal B is connected to the corresponding terminal which is grounded on the circuit.

Case of the Superheterodyne

The adapter for a power detector of the triode, tetrode or pentode types may be arranged as in Fig. 4. Although only a triode is shown in the figure it is simply symbolic of any power detector circuit. Connection to the control grid cathode and plate would be the same for the 27, 56, 37, 24, 24A, 35, 51, 36, 57, 58, 77, 78 and others used as power detectors. The total resistance values of Ra and Rd (Fig. 4) in series is sufficient to bias the tube properly for power detection but when Rd is shorted with the switch shown only Ra remains to bias the grid. Its value must therefore be properly chosen for this work. Thus when the switch is closed Rd is shorted and the detector becomes an audio amplifier. In each case the grid clip or terminal must be removed so that the tuning coil will not short the audio frequencies to ground.

When the detector grid is fed from an intermediate transformer (superheterodyne receiver) a very simple connection is possible as in Fig. 5. With this arrangement the pickup transformer may be permanently fixed in the circuit and it is only necessary to close the switch to operate the pickup. Point A may have been connected to ground or to an a-v-c feeder, and in either case the circuit is broken and the pickup inserted. A condenser Ca, 0.00025 mfd., is used to by-pass the i-f grid circuit. This arrangement is not feasible with the tuned radio frequency circuit.

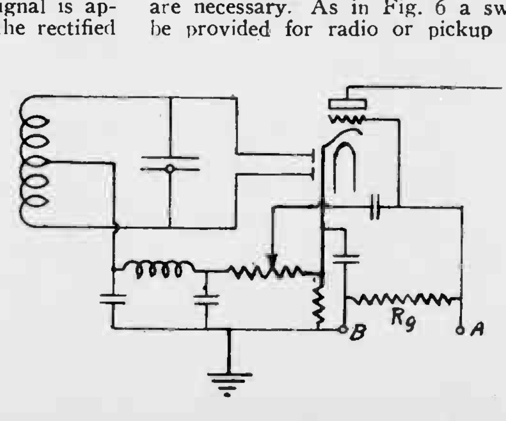
To prevent signals from coming in over the air simply reduce their volume which is done in the r-f system and detune the circuit if necessary.

Earlier Diodes

For diode circuits of the earlier types we have Fig. 6. Here the pickup signal is applied to the leads across which the rectified signal exists. No further changes are necessary. Terminal A of the pickup or microphone may be connected to A in Fig. 6 by means of a switch to change from radio to pickup if desired.

For the modern diodes we have Fig. 7. The pickup is applied directly between the control grid and ground. The triode section is already designed and the circuit is wired for audio amplification so no further changes are necessary. As in Fig. 6 a switch may be provided for radio or pickup reception.

FIG. 7
Connection for use with modern diodes. The pickup is applied directly between control grid and ground.



Thimble Tubes Offer Portable Opportunities

The miniature triodes and tetrodes that have been made experimentally, but not put in production, by RCA Radiotron Co., Inc., will find many applications outside the short-wave field for which they have been designed. There are many portable uses where light weight is essential, and here they will be valuable even for broadcast and lower frequencies.

Small tubes required a minute filament current should find many useful applications, and it is to be hoped that they soon will be produced. Imagine a tube the size of a small thimble in which the filament current is of the order of 10 milliamperes. Such a tube is not only possible physically, but relatively simple to construct. It would not be necessary to reduce the filament to the size of a spider thread, for an ordinary tube will function as an oscillator, for example, when the filament current is reduced to one-third its normal value. A 37 has been operated with 0.1 ampere whereas the normal current is 0.3 ampere.

At the same rate a filament tube requiring normally 60 milliamperes should function in the same circuit with 20 milliamperes in the filament. It would not be extremely difficult to design a filament which would have a normal current of 30 milliamperes, which should then be useful as an oscillator when the current is 10 milliamperes.

Method of Improving Regenerator's Sensitivity

A regenerative receiver can be made more sensitive by increasing the plate resistance of the tube used as regenerator. This increase can be effected by decreasing the filament current or by using an external resistance for decreasing the effective plate voltage.

In the early days when filament tubes were the order, regeneration was nearly always controlled by a rheostat in the filament circuit, and even now that is one of the very best methods of doing it. It is not satisfactory, however, when cathode type tubes are used, because the plate resistance does not respond quickly enough when the heater current is varied. In battery-operated receivers in which midget filament type tubes are used, the method of controlling the regeneration by controlling the filament current should be used.

Colpitts Oscillator Has Pure Wave Form

The Colpitts oscillator is not popular with designers of superheterodynes because it requires the use of two tuning condensers, yet it is one of the best oscillators that can be used when purity of wave is essential, and it is in a superheterodyne.

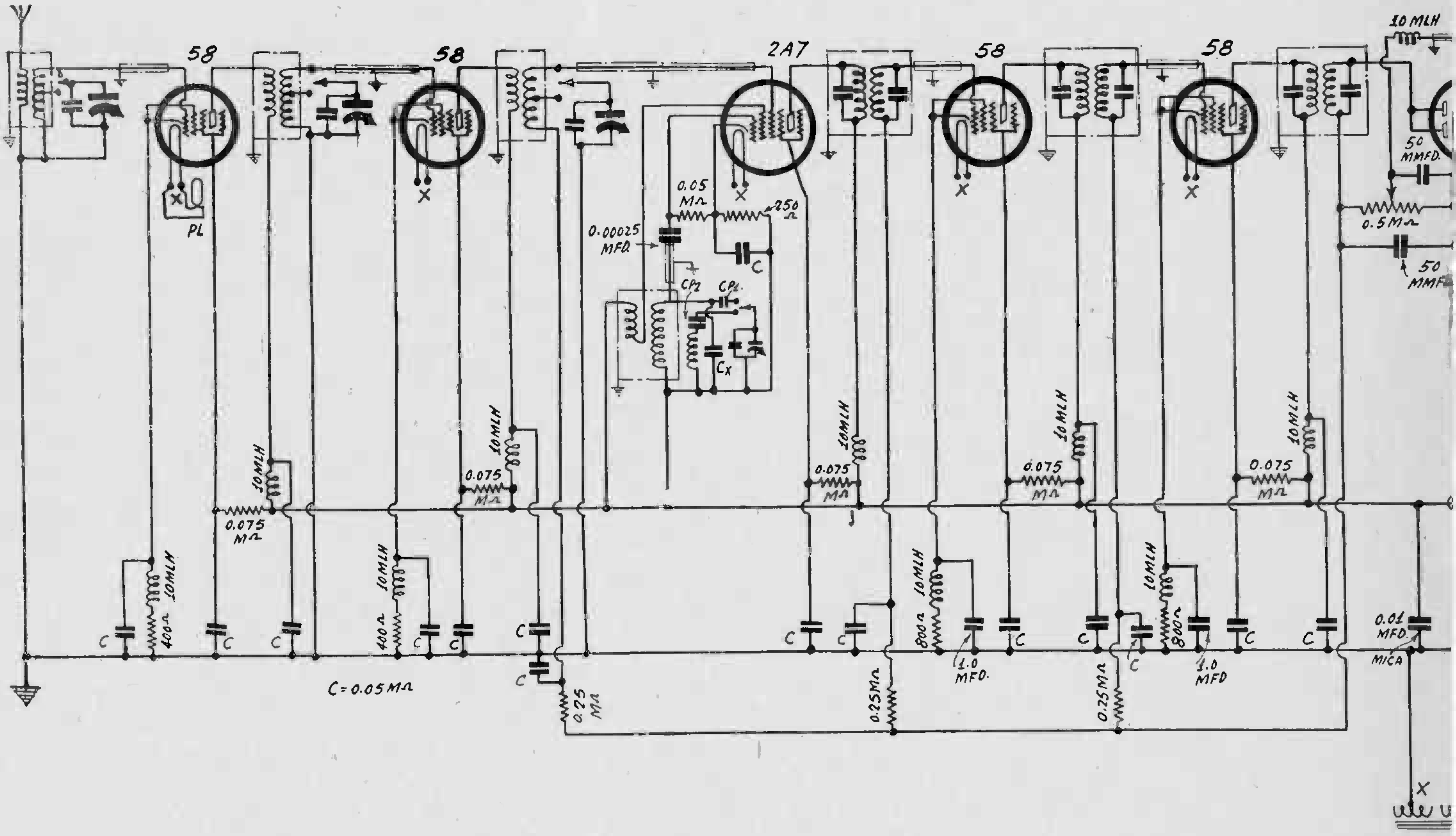
The fact that two condensers are required is not in itself a deterrent against using the Colpitts, for a four-section condenser could be used where ordinarily a three-section would be used. The difficulty is that if the circuit is to be padded to make it track, two sections will have to be padded, and that is much more difficult than one. Padding, of course, could be avoided by using tracking condensers, but condensers with two identical tracking sections could be fabricated readily. If there were demand for such condensers they could be produced very easily and on short notice, for it would not require any tools not already used for the production of tracking condensers with a single oscillator section.

A 25-WATT DUAL

SEPARATE C SUPPLY AFFORDS NE

IN QUAL

By Homer



A high-powered dual-range receiver, broadcasts and police bands. Automatic volume control is appl stages of audio, of which the first is in the triode of the 55, the second is that associated with the 59 push-pull 2A3 power stage. A separate C supply is built in, permitting Class B operation. Oscillator

THOSE interested in a high-powered broadcast receiver will find some valuable information in connection with the diagram herewith, because the circuit and constants are based on considerable experimental work, and represent the solution of several problems.

The circuit is arranged for covering the broadcast band, actually 540 to 1,600 kc being tuned in, and also the police band, the frequencies here being 1,600 to around 4,500 kc. The special note in connection with the police band—which also includes two of the amateur bands, some fire and airplane calls—is that the minimum capacity across the oscillator circuit is less for the higher-frequency band than for broadcasts. A separate winding is used for the oscillator in the police band. The trimmer that is affixed to the tuning condenser is set for this band, and the additional capacity, adjustable to 35 mmfd. or so, across the larger oscillator secondary, is adjusted for the other band. The adjustments may be made at 4,000 and 1,450 kc, respectively. Each circuit is separately padded, Cp1 for the broadcast band, lying between 400 and 500 mmfd., and Cp2 for the police band just below 1,000 mmfd. (0.001 mfd.).

A. V. C. on Three Tubes

The 55 is used as the full-wave detector, with both diode plates tied together at the socket, and the input to the triode section of this tube is diode-biased. Hence the bias is equal to the signal, and the two are therefore the same. Automatic volume control is used, affecting not only the two intermediate amplifier tubes but the modulator as well, and since the full amount of the rectified voltage in the detector serves for a.v.c., the control is all-sufficient, and of course reduces the sensitivity. That is the basis on which all a.v.c. systems work.

However, the sensitivity may be only so much, up to the detector, since the performance of the 55 triode is not satisfactory at signal voltage input much in excess of 12 volts. If the input is too high the triode will become saturated, and nothing will be heard when loudest response from strongest locals is expected, but a.v.c. avoids that trouble, and also permits an output of some 50 volts from the 55 triode. This is nearly twice as much as the input to the next tube should be, but the volume control is properly placed either as shown, or may be a potentiometer of 0.5 meg. or higher resistance in the grid circuit of the 59, slider to grid, extremes to stopping condenser and grid return.

Around 30 volts will be a suitable bias for the 59 used as a triode, the output being abundant to swing the push-pull 2A3 tubes. These output tubes have a very effective emitting filament, consisting of series and parallel filament wires, and are tubes permitting up to 15 watts output in Class A operation, if not self-biased, whereas if Class B is used, the output will be at least 25 watts.

