RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

620th Consecutive Issue—Twelfth Year

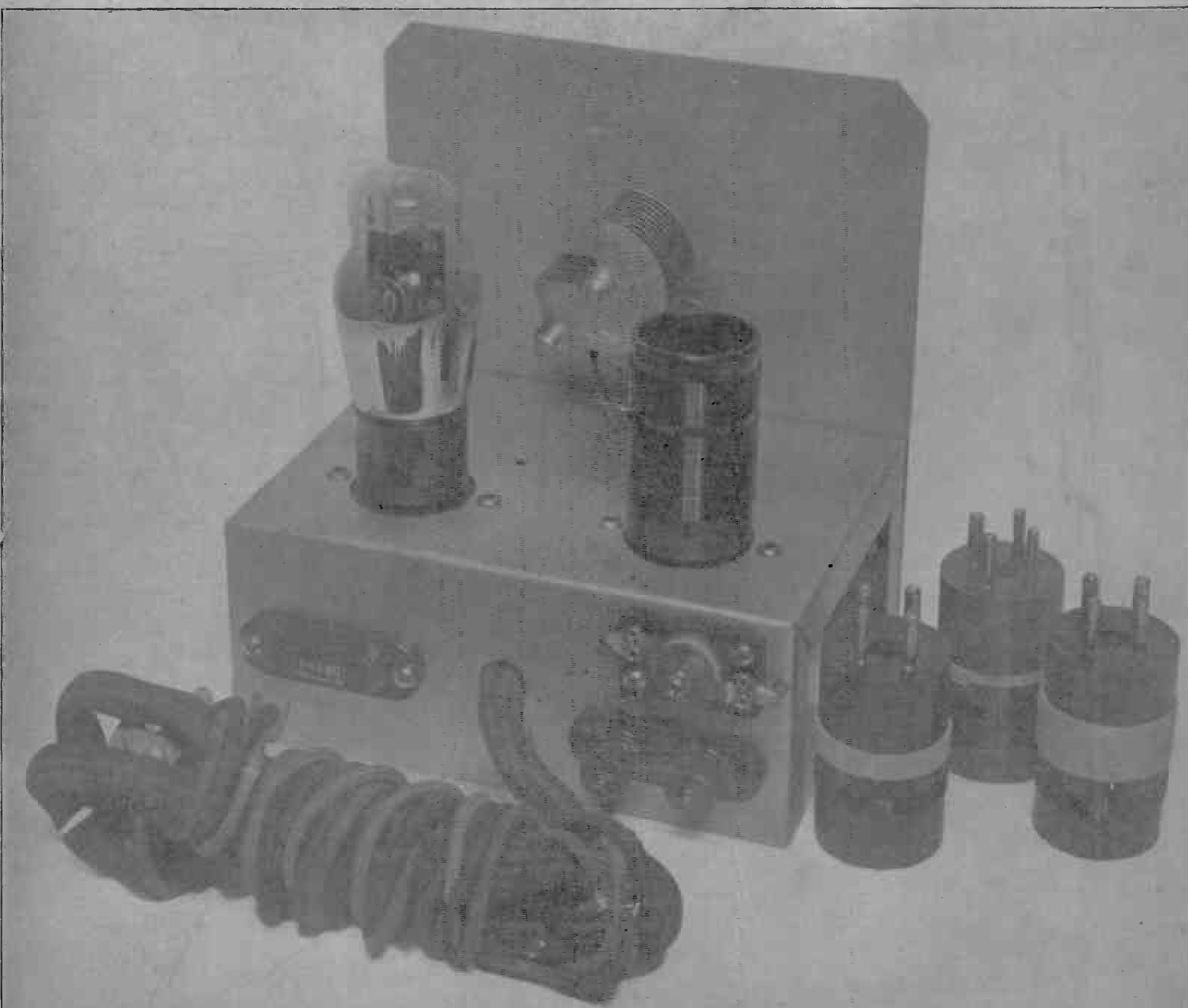
Feb. 10th 1934

15¢ Per Copy

How to Wind Coils for Short Waves

Switch Type Regenerative Set for High Frequencies

New Tube is Rectifier-Output



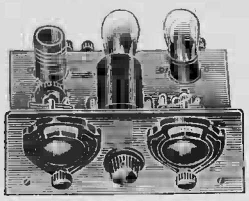
The One-Tube Scout for Battery Operation, for Short Waves. See pages 12 and 13.

Recommending - - -

NEW 1934 DIAMOND of the AIR

A-C OPERATED SHORT-WAVE RECEIVERS

12,500-Mile Reception

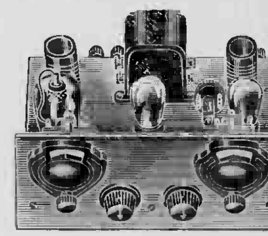


2-TUBE

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

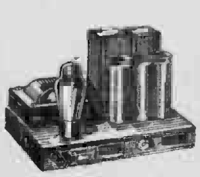
Cat. No. 5025-D. Two-tube A-C kit, with blueprint. Shipping weight, 5 lbs. $8.45
Cat. No. 5026-D. Above, wired and tested. Shipping weight, 5 lbs..... 9.45
Cat. No. 5027-D. Complete set of tubes for above, either one 57 and one 56 for a-c operation or one 77 and one 37 for battery operation. Specify 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. 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.

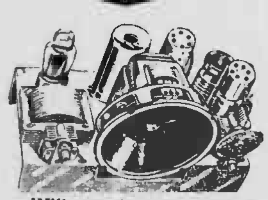
Will deliver 180 volts. Supply your own taps. 135, 90 and 45 volts. Supplies 2½ volts at 10 amperes for filament drain. All taps terminate at binding posts on the side of the pack. Employs an 80 rectifier. Will stand up to 75 ma. drain for B current.

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..........**$17.50**
Cat. 4TW. Above, completely wired and tested **$19.50**
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 RECEPTION A.C. D.C. 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

INFORMATION WANTED

Information is wanted of GEORGE BLOCK or CLARK, 34 years of age, 5 ft. 9 in. tall, weighs about 165 pounds, has dark hair, brown eyes, born in El Paso, Texas, a radio mechanic by trade, who deserted his wife Lillian and their child Frances, who was born in 1929, from their home in the Bronx about three years ago, since which time he has neither communicated with them nor sent any support, as a result of which the family is dependent on the charities. Kindly communicate with the National Desertion Bureau, 67 West 47th Street, New York City.

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Helpful Information on Winding SHORT-WAVE COILS

SECONDARY INDUCTANCE STATED AND NUMBERS OF TURNS GIVEN FOR SEVEN DIAMETERS, CHOICE OF TWO WIRE SIZES. CAPACITY, 0.00014 MFD.

By Herman Bernard

THE question of how to wind coils for short-wave tuning is always present during a vogue for short-wave reception. The data for winding the coils for a particular set, on a particular-sized form, using particular wire, have been given repeatedly. However, those constructionally and experimentally inclined are usually desirous of some assistance which enables them to use forms they have, or wire sizes they have.

If the tuning capacity is rated at 0.00014 mfd. the maximum actually will be a bit in excess of 0.00015 mfd., due to circuit distributed capacities, and if the tuning condenser is 0.00015 mfd. then the maximum actually will be correspondingly higher. However, for coil data the difference between these two maxima need not be considered, but simply 0.00015 mfd. taken as maximum. In micro-microfarads this capacity is 150.

Overlap Provided

The lowest frequency limit would be 1,450 kc, if 80 microhenries is the inductance. The coils for succeeding higher frequency ranges would have an inductance smaller by the tuning capacity ratio of the condenser. This ratio may be 7.5, using a condenser of small minimum, as most condensers are, somewhere around 6 mmfd. For the distributed values a total of 14 mmfd. is assigned, so an effective range of capacity range of 20 to 150 mmfd. may be accepted.

To supply overlap the ratio applied to the inductance is shortened a bit, and then whole-number values of inductances may be selected, except for the smallest coil. Applying this system, we can take the 80 mh coil first, and relate the capacities to the frequencies, so that if the coil is closely and accurately wound, the inductance will be sufficiently accurate for us to determine what the total capacity is at any setting for which we can strike a frequency value, but not the condenser capacity alone.