Separate C Supply

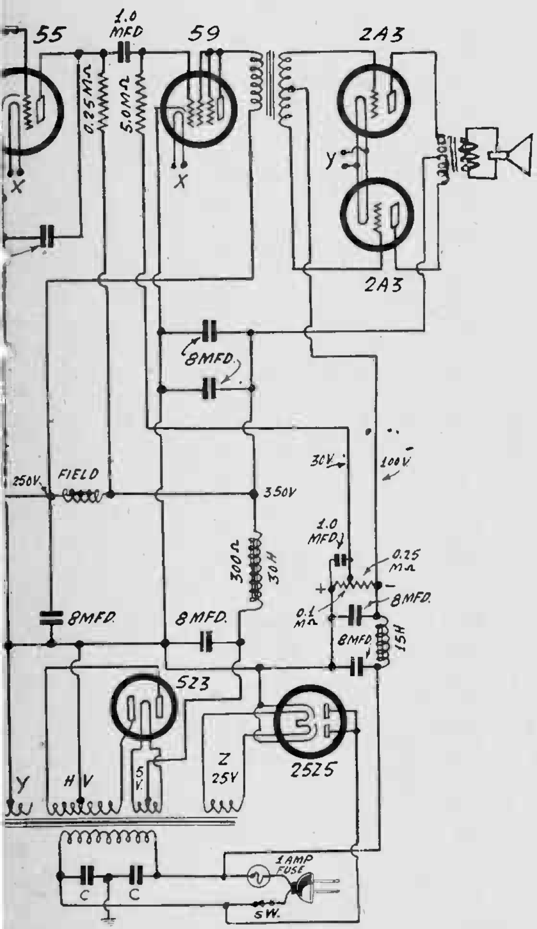
The biasing method is such as to permit either Class A or Class B output without any special transformers, although the output tubes' B current should not pass through a very high resistance.

-RANGE RECEIVER

GATIVE BIAS EXCEEDING 100 VOLTS

ITY SET

A. Wendell



ed to three tubes. There are three used as triode, and the last is the secondary return goes to ground.

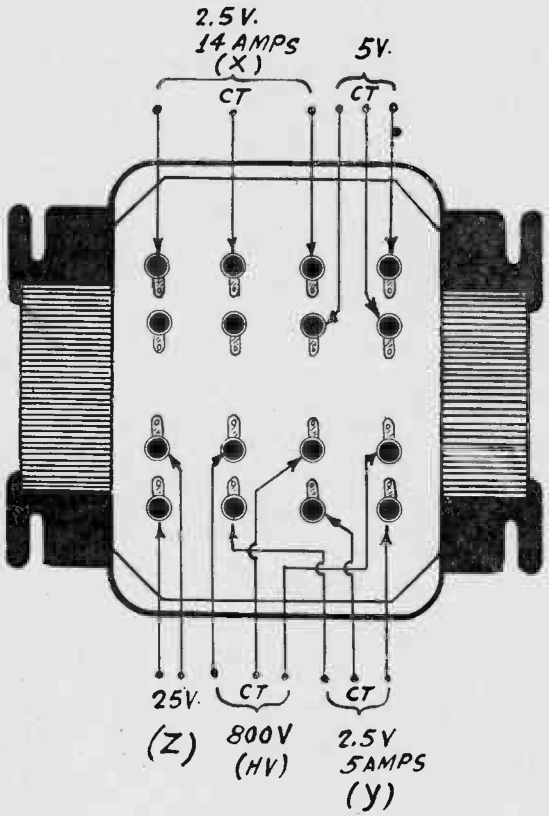


Diagram of the connections to the power transformer. Winding "X" is marked on the transformer, and the reference points may be taken from that starting basis.

Hence a separate choke is suggested, d-c resistance not greatly exceeding 300 ohms.

There is an independent C supply built in. The power transformer has a 25-volt winding, which will serve the heater of a 25Z5 rectifier. If the line voltage is introduced as shown, the rectified voltage available for C supply will exceed 100 volts, and that will be satisfactory negative bias for Class B operation without any other changes. The applied B voltage will be around 350 volts. Or, if Class A output is desired, instead of utilizing the full rectified voltage for biasing the output tubes, some voltage between 50 and 60 volts is selected.

The speaker now becomes of some importance, especially its output transformer. It has been found that relatively small differences in impedances affect the output more than was expected. An adjustment can be made by biasing for strongest output, if Class A is used. A modulated test oscillator may be connected to antenna input, modulation consisting of a-c hum, or hum introduced by connecting a condenser of 0.002 mfd. or so from a-c line to grid of the 55, and adjusting the volume control until an output meter reads within suitable range, or until the sound is comfortable to the ear, and not so loud as to denote overloading, if no meter is used. Then the bias is adjusted for maximum response somewhere between 50 and 60 volts.

Better Matching

The bias alteration changes the plate impedance so that this simple method yields a better match between tubes and speaker through the output transformer that is in the speaker. Usually a transformer of 5,000 to 7,000 ohms primary impedance is used (plate to plate), and the adjustment takes into account the effect of such a difference.

It must not be supposed that the 2A3 tubes are high-gain, simply because they are high-power tubes. In fact, the two considerations are, in general, antagonistic. The tubes will stand a greater input than practically any other power tubes used in receivers and will stand a larger output.

The efficiency is highest when Class B is used. The circuit follows rather closely the original Class B method as first proposed for battery receivers. It will be remembered that this method consisted of using small output tubes, biasing them heavily negative, and thus permitting a much wider voltage swing, with consequent enlarged power output. Small tubes of the medium amplifier type were used in the output with results surpassing in power output those of the power tubes usually recommended for battery receivers.

This was a quality type of Class B. There grew into favor another type, using high mu tubes, where grid current was endured, the tubes operating at zero bias at no signal, and the grids being driven positive by the signal. This was fine for very loud passages, but there was some distortion at low volume levels. It is a method highly suitable for an auditorium or for a public address system of some power consequences, but not so acceptable for home use.

Why So Much Power?

The argument might be raised about the present design, that it is more powerful in output than home requirements justify, but that is a matter of taste. Some do want very powerful receivers even in the home, perhaps because the sets are used at dancing parties, or perhaps because the possessor becomes enlivened and enspirited by tremendous volume without distortion when dance or symphonic orchestras are tuned in.

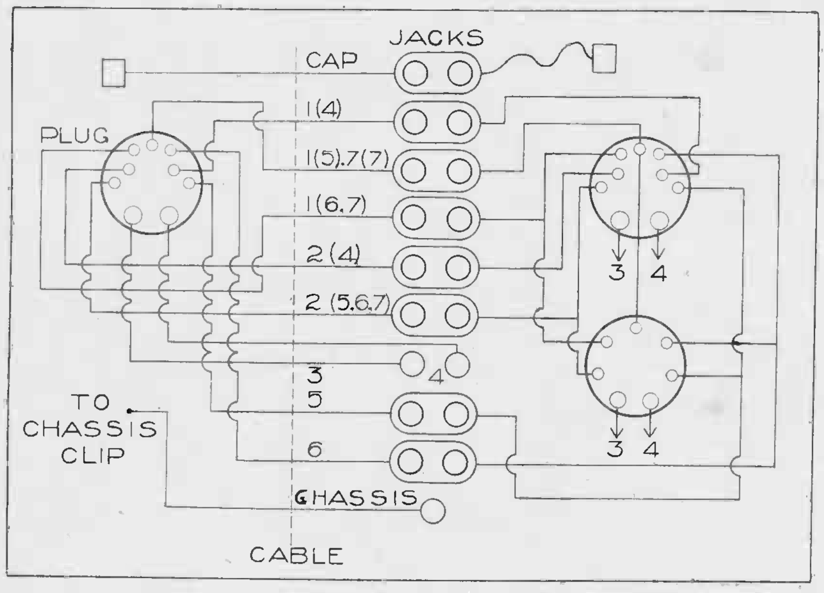
As stated, there is no grid current, as the Class B circuit would be of the high-negative-bias type, hence no special transformer is required for interstage coupling. The usual 3-to-1 ratio push-pull input transformer will suffice.

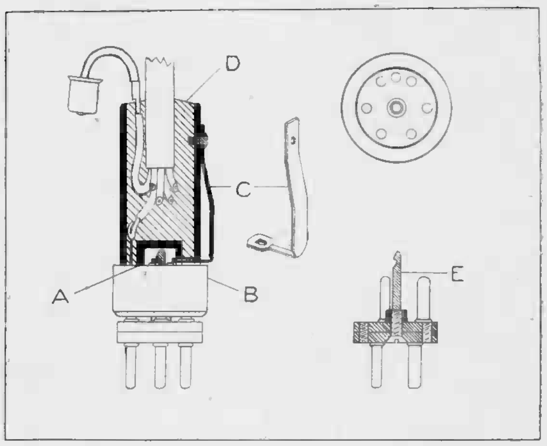
(*Continued on page* 21)

A NOVEL, SIMPLE ANALYZER

NON-OBSOLESCENT METHOD APPLIED TO AN EXISTING INSTRUMENT, BUT APPLICABLE ALSO TO NEW OUTFIT

By Carl F. Mathisen





At left is the wiring diagram. The jacks are numbered to agree with the manufacturers' prong numbers. Parenthetical numbers identify the style base. Wiring is shown from the lug side. At right is a cross-section of the plug with five-prong adapter in place, also top of large seven-prong adapter and cross-section of four-prong.

HERE is a simple and inexpensive method of making an analyzer plug and its adapters and of making the tube circuits available for measurement at the tester panel. These methods may be used in making a separate piece of apparatus or may be incorporated in an old analyzer, such as the Jewell 199, for modernization at least expense. The design allows for the future use of 8- and 9-prong adapters without any change.

The analyzer plug differs from the conventional kind in that it is really a socket with a handle, while the adapters have prongs on both ends, making for ease and less expense in construction. This plug may of course be used with a selector switch or switches on the analyzer panel, but Yaxley closed circuit twin tip jacks furnish a more flexible and inexpensive means of making the tube circuits available for measurement. In these jacks the insertion of one cord tip does not disturb the circuit, and voltage readings may be taken. However, if two tips are inserted the circuit is broken and current measurements may be made. These twin jacks also make it convenient to introduce a changed voltage in the grid circuit and to make other temporary circuit adaptations.

Modification of Jewell 199

A Jewell 199 analyzer is illustrated which was modified by these methods. It will be noted that the jacks have been mounted for the most part in the space originally taken up by the binding posts in the meter circuits. The circuits were changed to allow these posts to be removed and pin jacks were substituted for the posts that would still be necessary. It is interesting that with the use of the resistances furnished originally it was possible to increase the upper voltage range from 600 to 750 volts and include an additional range of 150 volts. Shunt and series ohmmeter circuits and scales were also added at small expense. It was not necessary to use a new panel.

It is well to make the adapters first. These can be made from the bases of old tubes, or if you do not have any, tube bases or Eby male plugs may be purchased. Heavy tinned wire, No. 14 or 16, is best for running through the prongs to tie them together except where the offset is too great, when a thinner wire must be used. No other means of fastening the tube bases together besides the latch screw in the center and the connecting wires are necessary except in the case of the 4-prong adapter, in which case because of the necessary offset, it seems best to drill and tap one or two holes as shown in the drawing. In the case of the two 7-prong adapters it will be necessary to modify either two 6-prong bases by adding one pin, or two 5-prong bases by adding two pins. For the extra pins reuse those from old tube bases.

In the diagram to the right of the circuit wiring the letters have the following significance:

A. Toothpaste cap ((non-metallic) filed to shape.
B. Universal socket with mounting lugs and flange removed.
C. Latch spring.
D. Red sealing-compound.
E. 8-32 screw with threads removed from upper end.

Mechanical Work Outlined

It is more satisfactory to use 5-prong bases, even though it means more work, because the heater prongs on the 5-prong bases are thin so that they slip in and out of the socket more readily and cause less wear and tear.