For the 80 mh coil the relationship of capacity to frequency is expressed in the following table:

mmfd.	kc.	mmfd.	kc.
150	1,450	85	1,900
140	1,500	78	2,000
130	1,600	50	2,500
110	1,700	35	3,000
96	1,800	25.5	3,500

Winding Data

Besides, 19 mmfd. represents 4,000 kc, so that if you can obtain a frequency of that value, either fundamentally or harmonically, a check can be made for a total of 19 mmfd. in circuit.

To achieve the inductance of 80 mmfd. close winding should be used, and either of the two wire sizes are given in the following table for seven diameters of tubing, solenoid winding:

WINDING DATA FOR 80 MICROHENRIES

Form Diameter	Turns No. 28 Enamel	Turns No. 30 Enamel
¾	90	86
⅞	70.5	70
1	60	60
1⅛	52	52
1¼	48.25	47
1⅜	42.25	43
1½	39	39

By selecting integral inductances we may use for the next two bands 15 and 6 microhenries, respectively, and for the last band an inductance of 1.3 microhenries, as a decimal value is required here.

We found that with the first coil we went from about 1,450 kc to about 4,000 kc, but to avoid uncertainty about overlap we will provide for starting the second band at around 3,450 kc. The relationship of frequency and capacity to this inductance of 15 microhenries is as follows:

mmfd.	kc.	mmfd.	kc.
150	3,450	66	5,000
140	3,550	46	6,000
105	4,000	34	7,000
83	4,500	26	8,000

Possible Check at 10,000 kc.

At 17 mmfd. the frequency would be 10,000 kc, which we could check provided that our total minimum were as low as that, which it might be.

WINDING DATA FOR 15 MICROHENRIES

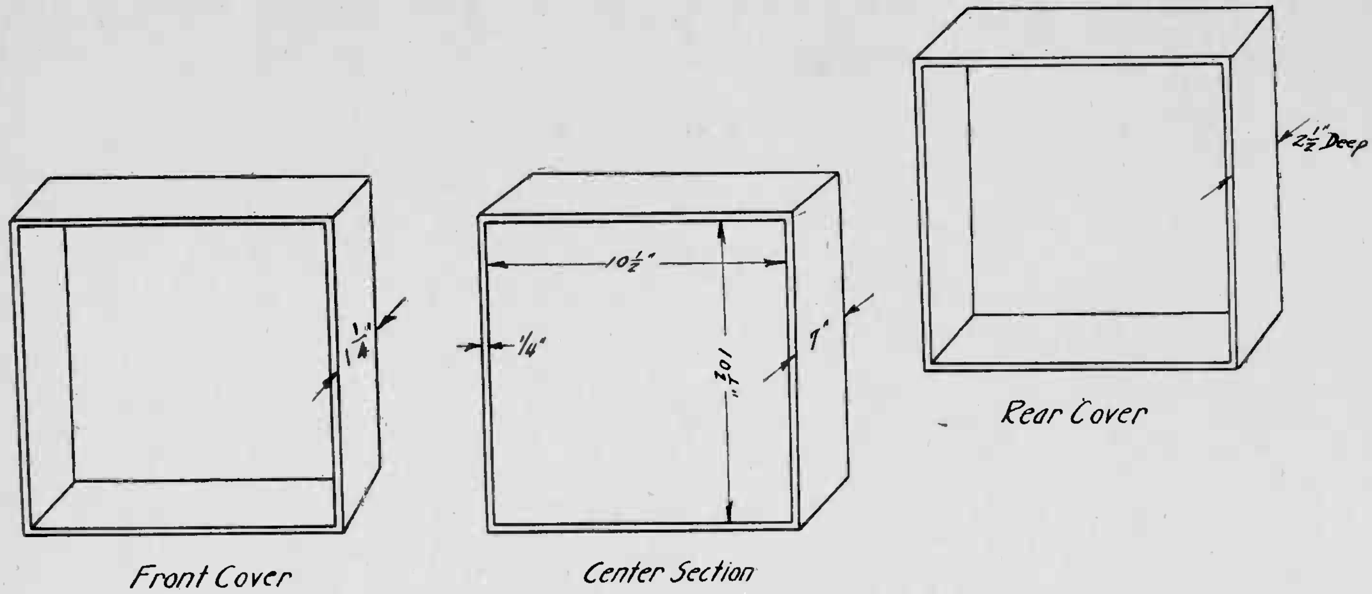
Form Diameter	Turns No. 28 Enamel	Turns No. 30 Enamel
¾	28½	26½
⅞	24	22½
1	21½	20
1⅛	19	18
1¼	17½	16½
1⅜	16	15¼
1½	14¾	14¼

For a coil of 6 microhenries the relationship of frequency and capacity follows:

mmfd.	kc.	mmfd.	kc.
140	5,400	42	10,000
118	6,000	29	12,000
84	7,000	21	14,000
65	8,000		

WINDING DATA FOR 6 MICROHENRIES

Form Diameter	Turns No. 22 Enamel	Turns No. 24 Enamel
¾	19½	18
⅞	16¼	15
1	14¼	13½
1⅛	12½	12
1¼	11½	11
1⅜	10½	10
1½	9¾	9½



Dimensional details for construction of the cabinet.

across the filaments is actually 2 volts. Otherwise the voltage would drop a bit, and sensitivity then would decline a little also, as the A battery becomes used.

Due to the 1-volt drop in this resistor, the negative bias actually is 1 volt more than the battery indications. Therefore, it is entirely permissible to use for the lower bias just 3 volts from the small cells, as the used voltage is 4 volts, and, of course, for the power tube the actual bias is 7 volts.

Use of Earphones

The output tube may well be the 33 pentode, as the sensitivity is then increased. A magnetic speaker of small dimensions will be fitted into the vabinet, and while results will be obtained whatever the speaker coil's impedance may be, preferably the impedance should be around 6,000 or 7,000 ohms. Speakers of such type are abundant in the present market, fortunately.

It is, of course, possible to use earphones in the output, but the impedance of phones is likely to be around 2,000 ohms or so, although the better types are made for a much higher impedance, even up to 20,000 ohms. So if you intend to buy phones you may get 7,000, 6,000 or at least 5,000-ohm phones, and the sensitivity will be increased. However, for a reception using 'phones the quantity of sound is so large that not too much attention need be paid to this impedance detail in connection with earpieces you have.

Try Your Skill

The circuit is the easiest short-wave three-tube set to build, electrically, although the parts are so disposed, for purposes of self-containment in a nice cabinet, that the woodwork is more difficult than would be ordinary chassis construction, where a formed chassis is sold to the constructor. Still, there's a great deal of fun in handiwork, and those inclined in the woodworking direction will, of course, welcome the opportunity to construct the container for this little circuit.

The diagram of the circuit shows the wiring well enough for any who have even only a little experience in radio. The only point that possibly requires a word of caution is that since the A voltage is 3 volts and there are obtainable 3 volts also from the biasing batteries, the two sources must not be confused, as the current in the A circuit is 0.38 ampere, hence the two No. 6 dry cells, the large round ones, are in series for the filament feed purposes, whereas the tiny cylindrical cells, also 1.5 volts each, are used for biasing purposes only. If this fact is not respected, the small cells would become exhausted in less than an hour, at the drain of close to two-fifths of an ampere. However, the larger cells will stand 0.5 ampere for a long time.

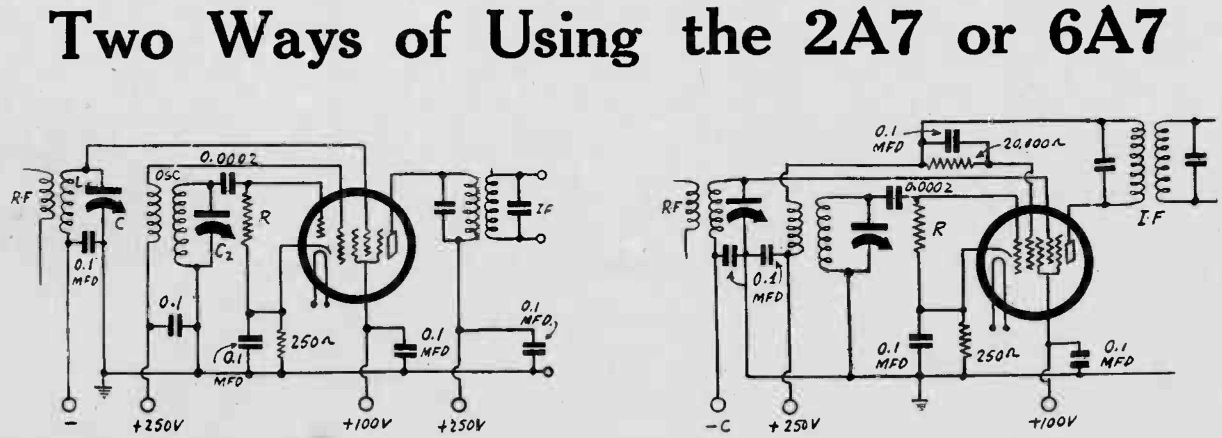
Terminal Strip

The cabinet has a hinge cover at rear, so that the two 45-volt B batteries are fastened in with straps, and the four 1.5-volt small dry cells are above it, held fast to a bottom bracket that is not in view. Beside the two B batteries is the second No. 6 dry cell, with shaded background, while the other No. 6 cell projects into a space purposely left in the rear compartment. Below this projecting cell is a combination block containing the audio transformers, but, of course, separate individual transformers of any audio type may be used.

The front may have a separate cover for a more finished appearance, and this is shown in the dimension drawing.

The detector tube is practically hidden from view, but the two audio tubes are shown, the one at left being the output tube (33). A binding post strip is used, and may be marked for Ant., G (ground), A plus, A minus, B plus 45, and B plus 90 volts. Also the C voltages may be brought out to terminals so that meter checks may be made without trouble.

Two Ways of Using the 2A7 or 6A7

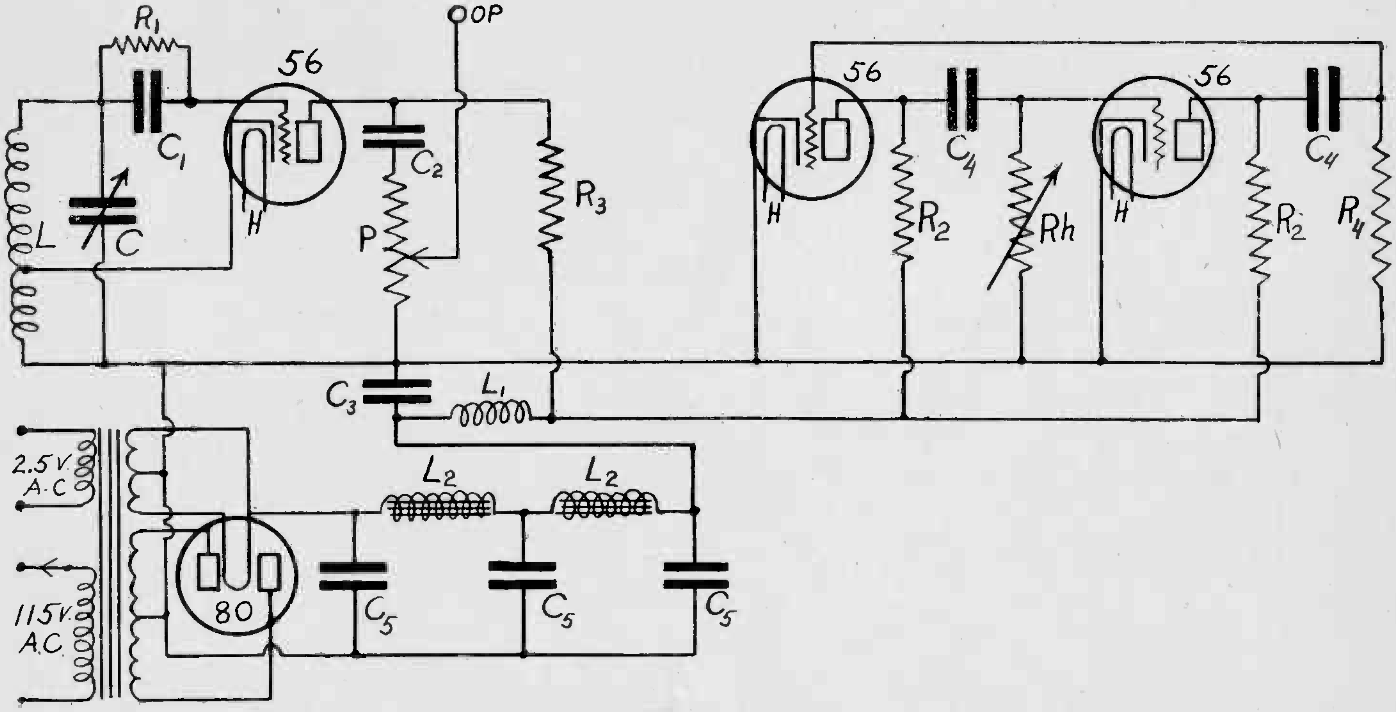


The two methods of using the pentagrid converter tube, as illustrated, refer to the application of the B supply voltage to grid No. 2 (second from left in each tube circle). The method at right is a little more frequency-stable. R, the grid leak, may be 50,000 ohms in either instance.

OSCILLATOR CALIBRATION

By Using the Step-by-Step Method

By Einar Andrews



ACCURATE calibration of oscillators and wavemeters requires accurate standards of frequency, and these frequencies should be available at close intervals, say 10 kc in the broadcast band and 50 to 100 kc in the short wave bands. The reason why the standard must be available in close intervals is that the calibration curve may not be regular. If readings are taken every 100 kc in the broadcast range and a regular curve is drawn between the observed points, the presumption usually is that the curve gives the frequency of the oscillator or wavemeter between the observed points. It may or it may not. Quite frequently, regularly in fact, there are deviations at certain points. If observations are not made at close intervals these irregularities may pass unnoticed and uncorrected. If the observations are made every 10 kc, there is small chance that such irregularities will not show up.

Now, we cannot very well have a fundamental standard of frequency for every 10 kilocycles in the entire radio spectrum. We have available on one primary standard of frequency in this country, and that is the 5 megacycle transmission from the Bureau of Standards. Broadcast stations are good secondary standards, for they are compared regularly with the primary standard.

Subdivision of Standard

What is required is a means for subdividing the standard frequency into a submultiple the harmonics of which are exactly 10 kc, or 100 kc, apart, and to do this in such a way that every harmonic of this submultiple is known just as accurately as the standard frequency itself. Suppose that we have an oscillator generating a fundamental of 10 kc and all harmonics of this fundamental up to a high order. Then if the 10 kc fundamental can be controlled by the standard frequency, we have the proper division. If we take the 5 megacycle standards of the Bureau of Standards and make this control the 10 kc oscillator, it would be the 500th harmonic of the 10 kc oscillator that would coincide with the standard. This control is possible, perhaps not in one step, but in no more than two steps. For example, there would be one oscillator which had a fundamental of 100 kilocycles controlled by the standards and this in turn would control the 10 kc oscillator.

Even when the primary frequency is not available, for lack of a sensitive receiver or because of improper time, the system can be used on a broadcast frequency which is known to be constant.

LIST OF PARTS

Coils

L—Coil in oscillator to be calibrated or to be used for calibration of another oscillator or wavemeter.
L1—One 10 millihenry choke coil.
L2—Two 30-henry choke coils.
One power transformer for rectifier and filaments.

Condensers

C—Tuning condenser in oscillator to be calibrated.
C1—One 250 mmfd. fixed condenser.
C2—One small capacity (Six inches of insulated wire twisted together).
C3—one 0.25 mfd. by-pass condenser.
C4—Two 500 mmfd. fixed condensers.
C5—Three 4 mfd. by-pass condensers, or larger.

Resistors

R1—One 50,000-ohm resistor.
R2—Two 150,000-ohm resistors.
R3—One 100,000-ohm resistor.
R4—One 100,000-ohm resistor, or variable.
P—One 100,000-ohm potentiometer.
Rh—One 100,000-ohm variable resistor.

The Multivibrator

The usual means for generating the low fundamental and the many harmonics is the multivibrator. This consists of two stages of resistance-capacity coupled amplification in which the output of each tube is fed into the grid of the other, as illustrated in Fig. 1, right. The frequency of this oscillator, naturally, is determined by resistances and condensers, since there is no inductance in the circuit, but just what particular combination of resistances and capacities fixes the frequency is not known. If the two series condensers C_4 are equal, and also if the grid leaks and plate coupling resistances are equal, it is sometimes said that the frequency is given by $0.636/C_4R_4$, sometimes that it is given by just $1/C_4R_4$. Besides these there have been many other guesses, all of which are "approximate."