Do not file notches in the latch pins until the latch spring has been made. When you do file these notches make them very slightly hooked so that slipping will not be likely to occur.

LIST OF PARTS

Two Na-Ald No. 456 Universal sockets.
One Na-Ald No. 477 socket.
One 10- or 11-wire cable, 11-wife if chassis clip from cable is desired.
Eight No. 432 Yaxley twin tip jacks.
One grid cap connector.
Three Yaxley No. 422 tip jacks, or two No. 432 twin jacks.
Two inch-length 1-inch diameter bakelite tubing.
Two 4-prong tube bases.
Four or two 5-prong bases.
Two or four 6-prong bases.
One small 7-prong base.
One large 7-prong base.
Eby laminated male plugs may be substituted for bases, except that one large 4-prong base is needed.
Panel, if new panel is required.
Miscellaneous hardware.

Short - Wave Set in Congo Regularly Gets Children's Hour Here

From an isolated mission station in the Belgian Congo comes a letter to Milton J. Cross, NBC announcer, saying that the Americans there often hear the NBC Children's Hour broadcast each Sunday from Radio City, New York.

"We think of you as part of our American family," said the writer. "While in the States in 1931-32, we listened to your voice many times. We have brought out a little short-wave set. You can imagine our thrill when we heard your voice over W3XAL, Bound Brook, New Jersey . . ."

W3XAL is one of NBC's short-wave transmitters, operated experimentally in conjunction with WJZ, New York City.

When Cross mentioned receipt of the letter on a later program, a much-surprised listener telephoned the announcer and stated that he was a brother of the woman mentioned over the air from whom Cross had received the greeting.

Remove the lugs and flange from a Na-Ald 456 Universal socket with saw and file. Smooth with sandpaper. Then cement the modified toothpaste cap in place with cement, while the latch is in place of course. Solder on the cable leads and the grid cap and cement up any cracks by the contact lugs in the cement. Score the inside of the bakelite tube with drill marks. Cement the bakelite tube in position.

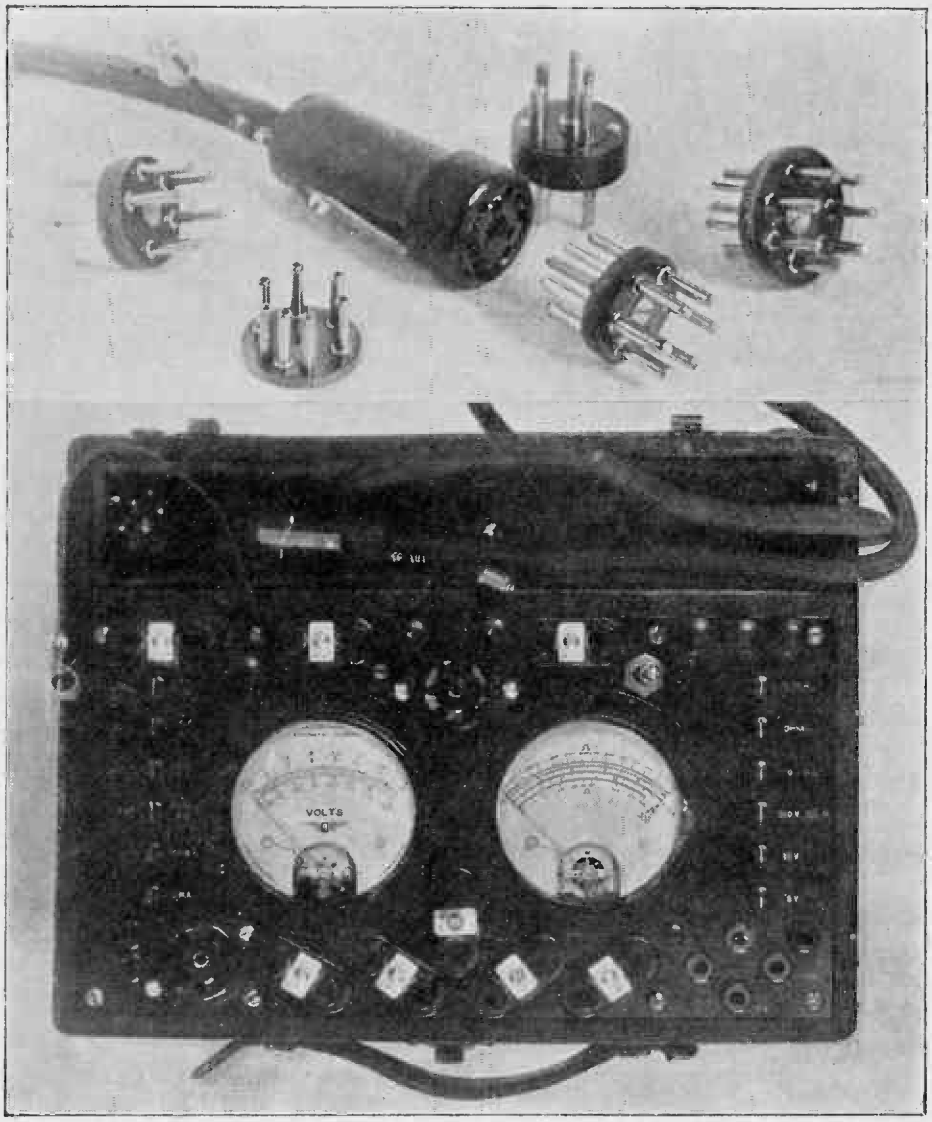
Pack strips of metal about the tongue of the latch, one strip underneath and one on the side, or more if necessary. Then fill the bakelite tube with melted compound. Let the plug hang suspended from the cable while pouring the compound and leave in this position to cool. When cool remove packing strips by latch and then drill and tap a hole for the latch screw. It will be found that the sealing compound will hold the handle securely to the socket.

The Numerical Arrangement

On the tester panel a Na-Ald 456 Universal socket and a combination 477 socket for 7-prong small and large base tubes will be needed, also two single tip jacks for heater connection and also one for chassis connection, if desired. Eight Yaxley twin closed circuit jacks are necessary. These jacks may be mounted above or below the panel. If room is lacking, as in the case of the Jewell analyzer shown, above-panel mounting is necessary. The arrangement of the jacks will depend upon the personal taste of the maker and the amount and shape of the panel space available.

In the wiring diagram a numerical arrangement of the jacks is used, which is also a good arrangement for the panel. However, other good arrangements are possible. For example, on the Jewell panel the arrangement shown was found best for the space available. Here the cap jack is placed in one corner, and the heater jacks on each side of the twin jack near the bottom. The grid and plate jacks for 4-prong tubes are at the top. For 5-prong tubes one at each end and the central one of the jacks at the bottom of the panel is used. For 6-prong tubes the central jack is omitted and the rest at the bottom used. For 7-prong tubes all of those at the bottom of the panel are used. For all the styles of tubes the jacks are in the same relative order as the prongs are, looking at the bottom of the base, and are numbered to correspond.

In soldering the leads to the twin jacks it must be kept in mind that the lugs connect to the hole on the opposite end.



The novel plug, which is really a socket with handle, and the "two-edged" adapters are shown at top, while below is the modernized Jewell 199, using Mathisen's method.

Therefore, if it is desired, for example, that the hole nearest the tube socket on the panel should be connected to the socket, the further lug should be the one soldered. The cable leads may be soldered directly to the jacks if these are arranged compactly, but if they are spread out it is best to use a connection block or use a cabled socket.

If desired for the sake of uniformity twin jacks may be used for heater and chassis connection also. For the chassis connection solder a wire across the lugs so either or both holes may be used without opening the circuit. For the heater leads bend back both contact lugs inside the jack so that it will be an open circuit jack and each of the twin jacks can be connected separately to the two heater leads.

THE EMPIRICAL METHOD

The exactness of radio drama often causes actors a lot of grief, but occasionally they get a break. Recently, during a rehearsal of one of the episodes in the "Dangerous Paradise" series heard twice weekly over an NBC network, a question of timing arose: how long would it take a man to carry a girl 25 feet? After everybody had taken a guess, Nick Dawson, who plays the leading male role, picked up pretty Elsie Hitz, leading lady, and toted her down the studio while the director solemnly timed the action on his stop-watch.

Tremendous Amplification for New WLW Modulator

7,000,000,000,000,000.

This almost unreadable figure represents the degree of amplification being built into the world's largest radio modulator. The faint power caught by the microphone must pass through 16 large tubes, and transformers weighing 65 tons, so that it may be amplified to provide complete modulation for the WLW new 500 kw. broadcasting station.

Merely to amplify, even to this degree, might not involve unusual difficulty, but to do so with imperceptible distortion becomes a real accomplishment. Frequencies ranging from 30 to 10,000 cycles reach the microphone, yet the irregular wave with all its overtones and harmonics is transformed into the giant modulating wave so accurately that the trained ear can defect no distortion.

This modulator is part of the new Crosley broadcasting station at Mason, Ohio. Its power is ten times greater than that now actually used by other large broadcasting stations.

GRID BLOCKING

Sensitivity is increased as the leak value is increased in leak-condenser circuits, but the leak should not be so high as to cause blocking.

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6 without any other premium.

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Capacity Measurements

WILL YOU PLEASE give me some assistance in measuring high and low capacities? I can obtain suitable accurate inductance for the low capacity measurements, but am at a loss how to measure high capacities.—O. R. C.

By constructing a rectifier and a low-frequency oscillator the low and high capacities may be measured, using the method diagramed. If the inductance of the coil in the oscillator is known, then the capacities to attain certain frequencies can be computed. For any inductance suitable capacity points to run a curve can be selected, or, laboratories at small cost will supply the data, either capacities related to frequencies, or known inductance or known capacity, or all three. All the information required for the relationship of capacity and frequency, and also winding the coil of known inductance, can be obtained from Edward M. Shiepe's book, "The Inductance Authority," which consists principally of curve-sheets. Beats with broadcasting stations used as frequency standards establish or verify the calibrations for low capacities. The measurement of high capacities requires that a known capacity be inserted next to the rectifier, between the posts marked "high capacities," and the voltage rise noted. Then another capacity is built up to establish the same rise as before, then the two put in parallel for the new rise, and so on, until the change becomes very slight. Thus capacities from 0.5 mfd. to 10 mfd. or more may be measured. The oscillator is not used in this connection.

* * *

Meaning of Hertz

SOMETIMES in your articles you use the term "hertz." What does it mean?—S. G.

The term "hertz" has been used in Germany for "cycles per second." It is in honor of Heinrich Hertz, the first man to transmit radio waves. Before broadcasting began radio waves were often spoken of as Hertzian waves. The term is finding favor in countries outside Germany because it is shorter than the expression ordinarily used. It is possible that the term will be accepted by some international radio conference, an action which would be welcomed by many throughout the world. It would be a reconciliation between those who speak of periods per second, mostly in England, and those who speak of cycles per second, mostly in America. The term hertz is preferable to either because it expresses in one word what otherwise requires three words. Simply to say periods, or cycles, is not exact, and "per second" is understood. But sometimes the sense requires that it should not be understood, so we could still speak of periods and cycles when they are meant and the time is not involved.

* * *

Why Difference in Timbre

WHY are the sounds of different instruments different when the same tone is struck? That is, why is it possible to tell the difference between the same notes as sounded by a violin and an oboe?—W. G. H.