The High Frequency Oscillator

The values given in the list of parts can be used as a guide in making adjustments. It is only by adjustment that the desired frequency can be obtained, and it is for that reason the 100,000 ohm rheostat is used for one of the grid leaks. It makes no particle of difference in which this tube is used, for neither tube is first nor second. The frequency can be varied by means of the condensers C4 as well as by the resistors.

On the right is a Hartley high frequency oscillator, coupled loosely to the multivibrator. In the plate circuit of this oscillator there is a provision for taking off the signal by means of potentiometer, P, OP being the output binding post. The condenser C2 in series with the potentiometer is extremely small, being only a few micromicrofarads. It may consist of a few inches of insulated wire twisted together.

Both the oscillator on the left and the multivibrator on the right feed into this potentiometer. If the Hartley should oscillate at any harmonic of the multivibrator, a heterodyne will be heard in the receiver that gets its signal from the output binding post. When this beat is adjusted to zero, the frequency of the ordinary oscillator is an exact multiple of the fundamental of the multivibrator.

Process of Calibration

The first step in using this combination is to select a standard of frequency which is a whole multiple of 10 kc, or 100 kc, depending on the steps required. Let us say for the sake of explanation that it is a multiple of 10 kc. Then it may be any broadcast frequency. Suppose we take 700 kc, the frequency of WLW. The Hartley oscillator is first adjusted so that it zero-beats with this frequency. Then the multivibrator frequency is adjusted until its 70th harmonic zero-beats with the 700 kc frequency of the Hartley. We now know that every harmonic of the multivibrator is a multiple of 10 kc, and we can calibrate the Hartley oscillator over the entire tuning band. L and C may be changed, either in steps or continuously, but as long as we make no changes in the multivibrator, the Hartley can be calibrated in steps of 10 kc.

Suppose that L and C are such that they just cover the broadcast band. We have already established one point by locating WLW, that is, 700 kc. If we decrease the condenser a little, there will be another zero beat, and that will be 710 kc, a little more and 720 will give zero beat, and so on up the scale until we reach the limit of the tuner. Starting with the known 700 kc point we can go down in frequency in the same way, getting 690, 680, and so on.

If we make the fundamental of the multivibrator 50 kc, we can "spot" all the broadcast stations that have frequencies divisible by 50. Thus we would get 550, 600, 650, and so on up the scale. And if we make the fundamental of the multivibrator 100 kc, we can locate every station the frequency of which is divisible by 100. It will be much easier to perform the calibration if the fundamental of the multivibrator has a high value, but the higher the value the fewer the points that will be located on the curve.

Checking Intermediate Points

Suppose that the 100 kc fundamental has been used in calibrating an oscillator and the curve resulting appears irregular at certain points. In order to remove any uncertainties as to where the curve should go, it is necessary to select another fundamental of the multivibrator, say 50 kc, which will locate all the intermediate points. The multivibrator is easily readjusted to the lower frequency. When this has been done it is well to check the points already obtained, just to test the accuracy of the settings, for with the 50 kc fundamental there should be a zero beat at every point previously found, as well as at every point half way between these.

It is better first to find the frequencies divisible by 100 and then fill in the half way points by using the 50 kc fundamental than to use the 50 kc frequency first, first, because it may not be necessary to use the 50 kc at all, and second, because it is less confusing to use the higher frequency to locate the main divisions.

Calibrating High and Low

It is clear that once a known fundamental has been found for the multivibrator it can be used for calibration both above and below the broadcast band. It is especially easy to calibrate an oscillator covering the intermediate frequency band, for then only the lower harmonics will be needed, and they will be relatively much stronger than the higher harmonics. When an oscillator covering the intermediate frequency band is to be calibrated, it is best to start with a fundamental no higher than 50 kc, for otherwise not many points can be located on the dial.

When the calibration is to be extended into the short wave region it is best to use 100 kc, for if this is not used, the zero beat points will be entirely too close together. It will be most confusing to keep track of the many squeals which will appear.

The method here outlined is used nearly always, in one form or another, for stepping up and down frequencies in definite steps from a highly accurate standard, because all the frequencies that can be obtained are known just as accurately as the standard.

Any oscillator generating strong harmonics can be used in place of the multivibrator in the same manner but the harmonics will not be so strong.

Condenser Plates' Effect on Frequency

We have variable condensers of many different plate shapes. Thus we have straight line capacity, straight line frequency, straight line wavelength, constant percentage change of capacity, and some in which the variation is straight line over a certain range and straight line over another portion of the range. In most cases when condensers are designed no allowance is made for minimum capacity, or a certain allowance is made but this capacity is not employed when the condenser is used. Indeed, the user knows nothing of the minimum capacity used by the designer of the condenser. The result is that the variation is not what it is supposed to be.

When the capacity change is such that equal frequency differences are represented by equal changes in angle, a certain minimum capacity must be taken into account. That is, the frequency change is to be linear over a definite range, not of absolute value of frequency or of a definite frequency ratio. The condenser might be straight line over a ratio of two-to-one, for example, and if any other ratio is used, the frequency variation will not be linear. The same applies to any other variation of the capacity, except straight line capacity. That this is so is obvious if the change is a constant percentage. If the percentage change has a given value when the minimum is C, it certainly will not be the same when the minimum capacity is 2C. If we have 100 dollars in the bank and get one per cent per annum interest, we get a dollar a year. But if we have $200 in the bank and still get only one dollar, we no longer get one per cent.

There is an exception when we are dealing with straight line capacity. If, for example, the condenser is such that the capacity changes by 10 micromicrofarads per degree, that change will not be affected by any change in the minimum capacity, it will only change the total. But, the percentage change will be different depending on the minimum. In a straight line capacity condenser we are not interested in the percentage change, only in the absolute change. For this reason, a condenser that is to be used for measuring capacity should be of the straight line capacity type.

It is very difficult to get a condenser that has any given rate of change because there are capacities which cannot easily be taken into account in the design. Take the simplest case, the straight line capacity condenser. It is not straight line from minimum to maximum, or from zero to 100 on the scale if there are 100 divisions. The straight line extends only from about 5 to 95 on the dial. It is perfectly possible, of course, to divide the scale so that there are 100 divisions from the beginning to the end of a straight line. That should be done when the condenser is used for making capacity measurements, especially as the linearity holds throughout.

Cathode Ray Electron as a "Missing Person"

What becomes of the electrons that reach the fluorescent screen in a cathode ray tube? This question was asked recently by a man who really should have supplied the answer. Perhaps he asked in the manner of the professor who wishes to determine whether the student really understands what he, the professor, has been explaining.

An electron is a negative particle of electricity, and it is attracted by a positively charged body. The electron will lower the potential of that charged body a little. If many electrons reach it, the potential will be lowered a great deal. Indeed, a condition will soon be reached where the positively charged body will no longer be positive, when it will not attract any more electrons. It may even become negative and repel electrons arriving as a result of a high speed which which they have attained under the influence of an electric field. It is possible to hurl electrons against a strong negative field if they have sufficient velocity.

If the electrons are to flow continuously from the cathode to the screen, they cannot be permitted to accumulate on the screen. It is necessary to maintain the screen positive. Now the screen is usually a conductor connected to a source of electromotive force. If the electrons are hurled against the screen, they must return to the cathode through the external circuit. The electrons that reach the screen, therefore, go the same way as they would in any other circuit, that is, around the circuit.

There is a little device in physics that illustrates the manner in which electrons behave if they are permitted to accumulate. That is, how those coming next behave when those preceding have been allowed to accumulate. Electrons are carried on tiny drops of water which fall from one level to another. At first the drops fall just as they always do, down. But soon the charges accumulate, making the electric forces considerable, when the drops no longer fall straight down, but begin to fall UP. They describe a curve, starting to fall down, but gradually bending around and going upward. Exactly the same thing would occur if the plate were first charged positively and then were gradually discharged by the electron stream.