The difference is called timbre and it is due to the difference in the harmonic content. The oboe is said to have a pure tone, or very nearly pure. A violin, on the other hand, produces a tone rich in harmonics. The same thing applies to different human voices. Two men might sing the same note, yet they will sound entirely different. The reason is that one man's vocal mechanism is such that it emphasizes certain overtones more than others while the other man's vocal mechanism will not emphasize the same overtones to the same degree. The difference in vowels in ordinary speech is due to the same thing. Two different vowels may be spoken by the same person in the same note, yet they are entirely different. Or two different persons, say a man and a woman, may speak the same vowel in different notes, yet they will be recognized as the same vowel. In this case the fundamentals are different but he timbre is about the same in the two instances.

* * *

Transmitter to Open Garage Door

WOULD it be possible to install a radio transmitter in a car and to have a receiver operating a relay in the garage so that when the power was turned on in front of the garage doors they would open? What are the objections to such a scheme?—G. L.

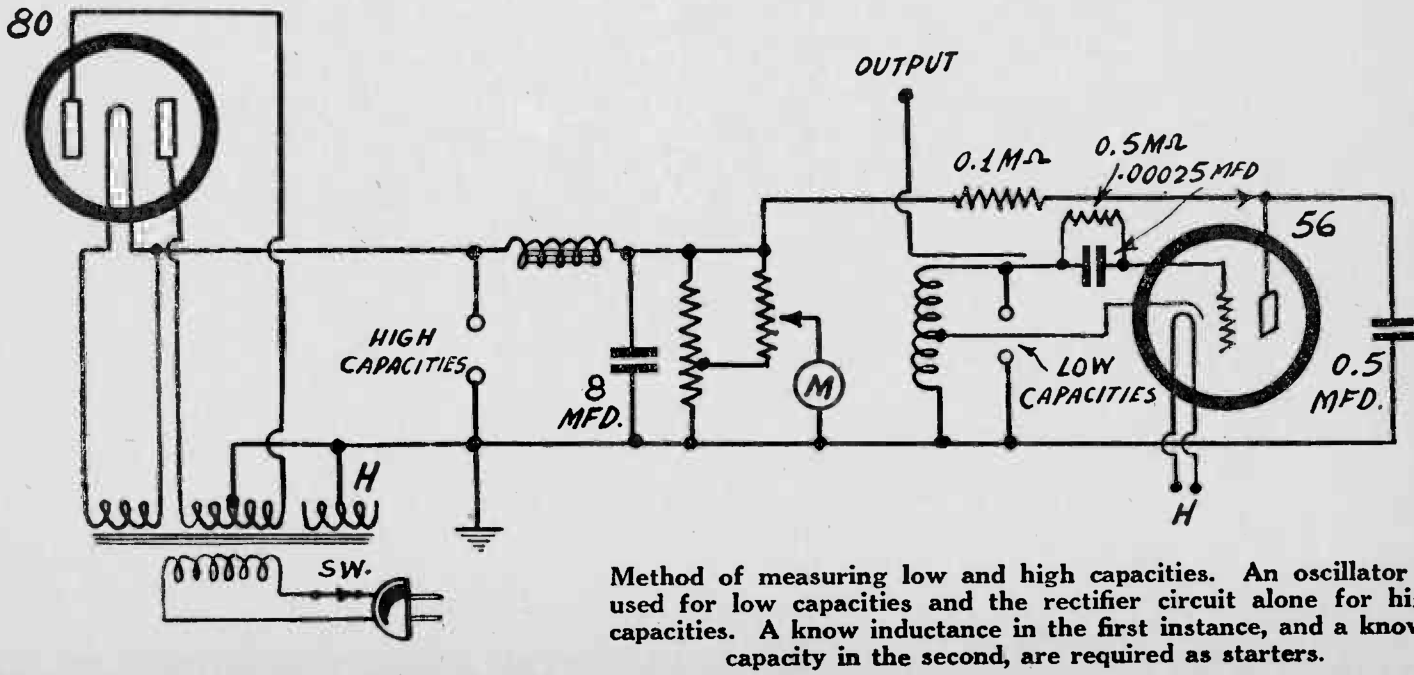
It would be possible, all right, for battleships have been maneuvered in that manner. There are two main objections to the scheme. First, a license would undoubtedly have to be obtained for the portable transmitter before it could be operated legally, and it might not be issued for such a trivial purpose. The second objection is that the receiver would have to be going all the time the car was not in the garage. It might, of course, be possible to have a transmitter powerful enough to make a crystal receiver trip the relay. But what good would that be if the car operator had to go into the garage to adjust the cat whisker before the set would function? A more practical method, it would seem, is a photo-sensitive receiver which would trip the relay by the headlights of the car. That, however, raises the problem of keeping the garage doors shut before sunrise and sunset, for if the headlights will open the door, the sun would undoubtedly do it too. That could be arranged, though.

* * *

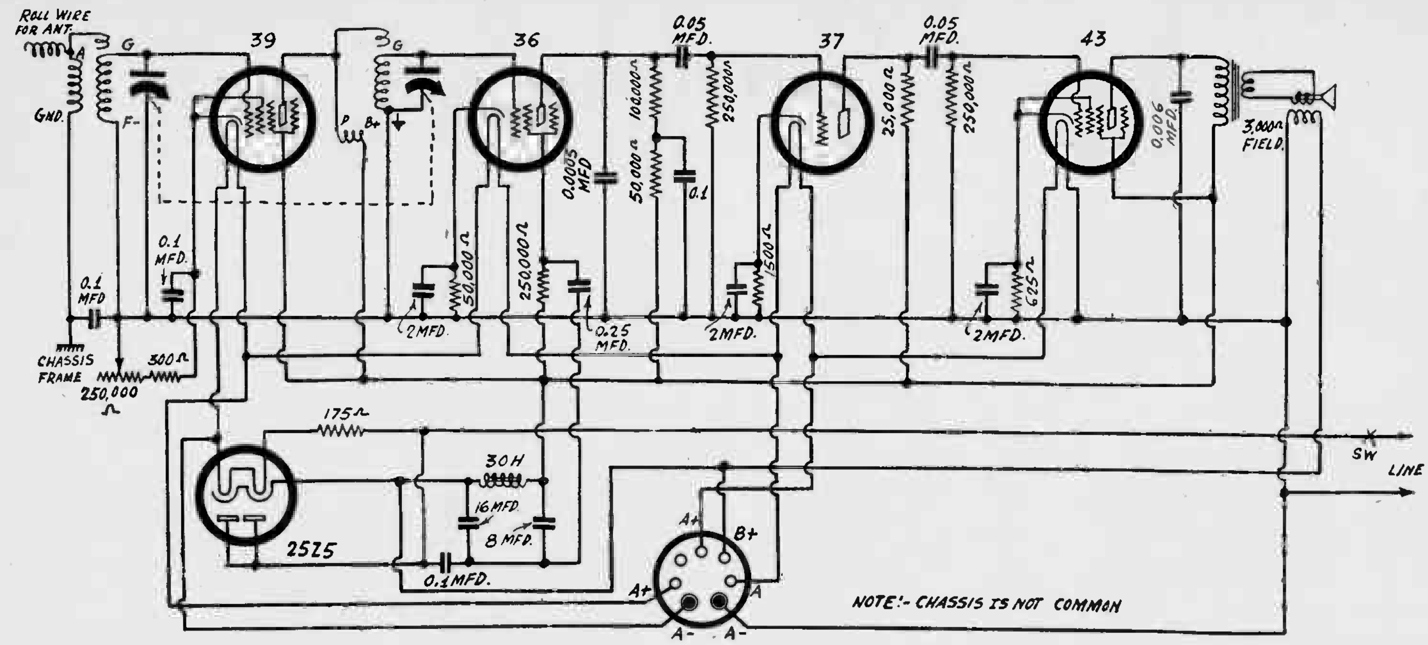
Problem of Transmission Line

THE surge impedance of a transmission line consisting of a central conductor surrounded by a metal sheath which is used as one side of the line is very low. I have a problem which requires a much higher surge impedance. Can you suggest a way of making such a line?—W. E. T.

Lines have been made by wrapping a ribbon of permalloy over the insulation of the inner conductor. The inductance per unit of length is increased in this way, and that increases the surge impedance. Perhaps if the outer conductor is just soft iron the inductance will be high enough. But whether or not this scheme works, that is, the use of iron or permalloy, depends on the frequency. It might also be possible to increase the inductance per unit of length by winding a coil over the inside conductor, or rather over the insulation of the inside conductor. There would have to be many turns per inch to increase the inductance much. Incidentally, the line impedance will go up if the capacity is small between the two conductors. Therefore if the inside conductor



Method of measuring low and high capacities. An oscillator is used for low capacities and the rectifier circuit alone for high capacities. A know inductance in the first instance, and a known capacity in the second, are required as starters.



A five-tube universal receiver, with 39 r-f, 36 detector, 37 driver and 43 output tube. The rectifier is a 25Z5.

be made large and a thick insulation is used, the outer solenoid will contain considerable inductance and at the same time the capacity will be small. It is the thickness of the insulation that would make the capacity small, not the thickness of the inner wire. The dielectric constant of the insulator should be as small as possible. Rubber has a dielectric constant of about four, and that is much. It would be a very tedious job to wind a solenoid half a mile long with about 50 turns to the inch.

* * *

Noise in Receivers

RECENTLY I have heard that in order to reduce noise in a receiver the plate current in the first radio frequency amplifier should be large and that accordingly the tube should not be put on the automatic volume control. Is this orthodox practice, or is it just gossip?—W. E.

There is more than gossip in the idea. It has been found that when the plate current is high in a tube the ratio between the signal and the tube noises is more favorable than when the plate current is low. Therefore anything that reduces the plate current will increase the noise. Since all the noise originating in the first tube will be amplified by all the tubes following, it is sound practice to keep the plate current in that tube high. Keeping the tube off the a.v.c. and on a low fixed bias is therefore good practice. It would be better to have all the tubes on low and fixed bias but then there is no way of controlling the volume automatically.

* * *

Converter with Superheterodyne

WHEN I operate my short wave converter with a superheterodyne there are many points all over the dial where I get a strong hiss indicating that there are signals present, but I have been unable to find anything but hiss at these points. What is the cause of the noise if it is not due to signals?—R. E. W.

The noise is due to harmonics generated by the converter, especially by the oscillator. The harmonics may be extremely weak but the superheterodyne is so sensitive that it will pick them up. The solution to the problem appears to operate the short wave converter so that the harmonics are very weak in the first place and then to prevent them from reaching the superheterodyne by means of suitable filters, that is, tuned circuits. Then it is not necessary to operate the super with is highest sensitivity.

* * *

Reducing Distortion in Amplifiers

IS IT a fact that the distortion in a two-stage amplifier is less than that in a one-stage amplifier, or three-stage amplifier? I have heard that when there are two or four stages the distortion in one tube will neutralize to some extent the distortion in the other.—W. J. S.

If the tubes are directly coupled there is a tendency for the distortion in one stage to neutralize that in the next. This would also be true in transformer coupled circuits if the windings were connected so that the two tubes were operating in opposite phase. The effect is the same, except in degree, as in the push-pull amplifier. In this circuit the distortion in one tube neutralizes that in the other, for the two tubes are equal and they are operated with the same signal, plate, and grid voltages, but in opposite phase. This does not mean, however, that the overall distortion will be less when tubes are added just to get an even number of stages, for each tube adds distortion and the neutralization is only partial.

* * *

Small Universal Set

KINDLY PRESENT a five-tube universal circuit diagram, using only a two-gang condenser. The set is to be used only for tuning in a few locals, but the volume should be good. Selectivity in this instance is not important.—E. I. N.

The diagram shows such a circuit. All the tubes draw the same current at the rated voltages, that is, 0.3 ampere, so there is simplification in that direction. The rectifier is a 25Z5.

* * *

Beat Note Oscillator

IN CONSTRUCTING a beat note oscillator of audio tones, should the rate of variation of the audio frequency to linear or logarithmic? In other words, should the total frequency band covered be divided so that one division on the dial represents the same frequency difference at all parts of the dial or should it represent equal percentage change of frequency? What kind of beat note oscillator do you recommend?—W. H. C.