THE ONE-TUBE SCOUT

A Regenerative Recei

By Herma
Try-Mo Rad

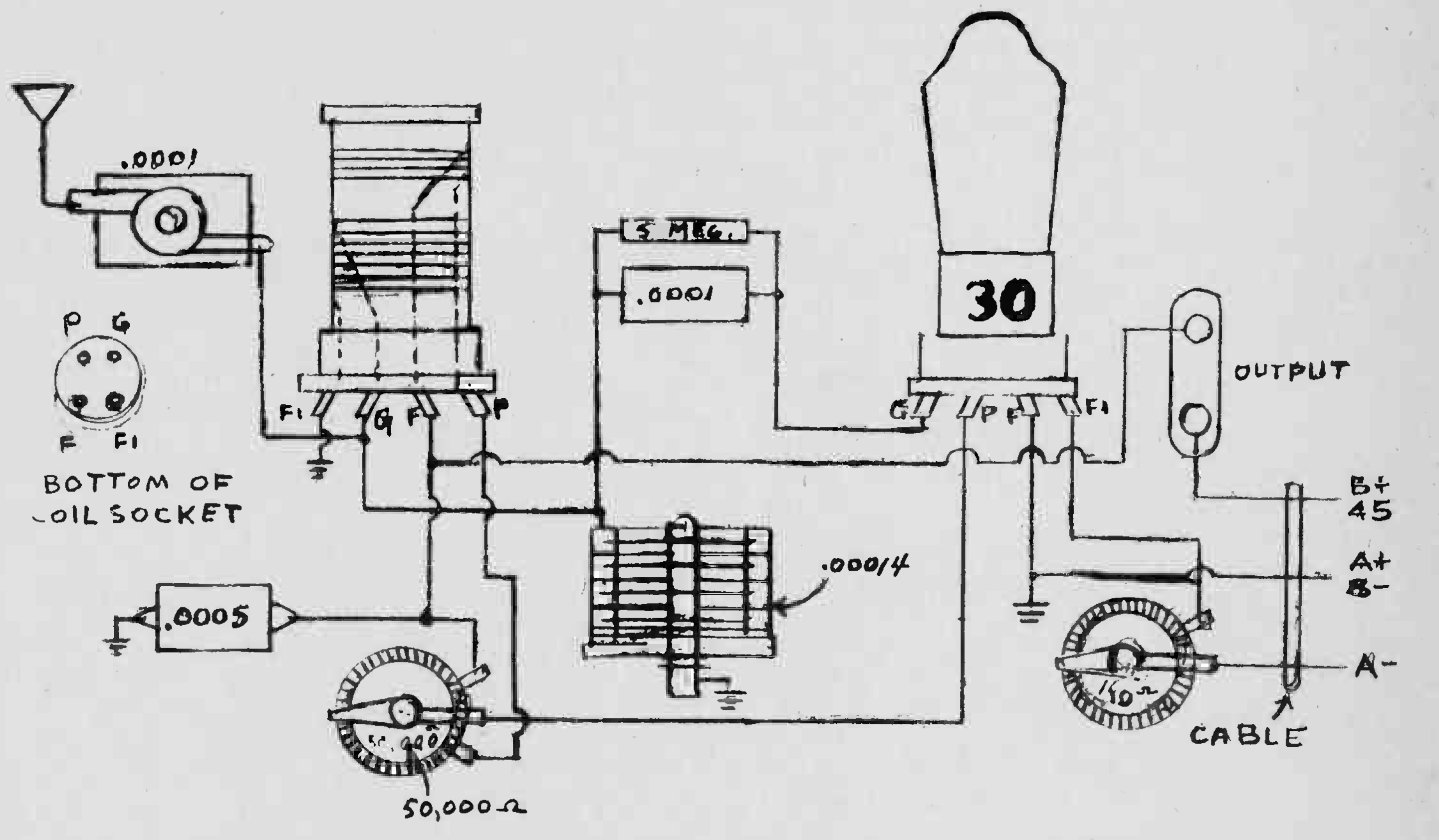


FIG. 1
The wiring diagram of the Scout one-tube short wave regenerative receiver. It is easy to build and to operate.

Oscillator Stabi

THE construction of a battery-operated test oscillator may be reduced to a minimum size requirement by using the 1A6 tube. The tube becomes a ready oscillator at very low plate voltages, if the screen is used as the feedback winding. The screen is the combined grids Nos. 3 and 5 and is between the pentode plate and the control grid of the pentode, as well as between the control grid of the pentode and the B-plus grid (No. 2) of the triode. The only possible objection would be that with usual capacity range tuning condensers the customary frequency ratio would not be achieved, because of the high minimum capacity developed by this special tube connection. The capacity is of the order of 80 mmfd. With circuit and condenser minima the total minimum might be 100 mmfd., and if the condenser is 0.00035 mfd. itself, the maximum when both condenser and tube are considered is around 0.00043 mfd. This is a capacity ratio of 4.3 to 1.

However, since the test oscillator is in the low-frequency range, and since the ratio of tuning will exceed 4 to 1, therefore the lowest-frequency fundamental of the tuning would be one extreme and the second harmonic would be the other extreme, approximately. There would be some overlap, in favor of the circuit. As harmonics are used anyway, the fundamental tuning range could be from 100 to 200 kc, and then if the dial is to be frequency-calibrated, the same bars or divisions could be applied to 200 to 400, 400 to 800 and 800 to 1,600 kc, for use at all commercial intermediate frequencies as well as in the entire broadcast band as newly constituted, since the Federal Radio Commission recently authorized extension to 1,600 kc in consonance with the decision of the conference of Western Hemisphere nations held in Mexico City a few months ago.

Since the plate voltage need be only a little, the room taken up by the B battery will be small. Even a 4.5-volt C battery could be used, although there is some improvement in intensity of oscillation if the 7.5-volt type C battery is used for B voltage. Also, instead of using 2 volts on the filament, which would require two 1.5-volt cells in series, with a limiting filament resistor of 16 2/3 ohms, one such cell may be used, and the oscillation will be sufficient, if the tuned triode grid (No. 1) is returned to the negative filament. There will be no oscillation, usually, if the return is made to the positive filament, because then the grid current is increased and even if no leak is used there will be too much power extracted from the tuned circuit to enable sustenance of oscillation.

Also, the amplitude will rise if the control grid of the pentode is connected to the control grid of the triode. Thus the plate of the pentode is not used as yet, but can serve well as a capacity coupling between the oscillator and the output.

Although this is a pentagrid converter type tube with electron coupling, when the tube is used in its customary manner, the coupling is not strictly electronic, due to the capacity between the pentode plate and any of the other live elements, however used.

By loading the plate circuit with a 10-millihenry r-f choke, output voltage is in-

T FOR SHORT WAVES

ver for Earphone Use

n Cosman
o Corporation

BOYS of the scout age throughout the country are becoming keenly interested in short wave reception, not just plain short wave reception, but long distance short wave reception with receivers which they themselves have built. The simpler the receiver the better, not only because it is less expensive to build and maintain, but because it is more of an achievement to pick up a signal coming from the other side of the world with a one-tube set than with a dozen-tube set. Moreover, when all the fun has been extracted out of a given receiver—the fun of building, of getting foreign stations, and of boasting about the achievements—then it can be done all over again without much expense, or something can be added to the receiver already made just to make it do a little bit more.

It is well to encourage the boys in this interest, for they derive many benefits from the work of building and operating. While they are doing this kind of work they are not likely to be interested in anything that will be harmful. Many boys who have started as amateurs in this manner, with the simplest possible receiver, have become so interested that they ultimately have become professionals and are now well known engineers. Any boy has the same chance of making fame and fortune in radio, or some allied branch of science and engineering.

The simplest set that can be depended on for results is the one-tube regenerator. It is really remarkable how sensitive this circuit can be in the hands of a skillful operator. Of course, not all one-tube regenerative receivers are equally sensitive. It depends what parts have been used and how they have been put together. All the builder has to do is to select a circuit that has been proved, like the one-tube Scout, then assemble it in the same way as the model was assembled, and then depend on increasing skill in manipulating it to get the distant stations, and then more distant ones.