Whether the frequency rate of change is constant or directly proportional to the frequency depends on the purpose of the oscillator. For a constant rate of change the scale would be logarithmic, or the scale would represent octaves. This would, perhaps, be the most desirable in the majority of applications. But if absolute frequency differences are desired, it would be better to have a linear scale. One of the best oscillators for a beat note generator is the Colpitts. It can easily be stabilized as to frequency, and that is important for measurement purposes. One application for the beat note oscillator having a logarithmic or octave scale would be to the tuning of pianos. Yes, it can be made accurate enough for this purpose. When the beat generator is to be used for taking response curves on speakers and other acoustical apparatus, the octave scale would also be the more suitable. It is clear that the scale can be either type for any given condenser used for varying the beat, but it would be by far preferable to have a condenser which would make the scale linear in either case. To have a linear variation of the frequency and the scale linear as well, the condenser used for tuning should be of the straight line capacity type, provided the beating frequencies were high enough. To have a logarithm frequency variation and a linear scale, the condenser would have to have a logarithmic change of capacity.

* * *

A Short Wave Receiver

IN THE Dec. 9th issue Mr. Edwin Stannard described a short wave receiver. I have decided to build this circuit, but I suspect that there is an error in the diagram. I notice that one side of the filament of the detector is connected to ground, and also that the middle point of the filament winding is grounded. It seems to me that there is an error there. Will you kindly publish a corrected drawing if the one in the issue cited is not correct?—B. W. T.

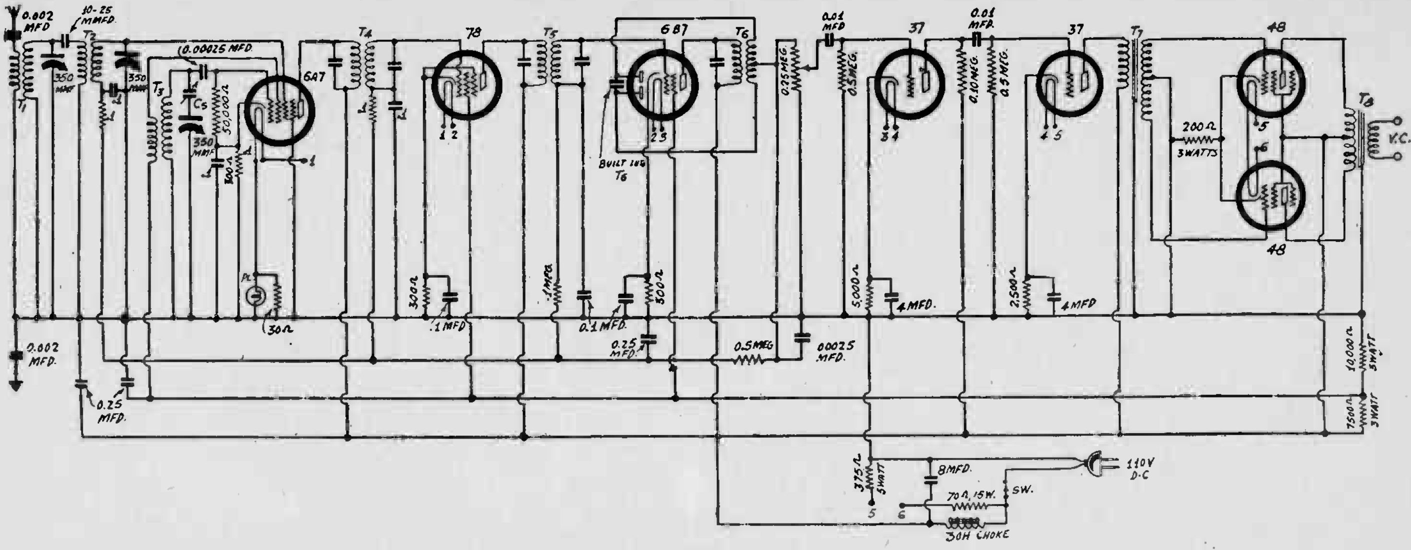
Yes, there is an error in the drawing as you suspect. The filament should not be grounded, for it would short circuit half of the filament winding and give the tubes only half the voltage. Moreover, the transformer would heat up. A corrected diagram is printed on page 8.

* * *

Wattages in Speaker Fields

WHICH will be the more sensitive speaker, one with a field coil of 4,000 ohms or one with 3,000 ohms? What determines the sensitivity of the speaker?—W. E. L.

It is not possible to compare sensitivities of speakers by the resistances in the fields alone, for there are many other factors. The best way of comparing, other things being equal, is by the number of ampere-turns in the field, for that is the magnetizing force. The resistance of the field coil is not involved at all in the ampere-turns. You may have the same ampere turns when the resistence is 6 ohms as when it is 10,000 ohms. The currents will be different, of course. Another consideration is the heating of the wire in the field, and hence of the field coil as a whole. If the resistance is high and an attempt is made to make the current high, the wire will overheat and the insulation might burn up. The heating of the coil is directly proportional to the power expended in the coil. By heating is not meant the final temperature, however. The power is the product of the current squared and the resistance, or the voltages



A bi-resonating circuit for use where there is no tube ahead of the modulator in a superheterodyne.

squared across the coil divided by the resistance. The sensitivity can be increased, for a given resistance, by increasing the voltage across the coil, but the safe limit of voltage is determined by the heating and by the final temperature. If the ventilation is good it is permissible to use a higher voltage than if the ventilation is poor, for the final temperature largely depends on the ventilation, as well as on the amount of heat supply in the form of volt-amperes.

* * *

27 As Rectifier

COULD the 27 or similar tube be used as a rectifier for the speaker field by connecting the tube, as a diode, in series with 110 volt a-c line and then in series with the speaker held? How much current could be drawn from the tube when it is used in this manner?—N. L.

Yes, the tube can be used in this manner, and a current of 30 milliamperes could be drawn. Of course, the tube would not last as long when it is drawing 30 milliamperes as when it is only drawing 5, but these tubes are inexpensive and frequent replacements would not be a burden.

* * *

Adjustments for Highest Sensitivity

CAN you suggest a simple way of making adjustments on a grid bias detector so as to make it the most sensitive? I have an output meter and a signal generator and should like to use them.—F. W. K.

Use the signal generator as a source and impress a weak signal on the grid of the detector. Use the output meter in its normal place. Make adjustments on the detector until the output is greatest for the weak signal impressed. The signal impressed on the detector grid should be modulated. If it is inconvenient to impress the signal on the detector it can be impressed on the regular input. It should be remembered that the sensitivity will not be the same for strong signals as for weak. Hence the signal should be as weak as possible to give a readable output. On strong signals it is not necessary that the detector be sensitive.

* * *

Choice of Output Tubes

WHEN high output of good quality is the main object of an amplifier, which are the better tubes, the 250 or the 2A3, assuming that the applied voltage in the plate circuit of the 250s is 450 and that in the 2A3 is 300 volts. Which tubes would give better results in a push-pull amplifier?—F. G. W.

The wattage rating of the 250 tube with 450 volts in the plate circuit is 4.6 watts, the bias being 84 volts. The output of the 2A3 with 300 volts in the plate circuit and a bias of 62 volts is 15 watts for two tubes in push-pull. The output of two 250 tubes would be about 10 watts. Hence the 2A3 is superior in the ratio of 3 to 2. Moreover, the signal voltage required on the 2A3 is considerably less than that required for the 250. Thus it not only has a greater maximum undistorted output but it requires less bias and less plate voltage and still it has a greater power sensitivity. Another point of superiority is that the 2A3 requires less plate current, only 40 milliamperes as against 55 for the 250. Therefore there are less losses in the tube.

* * *

Bi-Resonator

WHAT METHOD of connection may be used if one has a three-gang condenser, but there is no radio-frequency amplification ahead of the modulator in a superheterodyne, yet additional selectivity is desired?—U. D. C.

The method may be as diagramed, whereby a small capacity unites the two windings, of which the third winding from upper left is a primary of somewhat higher inductance than usual, say, about twice the number of turns as on the other primaries. The three windings constitute the input a bi-resonating circuit. The method has some advantages, as selectivity will be improved if the coupling condenser is small enough, but it is preferable to use tubes between tuned stages.

* * *

Low-Resistance Measurements

THE METHOD you have developed for low-resistance measurements by shunting the meter is interesting and practical. I note your formula in the December 30th issue, page 9. This is closely approximate. Can you give the stricter formula?—A. L.

The method you refer to is to short the high-resistance measuring terminals and shunt the meter with the unknown low resistance. The December 30th formula suffices. However, the closer one follows:

$$Rx = \frac{R\,Rm}{\frac{E}{Im} - (R + Rm)}$$

where Rx is the unknown low resistance shunting the meter, Rm is the internal resistance of the meter, R is the limiting resistance (3,000 ohms in the special case of the December 30th article), E is the battery voltage and Im is the current through the meter alone.

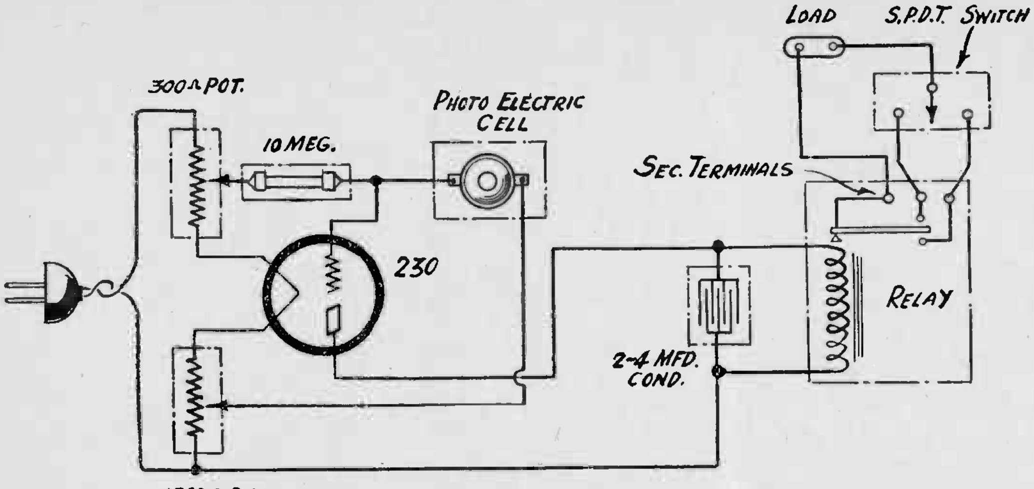
If the meter resistance is small in comparison to the limiting resistance, as it will be for all meters of 0-1 or greater sensitivity (lower full-scale current) the formula is:

$$Rx = \frac{Rm\,\frac{Im}{Io}}{I - \frac{Im}{Io}}$$

where Rx is the unknown, Rm is the meter resistance, Im the current through the meter only, and Io is the full-scale deflection current of the meter.

If the scale reads in divisions of 10 the formula based on deflections is:

$$Rx = \frac{Rm\ D}{1 - D}$$



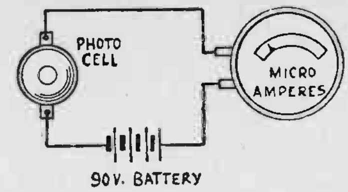


Diagram embodying the idea of starting a motor with the lights from an automobile, so that a garage door will open without the driver leaving his seat. The diagram at left should be considered. For a car the 30 filament voltage would be obtained not from the line, as shown, but from the six-volt storage battery, but the theory remains unimpaired. The small diagram at upper right is for calibration of the photo-cell current output in respect to amount of light input.

where Rx is the unknown, Rm is the meter resistance and D is the deflection in arbitrary units.