LIST OF PARTS

Coils

One set of four plug-in coils wound for 15 to 200 meters
One radio frequency choke

Condensers

One 140 mmfd. Hammarlund variable condenser
One 100 mmfd. variable condenser (antenna series condenser)
One 500 mmfd. fixed mica condenser
One 100 mmfd. fixed mica condenser

Resistors

One 50,000-ohm potentiometer for regeneration control
One 5-megohm grid leak
One 10-ohm rheostat

Other Requirements

One panel and base, drilled and punched
One coil socket
One 30 socket
One antenna and ground binding post strip
One phone binding post strip
One kit of assorted hardware
One roll of hook-up wire
One four-wire cable
Two knobs.
One four-inch tuning dial
Complete instructions for assembly

In Fig. 1 we have a combined wiring and circuit diagram of the one-tube Scout in the form it has been built by many throughout the country. The work is very simple, it will be noticed. The layout of the parts can be seen from the two photographic views of the circuit, one showing the front panel and the other the interior of the circuit. On the front panel we have only three things, the main tuning dial in the center, the regeneration knob at the left and the filament rheostat at the right. Both the potentiometer and the rheostat can be used for controlling the regeneration.

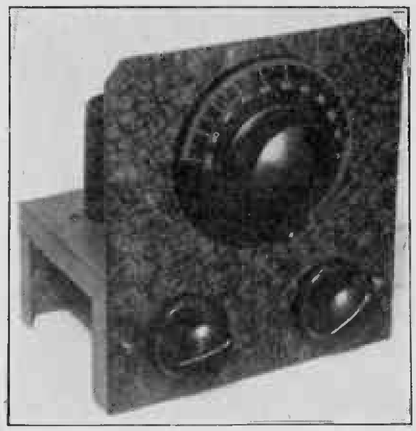


FIG. 2

The interior view shows the small tuning condenser on the panel as well as the two controls representing the knobs on the other side. On the subpanel are the tube and the coil—the coil in use. On the rear upright of the chassis are the binding posts, two for input and two output. The antenna series condenser can also be seen at the rear. Besides the coil in the socket, the three other coils required to cover the short wave band are also included. A line cable for making connections to the source of power may be seen coiled up.

The work of assembling this receiver is very easy, especially if all the listed parts are obtained.

lity Established

creased much, and a stopping condenser can be used for output isolation, if the screen-feedback circuit is followed.

Of course this method does not provide for modulation, and a separate modulator tube would have to be used. It is possible to use the pentode itself as the audio oscillator, but it is doubtful if oscillation will prevail at the meagre plate voltage mentioned, because of the low mutual conductance of the pentode. In fact, it was not possible to make the pentode oscillate at radio frequencies or intermediate frequencies, using the low voltage specified for the plate, no matter what size the tickler was. However, audio oscillation takes place more readily than radio oscillation, and some may have results by using the combination r-f and a-f oscillation for the two sections of the tube.

As a general rule it is necessary to omit grid leak and condenser from any circuit that won't oscillate with them in.

If the leak value is low the leak-condenser method may be included, although of course values such as 10,000 ohms, with stopping condenser of 0.0002 or 0.00025 mfd., do not provide much bias effect due to grid current through the leak. The very use of low filament voltage, 1.5 volts instead of 2, tends to check grid current, anyway.

Provided an oscillator has sufficient amplitude of oscillation, a series resistor between grid and tuned circuit, that is, grid leak without stopping condenser, may be used, as devised by Herman Bernard, for establishment of amplitude stability and also frequency stability. In fact, it is the simplest frequency-stabilizing method known. The leak is of such value that when the oscillation tends to become excessive, usually on the higher frequencies of tuning, the damping effect is just right to suppress the excess oscillation, with practically no effect at the other end, and thus maintain an even value throughout a large tuning range, say 3 to 1. In a given instance, using the 1A6 in a somewhat different manner than stated, the change in plate current was limited to 2.5 microamperes out of a total average flow of 600 microamperes over a 3-to-1 tuning range of frequencies. This is at least an amplitude stability of 0.4 per cent (0.004), or 4 parts out of 1,000. The leak was 10,000 ohms. By a more careful choice of leak value the constancy could be further improved.

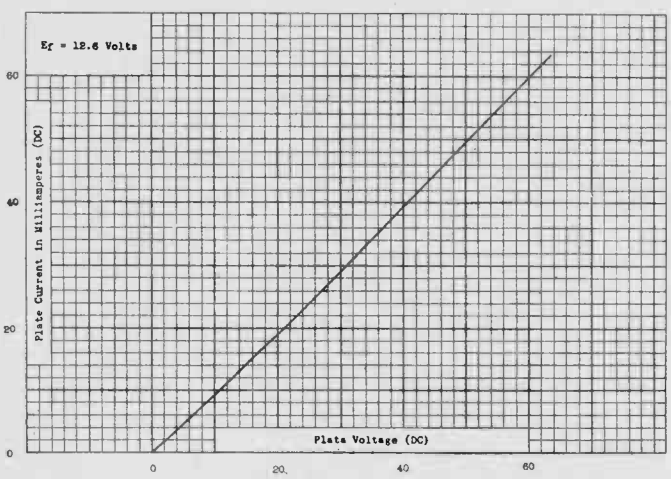
The question may arise as to the value of amplitude constancy at all. Well, one good reason for having it is that if the sensitivity of a receiver at different radio frequencies is to be tested, one need not measure the output of the test oscillator, knowing that it is practically constant anyway. The r-f oscillation measurement itself is in general beyond the electrical equipment of most experimenters, although the receiver response measurement almost any one can make with an inexpensive plate current meter in a detector circuit, or an output meter in the power tube circuit.

Moreover, without amplitude stability there can be no frequency stability. While the amplitude stability as measured in terms of plate current change, with a d-c meter, really reflects a constant d-c resistance in the case cited, the a-c condition follows this substantially in these instances.

Combination Rectifier And Pentode Power Tube

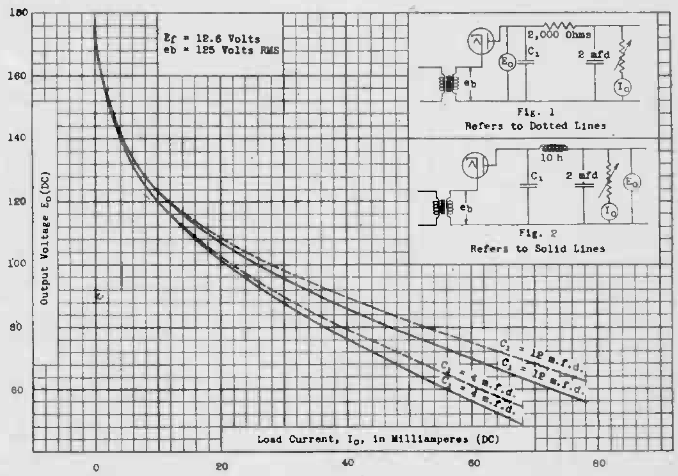
THE 12A7, INTENDED PRINCIPALLY FOR UNIVERSAL SETS, FIRST SUCH CONSOLIDATION, USING SEPARATE CATHODE

By J. E. Anderson



Curves by courtesy of The Ken-Rad Corporation

Rectifier characteristic of the 12A7 with d-c on the anode and 12.6 volts on the heater.



Regulation curves of the 12A7 rectifier under four different conditions as indicated by the circuit inserts and legends.

TWO-IN-ONE tubes are becoming more numerous. Perhaps some day we shall have a tube that performs all the functions of the various tubes now used in a receiver. The first dual-purpose tube was the 55, which combined a triode amplifier with two diode rectifier elements. This tube can be used as radio- or audio-frequency amplifier or as an oscillator, and at the same time it can be used as a full-wave rectifier, either for detection or for the production of a bias. The 85 is the same tube but it is provided with a 6.3-volt heater instead of a 2.5 volt heater.

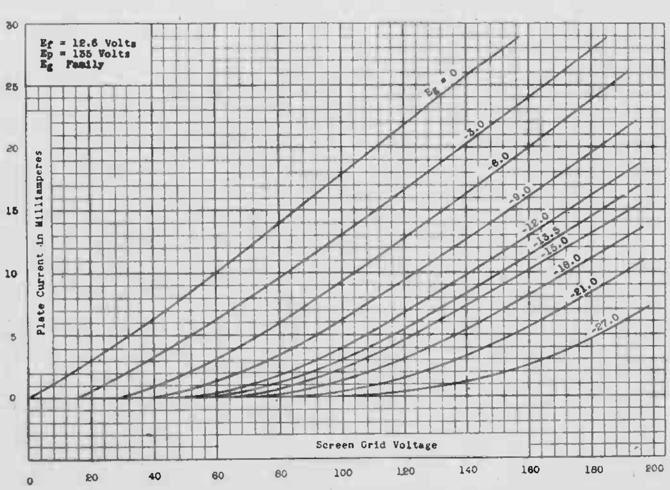
The 2A6 and the 75 are similar dual-purpose tubes but they differ from the 55 and 85, respectively, in that they have a high mu triode. The 2B7 and the 6B7 are also duo-diodes, but the amplifier element in each is a pentode.