The formulas apply to any d-c meter.

* * *

Photo-Cell Setup

HOW CAN a photo-electric cell be used to operate a switch on a motor, as for headlights of a car entering a garage to start the motor that opens the garage door without the driver leaving his seat?
—I. E. C.

The principle is illustrated in the diagram herewith, although this circuit is intended primarily for operating from the a-c or d-c line, of around 110 volts. For a car the filament voltage would be dropped to 2 volts for the 30 tube, from 6 volts at the battery, through a 66-ohm resistor, 5 watts. Reading the diagram at left, the light is picked up by the photo-cell, which changes light values into current values. When the light is strong enough, as it may be from the bright headlights, or from a special light cast from the car onto the cell, which cell should be of the highly-sensitive type, the current output causes a voltage drop in the 10-meg. grid leak, and the 30 tube acts as a d-c amplifier to cause enough current through the field of the relay winding to throw the armature. The relay may be made either to open or close a circuit by the illumination of the cell, depending which way a single-pole, double-throw switch is thrown. The switch is then left in that position. The other or motor switch is relay-controlled and either the electro-magnetic action throws one contact against another (closing circuit) or moves one contact away from another (opening circuit). The small diagram at upper right shows how to measure the current due to the light, if calibration is to be made as part of the experimental work.

* * *

WAVE New Member of NBC Networks

A welcome to WAVE, Louisville, Ky., when it joined the National Broadcasting Company networks was extended in a program of popular vocal and dance music over an NBC-WEAF hookup.

New York, Chicago and the Louisville station took part in the dedication frolic.

The new NBC affiliate serves a large section of north-central Kentucky and brings the network programs into thousands of homes in the bluegrass country. WAVE operates on 319 meters, 940 kilocycles, and can be linked with either NBC-WEAF or NBC-WJZ networks.

The Review

Questions and Answers Based on Articles Printed in Last Week's Issue

Questions

1. State a method of frequency stabilization applying even to a regenerative detector.

2. State one of the requisites to a good television picture, relating to scanning at the sending and receiving ends, and give a general statement of the required frequency band of transmission.

3. Taking a book as the analogy, state the equivalents to the following: scanning line, frame, picture frequency.

4. Give the true definition of decibel. State in general how a voltage divider may consist of a series of fixed resistances to cause attenuation in steps of 2 db from 2 db to 20 db by moving a slider to the contact points of the resistance network.

5. For a 0-1 milliammeter of 32 ohms internal resistance, assuming the meter itself is being shunted to measure low resistances, when the usual high-resistance-measuring circuit is closed, why is the low-resistance calibration much different than for a 27-ohm meter?

6. If a 3-volt battery used in conjunction with an ohmmeter requires a resistance of 3,000 ohms to protect the meter and afford full-scale deflection, what is the sensitivity of the meter? How can the apparent increase of the battery resistance be compensated if the limiting resistor is fixed? What would be a remedy? If two resistances are part of the solution, give some idea of the proportionality.

7. Where there are numerous meter ranges, state the precaution to be taken for safeguarding the meter, though no fuse or relay is used.

8. State two practical reasons why improved selectivity ahead of the mixer in a superheterodyne is important, and state the minimum number of sections of a gang condenser to be used for broadcast reception to bring about the dual advantage.

9. Are there harmonics present in the oscillator of a pentagrid converter tube as usually hooked up, and if so, why?

10. For minimum of harmonic intensity should the feedback be large or small? Which is applicable to greater gain and smaller harmonic content—large tickler or small tickler?

11. State three methods of preventing or curing oscillation at the radio-frequency level. Give details or precautions as to use.

12. State values of inductances for r-f and oscillator, and values of oscillator series padding condenser, for the following: 0.00035 mfd. to 0.0004 mfd. condenser sections; 175 kc and 465 kc intermediate frequencies.

13. In the leak-condenser type oscillator is the oscillation intensity greater at the low-frequency end or at the high-frequency end, and why?

14. How many frequencies are present in the output of a mixer in a superheterodyne, and does the i-f amplifier select all of them, or less, and why?

15. Does the control of a single i-f tube by a.v.c. give any appreciable result? What is the situation in respect to very weak signals which are subject to fading?

16. Can the voltage across the load resistor of a diode detector be read with a current-drawing meter, and if not, why not? How can the voltage be read, assuming the same meter is used as indicator?

17. State a method of building a nine-tube universal receiver that totally or practically eliminates the waste in a limiting resistor. State in general the heater characteristics of the tubes to be used.

18. Is it practical to put shunts on a-c meters for current-range extension, just as is done with d-c instruments?

19. If a 56 oscillator is somewhat close to a 58 modulator is it usually necessary to provide extra coupling, to unite the r.f. with the o.f.?

20. What is the grid number of the control grid of the 2A7 and 6A7?

Answers

1. Frequency stabilization may be established by tuning the plate circuit of the tube, and having an isolated coil of the same inductance as that across which the condenser is put, connected between condenser stator and plate. There must be no grid current.

2. One of the requisites for a good television picture is that the picture itself should be picked up at the transmitting end with sufficient detail, which requires that the number of lines be larger than commonly encountered, good results being obtainable with 240 lines. The more numerous the lines, the wider the required channel width. At the receiving end the scanning must be on the same line basis as at the transmission end for best results.

3. Comparing these things to the situation obtaining in respect to a book, the scanning line is like the line of type in the book, as it reads also in the same direction, left to right. The frame is equal to the printed page of the book, for the frame is the single picture, and that consists of the total number of lines, and these, as in a book, are from top to bottom, as well as being, per line, from left to right. The picture frequency, or number of frames per second, to press the analogy perhaps a bit artificially, would be the number of times per second the pages were turned for viewing. Thus, if the pages were assumed to be viewed 24 in sequence per second, that would be equivalent to a picture frequency of 24, as used in the movies and also in some television transmission.

4. A decibel is 10 times the common logarithm of the ratio of two powers. One decibel is supposed to equal the smallest difference in sound quantity readily perceptible to the human ear. The true definition by equation is $db = 10 \log_{10} (P1/P2)$, in which P1 and P2 are the powers compared. Consider a signal voltage introduced across a total resistance series network, the grid of a vacuum tube connected to slider that picks off taps on the network, grid returned and tube biased, etc. If the total resistance is known, the integral resistances may be selected on the basis of the equation, for variations of input in steps of 1, 2 or more decibels, from 2 or less to 20 or more decibels.

5. The internal resistance of the meter is the resistance that is being shunted, and therefore the difference between 27 and 32 ohms, about 20 per cent., can not be neglected, if the accuracy is to be better than 20 per cent. By correct proportioning of resistors the accuracy could be 1 per cent.

6. The sensitivity of the meter is expressible in terms of the current at full-scale deflection, the current equalling the voltage in volts divided by the resistance in ohms, or, $3/3{,}000 = 0.001$ ampere (1 milliampere). At full-scale deflection the sensitivity may be expressed in ohms per volt, equalling the resistance divided by the voltage, or $3{,}000/3 = 1{,}000$ ohms per volt. If the limiting resistor (3,000 ohms, e.g.) is fixed, there can be no compensation for apparent decrease in the battery voltage due to time and use. A remedy would be to add about one-third to the total required value, use half of this total as a fixed resistance and the other half as a rheostat. Then as the battery resistance increases, the series resistance external to the battery may be decreased by the same amount. This always can be checked so that full-scale deflection is obtained, provided that the zero setting of the pointer is correct from the start.

7. For various meter ranges, always assume that the voltage to be measured is the highest voltage the meter will read, and that the current to be measured is the highest current the meter will read. This is like the safeguarding presumption that all guns are loaded.

8. Improved selectivity in a broadcast superheterodyne's r-f level reduces or eliminates the heterodyne interference due to off-resonant locals getting by the tuner and creating spurious reception due to union in the mixer with oscillator frequencies and harmonics. Also, improved selectivity reduces or prevents reception of high-frequency stations at low-frequency settings of the dial, due to affectation by oscillator second harmonic. The minimum number of tuning sections to accomplish this is four, meaning in general two stages of t.r.f., tuned modulator input and tuned oscillator.

9. Harmonics are abundantly present in the oscillator of the pentagrid converter, hence in the modulator as well. This is because the grid leak type of oscillator is used. The action depends on the flow of grid current. When there is grid current there are bound to be harmonics.

10. For minimum harmonics use a small tickler. Large tickler spells greater oscillation intensity, greater gain, more and richer harmonics; small tickler the opposite.

11. Oscillation may be prevented at the radio-frequency level by putting large-inductance r-f chokes in plate leads of each r-f coil, bypassing from coil return to ground through a condenser; by using shield wire on overhead grid leads and grounding the shield; and by using unbypassed series plate resistors of 2,000 to 5,000 ohms, depending on the intensity of the oscillation to be cured. Selectivity must be watched where the resistor method is used.

12. The r-f inductance for 0.00035 to 0.0004 mfd. is the same for any intermediate frequency, because independent of it, and may be 230 microhenries. The oscillator inductance for 175 kc should be 190 microhenries, padding condenser 850-1,350 mmfd., the oscillator inductance for 465 kc 126 microhenries, padding capacity 400-500 mmfd.

13. The oscillation amplitude is greatest at the low-frequency end, and is very steady until the capacity in the tuned circuit is small. This is because the leak is a limiting resistor for d.c. that by negative bias reduces the oscillation circuit current as the oscillation voltage tends to build up.

14. Too many to mention. Three of them are (1), the frequency equal to the modulator frequency subtracted from the oscillator frequency, (2) the frequency equal to the sum of the modulator and the oscillator frequencies, and (3) the frequency equal to the difference between the modulator's fundamental and the oscillator's second harmonic.

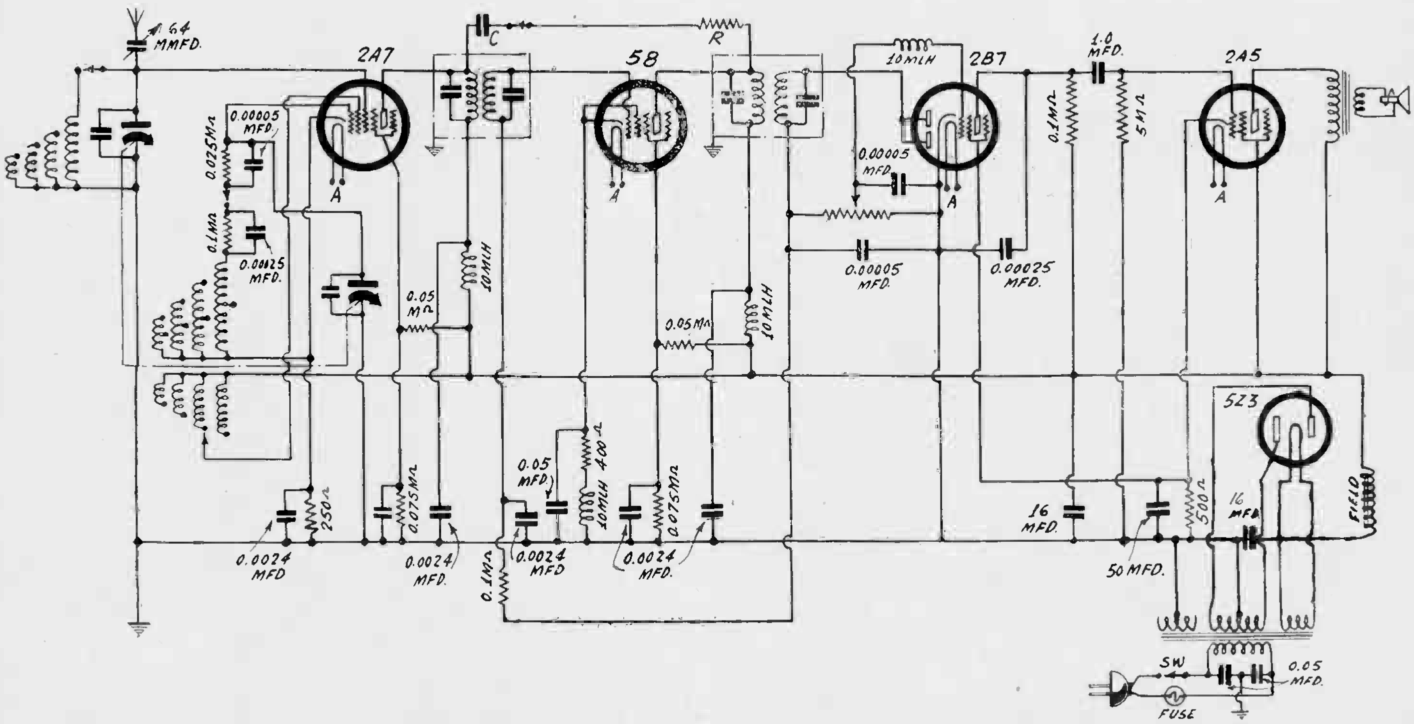
15. Yes. But in respect to very weak signals, a.v.c has practically no effect on reducing fading, as there is not enough rectified signal voltage present to accomplish such result.