In the pentagrid converter line we have three tubes, namely, the 1A6, the 2A7 and the 6A7. Each of these can be used as oscillator and mixer in a superheterodyne.

The 6F7

The 6F7 is a highly interesting tube in that it combines two amplifiers in one envelope, one being a triode and the other a pentode. Although the two elements utilize the same cathode, the grids and plates are placed so that there is virtually no interaction between them. Many applications can be found for this tube for this reason. The triode might be used as an oscillator and the pentode as a mixer. If the stray coupling between the two elements is not strong enough, it is possible to secure any degree of coupling desired by external manipulation. Indeed, even if the stray coupling is too close, it is possible to loosen it by means external to the tube. This is an advantage that cannot be realized with the pentagrid converters.

The pentode section can also be used as radio frequency, or intermediate frequency, amplifier and the triode as detector, either



Characteristic curves showing how the plate current varies with the screen voltage for different bias values in the 12A7 pentode.

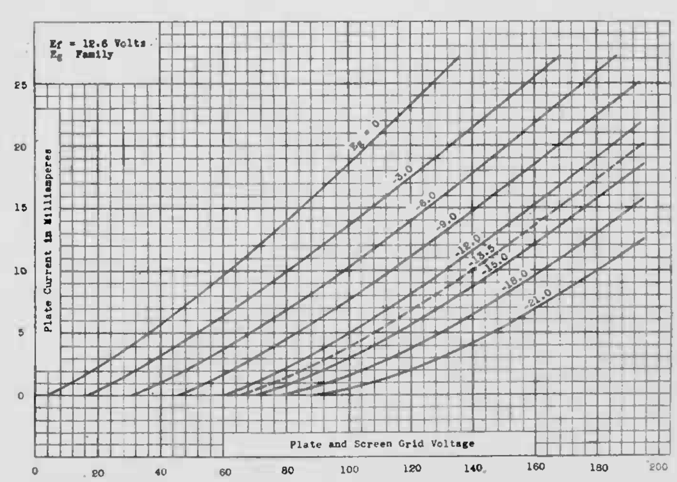
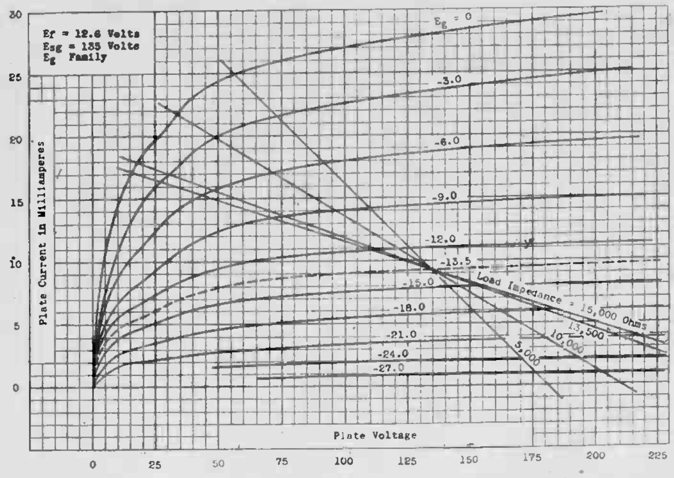
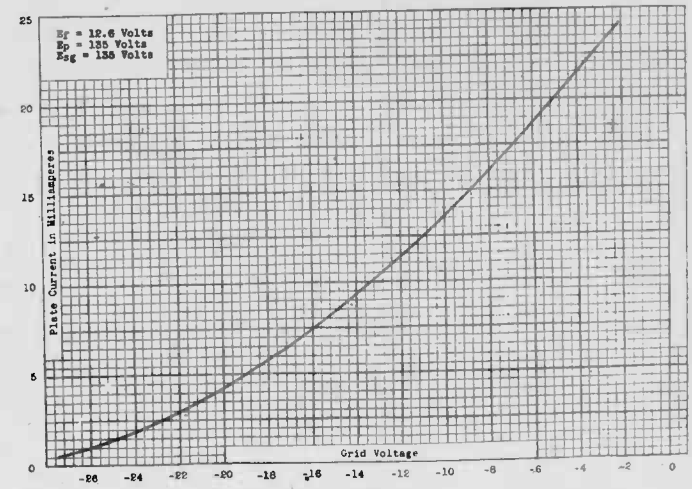


Plate current versus plate and screen voltage in the 12A7, both late and screen voltages are the same and they vary together.



The relation between the plate voltage and the plate current in the 12A7, the screen voltage being held constant.



This shows how the plate current varies with the grid bias in the 12A7 pentode when the screen voltage is held constant.

grid leak or grid bias. Another possibility is that the pentode be used as an amplifier and the triode as a beat note oscillator. The pentode unit might also be used as a grid biased detector and the triode as an audio frequency amplifier. The tube is so versatile that it is possible, almost, to design a given receiver with half the number of tubes that would be required with ordinary tubes. Moreover, the tube is of the heater type. Hence it can be used on either a-c or d-c, with the heaters in series when the circuit so requires.

The 12A7 Tube

The new 12A7 is another interesting tube of the dual purpose type. First of all this tube is a power pentode. As such as can be used exactly as any other output tube of this class. In addition it is also a half-wave rectifier, and the cathode for this purpose is different from that of the pentode. Thus the rectifier can be used either for supplying the plate voltage in the entire receiver or it can be used to supply the field current for a loudspeaker.

When the rectifier is placed on d-c voltage, the plate current varies almost directly as the voltage applied, the current being 60 milliamperes when the voltage is 60 volts. Thus the internal resistance is 1,000 ohms. At 30 volts on the plate the current is 29 milliamperes, and therefore the resistance at this value is slightly more than 1,000 ohms.

When the rectifier is used in an a-c circuit with 125 volts, r.m.s. on the plate, the output falls rapidly as the current is increased. Hence the tube cannot be used very well when the output power is large, or when the receiver has many tubes drawing much plate current. At 60 milliamperes, for example, the voltage across the load is about 70 volts, the condenser next to the rectifier being 12 mfd.

Use of Tube as C Supply

When the circuit requires more current than this rectifier can deliver, the tube is still useful as a C supply, provided that the tubes to be biased are of the heater type the same as the 12A7. Certainly the rectifier can be used to supply the bias for the pentode section of the same tube. While the required voltage is only 13.5 volts, this is a large proportional of the total voltage available when the supply is only 115 volts. By using the rectifier it would be possible to save this voltage and apply it all to the plate.

The rectifier and the pentode having different heaters, each one rated at 6.3 volts. However, the two are connected in series inside the tube, so that the terminal voltage required is 12.6 volts. The normal plate voltage is 135 volts, and this can also be applied to the screen.