16. No, because the current through the measured circuit is so small, and that through the meter so large by comparison. Put the meter in series as a voltmeter, omitting the usual load resistor, and correct voltages will be read, though at the low end of the meter scale even for strong signals.

17. To build a universal receiver practically without a limiting resistor, use tubes of the same heater current rating (0.3

(*Continued on page 22.*)

For Wide Frequency Coverage, Using Only Five Tubes



While results of course do not compare with those from high-powered sets, nevertheless foreign reception is not unusual from a circuit of this type, for short-wave construction.

High-Powered Eleven-Tube Receiver

(*Continued from page* 13.)

ampere), heaters in series, and have the sum of the dissimilar heater voltages equal

There is a power transformer commercially available that suits the requirements of this circuit, and the transformer connections are diagramed herewith. The wiring diagram of the circuit to that extent is imprinted to coincide with the transformer designations. While the direction of lugs is a clue to identities, the winding X is additionally identified on the transformer by a penciled X.

All necessary filtration precautions have been taken, and the hum will be exceedingly low, and can be kept under 2 per cent. This is due to the use of a 30-henry choke of low d-c resistance for output tube service, and inclusion of the field winding of the dynamic speaker for additional filtration for the other tubes' B supply, and incidentally to reduce the maximum B voltage to somewhere around 250 volts or less. The B voltage may be even 200 volts for these tubes, especially as the 58's B current is determined by the screen voltage rather than on the plate voltage.

The resistance of this field winding is not critical, and may be from 1,200 to 2,500 ohms. Of course the higher the resistance, the lower the B voltage to the tuner tubes, but, as stated, this is not so important.

The four-gang condenser used had a capacity of 0.000406 mmfd., and the secondary inductances for the r-f level were 230 microhenries, while the oscillator secondaries were 126 and 67 microhenries respectively. These coils are commercially obtainable.

Squealing trouble is avoided by introducing the filtration as shown, and also by using shielded wire for the grids of the 58 tubes and the 55. At the r-f level this wire should have a thick serving of cotton between the conductor and shield, to avoid too high capacity to ground, which would prevent reaching even 1,500 kc, much less 1,600kc. At the i-f level the type of shield wire is immaterial.

The parts are generally obtainable, except perhaps to 50 mmfd. condensers (0.00005 mfd.), but it is permissible to use 100 mmfd. instead (0.0001 mfd.).

A long aerial may be used, and selectivity will still stand up adequately, for there is a total of ten tuned circuits.

The tickler for the oscillator should be the smaller of two windings found on commercial coils, as by using a small tickler, while the conversion conductance is, indeed, relatively lowered, the harmonics are reduced perceptibly, as this checks the vice of tuning in higher frequency stations at low-frequency dial settings, where the second harmonic of the oscillator is beating with a fundamental that escapes through the tuner. With the three tuned stages devoted to the r-f level this escape is very small indeed, and in nearly every instance unnoticeable.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*

R. J. Gatling, 251 Fairview Ave., Bogota, N. J.
R. R. Coll, 1411 West Street, Wilmington, Del.
Leo Mills, Kulgoa Road, Kulgoa, Sydney, Australia.
S. Deuchar, 56 Denbigh Road, Armadale, Melbourne, Australia.
C. D. Brock, 128 North Terrace, Kinsington Gardens, Adelaide, S. Australia.
W. Hickman, 41 Aberdeen St., Perth, W. Australia.
W. Burl, Englefield, Broughton Road, Artarmon, Sydney, Australia.
Geo. R. King, Gordon Inst. Tech., Seelong, Vic., Australia.
F. C. Martin, Fukien Christian University, Foochow, Fukien, China.
P. A. Mongredien, Let Live Cottage, Weston, England, Stevenage Herts.
F. V. Morris, Natala, 192 The Avenue, Royal Park, Melbourne, Australia.
W. K. L. Dickson, Vermont Cottage, La Haute, Jersey, Channel Isles.
G. Jenks, 3 Finch St., Morningside, Auckland, New Zealand.
P. A. Johnson, Blackwood Farm, Northlands, Johannesburg, So. Africa.
H. C. J. Asche, St. Stevens College, Stanley, Hongkong, China.
Prof. Griffing, 446 W. Garfield Ave., Glendale, Calif.
Rev. J. R. Harper, Kongwa, via Mpwapwa, Tanganycka Ter'y, Africa.
Chon PeLok, Tamboanga Chinese School, P. O. Box No. 40, Marauai St., Tamboanga, Ph. Is.
Rev. A. W. Knoll, Lubuangan, Kalinga, Mt. Province, Ph. Is.
Robert Kemper, 5344 Broad Branch Road, Washington, D. C.
William E. Cox, 912 S. Harlem Ave., Freeport, Ill.
Tom W. Burress, Jonesboro, Ark.
M. Mickelson, Paramount Radio Technicians, 3229 Bloomington Ave., Minneapolis, Minn.
E. A. Gauthier, 455 Mass. Ave., Boston, Mass.
J. W. Moore, Fort Edward, N. Y.
H. N. Bliss, 107 Elmwood Ave., Ithaca, N. Y.
G. A. Dey, 284 Huron St., London, Ont., Canada.
Roy B. Corry, Route No. 4, Orlando, Fla.
Donald C. Fleming, 511 7th Ave., West., Calgary, Alberta, Canada.
A. R. Moser, No. 33697, c/o A. W. Schwerdtferger, Chief Electrician, Box 47, Jefferson City, Mo.
T. O. Catlett, No. 34085, c/o A. W. Schwerdtferger, Chief Electrician, No. 47, Jefferson City, Mo.
Vernon A. Douglas, 8 Second Ave., Garwood, N. J.
Chas. W. Engelman, Radio Service, 404 3rd Ave., So. Minneapolis, Minn.
R. F. Voth, 4320 42nd Ave., So., Minneapolis, Minn.

Station Sparks

By Alice Remsen

Jack Pearl's New One

Well, by the time this reaches print another year will have begun; of course, it is trite to wish things better, for that is what every mother's son and daughter has been doing for years, but it really does look as though an upward trend has set in; some of our clouds have a real silver lining. . . . Jack Pearl started the New Year well; he finished with Lucky Strike on December 23rd and opened with Royal Gelatine on January 3rd. He is retaining his character of Baron Munchausen and has taken his straight man, Cliff Hall, right along with him to the new show. . . . Ring Lardner, Jr., son of the famous humorist, was partly responsible for the libretto of the Princeton University Triangle Club Show, which was heard over NBC last month. This was the forty-fifth annual production of the Princeton student's organization. . . . A book that should make interesting reading is the autobiography of Cliff Walker, NBC actor, which is now in preparation; in it he will tell about his early life in East Africa, where he was a close friend of Cecil Rhodes, Edgar Wallace (then a private in the British Army) and Olive Schreiner, famous writer; after Walker went on the stage he toured for many years through Australia, India, New Zealand, Tasmania, and the Islands, first with dramatic companies and later as a "One Man Show." During part of this time his advance agent was Harry Neville, now also an NBC player, who is frequently heard in Radio Guild, and other dramatic productions. Walker himself is at present appearing in a leading role with the "Adventures of Dr. Doolittle," broadcast over an NBC network. . . .

Glen Gray and His Casa Loma

Many people have wondered how Glen Gray came by the Spanish sounding name, Casa Loma, for his orchestra; the explanation is very simple. A few years ago, before the Prince of Wales bought his Alberta ranch, the Canadian people decided that a castle should be built for the residence of the Prince when he visited Canada. So Sir Henry Pellat designed and built the Casa Loma castle, but the Prince of Wales bought his ranch and stayed there, never even visiting Casa Loma. Sir Henry lived there himself for five years, then the Castle was turned into a hotel; Glen Gray's orchestra was hired to play there—and hence the name, which has stuck ever since and become nationally famous. . . . And just to prove that the saying "You never know your neighbor in New York" is true, here are Frank Luther and Howard Barlow, living next door to each other for a year and half, not knowing it and meeting almost every day in the CBS studios. . . . Fray and Braggiotti, Columbia's well-known piano team, are the latest radio artists to succumb to the lure of the Kleig lights; the boys are doing a number in the feature picture, "Social Register." . . . The David Ross Anthology, "Poet's Gold," is going into its second printing. . . . And Charles Howard, NBC tenor likes a Bermuda onion sandwich for his midnight lunch! . . . Nino Martini's contract has been renewed on the Seven Star Revue, for an extended period. . . . Ted Husing visited Los Angeles over the holidays, as also did Ralph Wonders, head of Columbia's Artists Bureau, and Phil Regan, the handsome excop. I'll bet the movie-magnates will have something to offer the handsome Phil, for his profile is just as fine as his voice. . . .

Their Favorite Lines

The other afternoon I discovered a prowler with a pad and pencil up at the CBS studios earnestly inquiring for the favorite lines of CBS artists; he asked me mine—I don't happen to be a CBS artist at present, but I obliged just the same; my favorite line is one which was drilled into me by my mother: "Anything which is worth doing at all is worth doing well;" I've never forgotten it, either; other artists responded, among them: Gypsy Nina —"Silence is golden;" Harriet Cruise— "Do unto others as you would have them do unto you;" Boake Carter—"No gains without pains;" Jacques Renard—"Strike while the iron's hot;" Willard Robison— "Be sure you're right; then go ahead;" Tom Waring—"Distressed dollars never win;" Nino Martini—"By going with wolves you learn to howl;" Donna "Marge" Damerel—"Fools and children tell the truth;" Johnny Green—"Hitch your wagon to a star;" Jane Ace—"What is to be will be;" Edith Murray—"It's never too late to learn;" Elaine Melchoir —"Practise what you preach;" Georgie Jessel—"If God will a broom can shoot;" H. V. Kaltenborn—"Do or die," and Ray B. Collins—"A rolling stone gathers no moss." Rather an interesting survey! . . .

Gertrude Niesen, Actress

Gertrude Niesen has become an actress since Lulu McConnell's dramatic exit from "The Big Show;" Gertrude is starring as herself in a script written by David Freedman; featured with her are Stephen Fox, Geoffrey Bryant and Lionel Stander. . . . Maestro and Mrs. Don Voorhees are the happy parents of an eight-pound boy, born on the night prohibition ended, December 5th. . . . Vera Van and the Men About Town are making a movie short together. . . . And Alexander Woollcott got his wish—a copy of the first Gibson book; he asked for it over the radio—offering to purchase a copy, but a New York woman, who enjoys his broadcasts, sent him a copy for a Christmas gift, and so "Woolly" is happy. . . .

How You Can Tell

You may know them by these: Glen Gray—"Smoke Rings;" Don Redmond— "Chant of the Weed;" Guy Lombardo— "Comin' Through the Rye;" Harry Frankel—"Tammany;" Vera Van "Blue Hours;" Mildred Bailey—"Rockin' Chair;" Gus Arnheim—"Sweet and Lovely;" Ozzie Nelson—"Loyal Sons of Rutgers," and, of course, Little Jack Little—"Little by Little" . . . Gypsy Nina's first movie-short will soon be released. . . . There is a new program at WMCA known as "The Songs of Israel," presenting a wide variety of Jewish music and featuring Eva Miller, and a quartet and a guest artist each Tuesday evening at 7:15 p.m. . . . Charles Hackett, the eminent American tenor, is busily engaged rehearsing for the opening of the Metropolitan Opera season, but still finds time to sing over WMCA. Mr. Hackett is especially fond of 16th century music and usually manages to include one or two of these old classics in his recitals. . . . A popular program down south is "Three on a Mike," which goes out over Station WSM, Nashville, Tennessee, with the voices of Velma Dean, Betty Waggoner and Marjorie Cooney joining in blues harmony extraordinary; each Monday evening at 9:45 p.m. . . .

It's in the Blood

Harry McNaughton, who is Phil Baker's butler, Bottle, comes of an all-theatrical family. His father was a theatre manager in London. Three uncles, Tom, Fred and Charles McNaughton, have been prominent on the stage in England and America. Harry is the youngest of the McNaughton tribe—and is he clever! . . . Harry Link left the firm of Keit-Engel, Inc., music publishers, with the New Year. Harry has not yet announced a new affiliation. I should think radio could use a man like Harry. He has a lot of good ideas about radio artists and programs. . . . Jack Kay, master of ceremonies on the Station WLS, Chicago's Sunshine Express, asks for old jigsaw puzzles, decks of cards, or games of any sort for distribution among disabled war veterans. You may reach Mr. Kay in care of Station WLS, Chicago. . . . Henry King, popular orchestra leader, now playing at the Hotel Pierre, New York, and recording artist for the RCA Victor Company, has just signed a contract which places him under the personal management of Irving Mills. . . . Excuse me please; I hear the voice of Rosa Ponselle pouring out of my loudspeaker and I must go and listen.

A THOUGHT FOR THE WEEK

RICHARD HIMBER'S ORCHESTRA, which broadcasts from the Ritz-Carlton, is a combination that makes the ordinary bunch of musicians sound squawky and ridiculously lacking in any real talent. Mr. Himber has common-sense enough to know that there is no truth in the oft-repeated statement that the average listener-in has the intelligence of a twelve-year-old. He knows the value of popular music but he does not approve of the dreary stretch of honk-honk and blah-blah to which so many orchestras devote their misspent efforts and their wind. Dick Himber should start the American Academy of Musical Don'ts and teach some of our directors what not to serve up for the tired public ear!

P.S.—And Mr. Himber has rediscovered what so many of us have forgotten because of neglect—that the harp is still a lovely instrument of sound!

The Review

(*Continued from page 20*)

the line voltage, or, to make up any small difference, use a pilot lamp in series, possibly shunted by a resistance somewhat greater than the lamp's working resistance.

18. If the meter is non-reactive and if non-reactive shunts are used, it will work. It is difficult to get non-reactive shunts even if the instrument is non-reactive. An a-c meter using a hot wire or a thermocouple is practically non-reactive and for these shunts might be used. If the frequency of the alternating current to be measured is low there is no difficulty in making the shunts non-reactive.

19. The coupling usually will be sufficient due to the proximity and also to the stray coupling through the wiring capacities, inductance strays, etc.

20. No. 4.

WOR Gets Disc of Its Reception in England

J. R. Poppele, chief engineer of WOR, Newark, N. J., has received evidence of foreign reception of WOR programs in the form of an aluminum disc on which they were recorded.

The disc came from F. Wiseman, General European DX-ers Alliance, 13 Kyle Street, Scotswood, Newcastle-on-Tyne, England. He recorded parts of two compositions played by Paul Whiteman's orchestra. Poppele's engineers almost wore out the record in familiarizing themselves with how the station sounds in England.

SPECIAL GIFT LIST

Reliable Radio Tips

Watch for This Special Page Weekly

RELIABLE RADIO RUNS GIANT HOLIDAY SALE!!

FOR A PRACTICAL GIFT SUGGESTS GIVING A RADIO—LET THE ENTIRE FAMILY ENJOY IT

EXTRA!

SHORT-WAVE SETS

ACCLAIMED THE IDEAL GIFT FOR RADIO-MINDED FOLKS

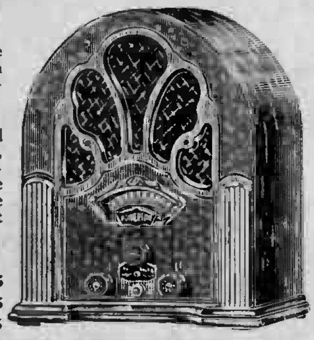
If you really want to please your radio-minded son, father, mother, brother, sister or friend this Christmas, give a short wave receiver. On this page are several very fine receivers for both the beginner and the more advanced short wave enthusiast, yet all at extremely low prices.

Reliable Treasure Chest Receiver

A Handsome Four-Tube "Treasure Chest" model receiver which is a splendid piece of furniture and a high quality midget receiver. The beautifully designed cabinet built by craftsmen will satisfy the most critical person. Tubes used: 1-57, 1-58, 1-80 and 1-47 power pentode. Uses a full sized dynamic speaker. Price **$9.50**

4 tubes $1.45

4 and 5 Tube A.C. Midgets



A practical gift for the entire family. The most advanced features are embodied in these receivers. Quiet, smooth, distortionless reception.

Four-tube receiver uses 1-57, 1-58, 1-80, and 1-47 pentode; five-tube set uses 1-57, 1-58, 1-80, and 2-47's. Both models use a dynamic speaker especially designed for the output of the pentodes. The receivers are encased in a beautiful hand-rubbed walnut cabinet. Price, 4-tube A. C. receiver **$9.95**

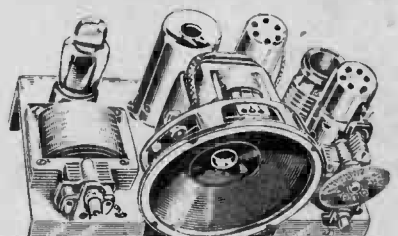
4 tubes $1.45

Price, 5-tube A. C. receiver $12.95

5 tubes $1.95

Four Tube A.C. Short Wave Receiver

COMES MOUNTED INTO A BEAUTIFUL MODERNISTIC CABINET WITH BUILT-IN SPEAKER

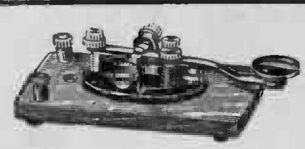


Looks like a midget broadcast receiver. Will tune in short wave stations from all parts of the world with ease. Uses four coils to cover the short wave bands from 15 to 200 meters. The built-in power supply is entirely free from hum or disturbing line noises. Uses an ultra-sensitive dynamic speaker to aid in tuning in the weaker signals. Kit of parts...... **$17.50**

Wired and tested........$2.00 extra

Kit of tubes.................. $1.95

Powertone Sending Key



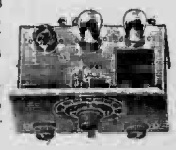
The most practical gift to one who has just become interested in amateur radio. Widely used as a code practice key. Well balanced and fully adjustable. Price.. **75c**

Stromberg-Carlson Phonograph Pickup

Makes any radio a modern up-to-date phonograph radio combination. Instruction sheet furnished with the outfit makes it simple to install. Volume control mounted on the pick-up enables one to control the volume, without adjusting any part of your receiver. Special Holiday price **$5.50**

For The Beginners

Rocket Two-Tube Short-Wave Battery Receiver



Economical! Uses two 2-230 tubes, which assures long battery life. Tunes from 15-200 meters. Pulls in amateurs, police calls, etc. Kit of parts. **$5.50**

Wired..$2.00 extra Tubes.......$1.50

Batteries $2.25

Powertone Two-Tube Battery Receiver

Enclosed in a handsome crystal finished metal cabinet. Can be built by any one. Beautiful full vision modernistic vernier dial aids in logging weaker stations. Will receive all types of short-wave signals, police, amateur, ship-to-shore, airplane, etc.

Kit of parts............ **$7.95**

Wired..$2.00 extra Tubes.......$1.95

Batteries $2.75

A Power Pack That Converts Any Battery Operated Receiver Into an A.C. Receiver

Will convert any battery receiver to operate on a 110 volt A.C. line. All voltages terminate at binding posts on the chassis. Output; 2½ volts at 10 amperes, 180 volts tapped at 135, 90, and 45. Supplies clear hum-free power regardless of circuit sensitivity. Price including 280 rectifier tube. **$5.95**

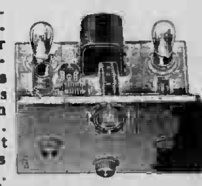
For A.C. and D.C. Operation

Will work anywhere that 110 volt A.C. or D.C. is available. U. S. amateur reception is assured on loud-speaker by the use of a 43 power tube in the output. With headphones the entire world is at your finger-tips. Chassis is completely encased in a beautiful crystal finished cabinet. Covers the short wave, band form 15-200 meters. Uses 1-78, 1-25Z5, and 1-43 tube.

Price kit **$8.95**

Wired..$2.00 extra Tubes.......$3.25

Beginners Twin Two-Tube Short-Wave Battery Receiver



A more advanced short-wave receiver for the beginner. Letters from builders verify foreign reception. Uses highest quality parts throughout. Complete with four plug-in coils to cover the entire short-wave band from 15 to 200 meters. Easy to build.

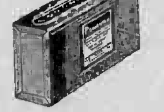
Kit of parts.......... **$8.95**

Wired..$2.00 extra Tubes.......$1.50

Batteries $2.50

GIFTS FOR THE SERVICEMAN

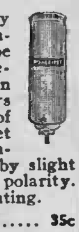
Majestic 70 and 90 Condenser Blocks



Replacement condenser blocks for the Majestic 70 and 90 series receivers. Built to the exact specifications of the original. Absolutely guaranteed.

Price $1.35

4 and 8 mfd. Electrolytic Condensers



High quality electrolytic condensers. Can be used as a replacement in many receivers without fear of breakdown. Wet type—thus cannot be injured by slight overload or polarity. Inverted mounting.

4 mfd 35c

8 mfd. 40c

RESISTORS

Assortment of 50

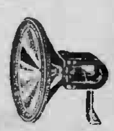
An assortment of 50 R.M.A. color coded resistors. Composed of 1/3, ½ and 1 watt resistors. All popular sizes are included in the kit ranging from 100 ohms to 10 megohms.

FREE

A beautiful bakelite case—a souvenir of the Chicago Century of Progress Exposition.

Price $2.50

Farrand Inductor Dynamic Speaker Chassis



Not to be confused with the various models now on the market and labeled Farrand Inductors. These models are genuine factory-built Inductors.

Two models are available, a 12" model and a 9" model. Mounting brackets are placed on both models.

Price, 9" model........$3.95 Price, 12" model.......$5.95

A Handy Manual Published for SERVICEMEN AND SET DEALERS

Full of information, hookups, charts, trouble shooting hints, etc. Reg. $1.00 **25c**

RELIABLE RADIO COMPANY, 143 West 45th Street, New York City