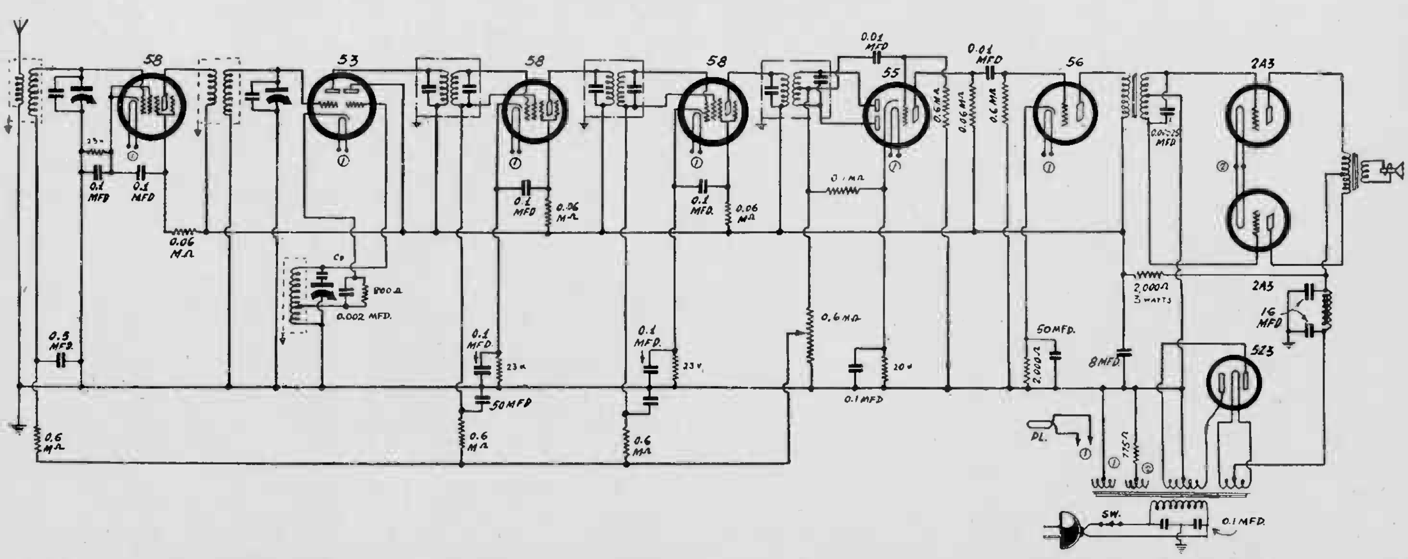
Ratings and Characteristics of 12A7

Heater Voltage, 12.6 volts.
Heater current, 0.3 ampere
Plate voltage, pentode, 135 volts.
Screen voltage, 135 volts.
Grid bias, 13.5 volts.
Plate current, 9 milliamperes.
Screen current, 2.5 milliamperes.
Amplification factor, 100.
Plate impedance, 102,000 ohms.
Mutual conductance, 975 micromhos.
RMS on rectifier anode, 125 volts maximum.
Average d-c output, 30 milliamperes.
Maximum overall length, 4 17-32 inches.
Maximum diameter, 1 9-16 inches.
Base, small 7-pin.
Bulb, ST-12.

Base Connections

If the socket or tube is viewed from the base, or bottom, the following are the connections, going around the circuit in the counter-clockwise direction: (1), heater; (2), pentode plate; (3), pentode grid No. 2; (4), rectifier cathode; (5), rectifier plate; (6), pentode cathode and grid No. 3; (7), heater. The pentode control grid, No. 1, is on top of the tube.

The 53 As Capacity-Coupled Mixer



The 53, two triodes in one envelope, may be used as the mixer in a superheterodyne, without any external coupling, as in a sensitive receiver the inter-element capacity is sufficient for coupling.

A NEW INSULATION

Victron Shows No Heating Effect at High Frequencies, Practically No Losses, and is Completely No-Hygroscopic

A NEW insulating material, called the Victron, has been developed by the United States Rubber Company, and is now ready for radio applications. It has some very desirable characteristics for high-frequency work. For example, the loss factor of this material is only one-eighth of that of low-loss hard rubber, which for long held the leading place in this respect. The new material can be moulded and machined into almost any desired shape. It is unaffected by moisture, acids, alkalis, mineral oils, and organic oils.

It has a mechanical strength sufficient for coils, sprockets, spools, and condenser spacers, as well as for many other devices used in radio. One of the advantages is that the loss does not seem to increase rapidly as the frequency goes up, at least not as rapidly as for other materials heretofore used. The new material comes in two kinds, amber and white. The amber Victron seems to be slightly superior to the white.

Called Extraordinary

J. L. Bernard, for Dielectric Products Corporation, 11 Park Place. New York City, has furnished the following report on the material, which his company markets:

The electronics art and industry are again in the debt of modern chemical research and engineering. First from the laboratories and then from the production facilities of the United States Rubber Company, a new and revolutionary dielectric—Victron—emerges to take its place among the classics in current achievements of organic chemistry.

Now, for the first time, a dielectric is available whose application to electronic devices contributes practically no electrical loss. In this respect Victron is beyond comparison with any other plastic yet brought forth commercially. Such an achievement will command the admiration of those whose tireless search for such a substance has thus far resulted merely in fractional improvement in dielectrics introduced since the world war.

While the discovery of Victron was, in itself, a praiseworthy contribution, those who paved the way for its commercial usefulness share the distinction which has characterized the efforts of workers in behalf of this new insulating substance. They have elevated the electric arts by supplying a dielectric of such extraordinary properties that we are now obliged to revise our concepts of insulating possibilities.

No better support for the above conclusion can be given than simple and direct comparisons between the new Victron and other insulators. These appear below. Values are based upon actual measurements.

Material	*Loss Factor*	*Times Greater than Victron*
New Victron	0.2	—
"Low-Loss" Hard Rubber	1.6	8
Phenolic Insulators recommended for high frequency	3.6	18
Phenolic Insulators recommended for electrical service	18.0	90

A Pure Saturated Hydrocarbon

In attempting to account for such an enormous difference in insulator losses, it is clear that we must refer to the fundamental composition of dielectric substances for an explanation. The reasons given currently in some quarters for the spectacular behavior of symmetrical hydrocarbons in an electric field, to which the reader is referred, would seem to indicate that Victron falls in this class. Unlike the other materials listed above, Victron is a pure saturated hydrocarbon.

That Victron stands alone among the organic insulators as a material that is practically uninfluenced in fields of great intensity has been demonstrated. Its lack of response even at frequencies corresponding to a few meters is remarkable. Apparently, it does not obey the law for heating observed for other types of insulators in which it is now well established, that the temperature rise varies in proportion to the square of the electrode voltage. Experiments with organic and inorganic dielectrics in a high frequency field of great intensity are in progress.

A True Thermo Plastic

The process of manufacturing insulating details in Victron is radical and significant. It undergoes no chemical change upon forming or molding. Phenolic resins and the rubber sulphur formulae do undergo a chemical change during manufacture of the finished piece and the final compound formed is entirely different from the original. Victron is a true thermo plastic. Heat and pressure are needed only for softening and compacting the body to produce a dense homogeneous mass of suitable strength in the finished article.

Since no chemical change takes place upon molding, it is unnecessary to adhere to a maturing or curing schedule in the fabrication of Victron. Furthermore, immature pieces or those in which a primary or secondary action is incomplete, and in which physical and electrical defects may develop after the insulator is in service are wholly eliminated in the Victron process. This is a very important feature of the Victron process for it assures uniformity of product with respect to its physical, chemical and electrical characteristics.

Chemical Constitution

The basic material from which Victron is produced does not appear in any other dielectric. It is known as Meta Styrol produced by the polymerization of Styrol. Styrol is Phenyl Ethylene, the latter having the chemical formula $C^6H^5.CH:CH^2$. This is a water white liquid having a density of .93. The formula for Meta Styrol is $(C^6H^5.CH:CH^2.)X$. The value for X determines the physical properties of the compound, but not its electrical characteristics which are practically independent of the former. Until very recently Styrol was a rare chemical and its production difficult and costly.

After fabricating to shape, polymerized Meta Styrol or clear Victron is available as an insulator from which sheets or molded parts may be manufactured. It is also compounded with special inert fillers to produce insulators possessing various physical properties. We are concerned here only with that combination from which it is possible to manufacture insulators for service in high frequency circuits.

Machining Victron

For best results in machining Victron the following appear among recommendations from those experienced in its use in the shop:

1—Keep tools sharp.

2—Grind lathe tools with considerable rake on leading or cutting edge to eliminate drag and lower friction. Rake should be about 30 degrees from horizontal.

3—Rake of 15 degrees to 30 degrees on trailing side of lathe tools is desirable.

4—Turn, drill or mill at same speeds used for brass.

5—Use drills with coarse flue pitch. Do not allow chips to clog drill.

6—Use well set cross cut circular saw.

7—When necessary lubricate with mineral oil. Wash free with alcohol.

8—For polish use fine pumice and mineral oil, first finishing with sand paper.

Machining Qualities—Both grades admit of a good finish. Both may be drilled, turned, tapped and fabricated in much the same manner as any resinous insulator.

The author wishes to thank Mr. O. H. Smith of the U. S. Rubber Co. for his help in the preparation of the foregoing.

PROPERTIES OF CLEAR AND COMPOUNDED VICTRON

Properties	*Victron AA*	*Victron K*
Color	Amber	White
Density	1.06	1.15
Power Factor %	.049— .08*	.12— .15*
Dielectric Constant	2.5 —3.0	3.5 —4.0
Loss Factor	.15 — .24	.42— .60
Transverse Strength	13,000 lbs. per sq."	12,000 lbs. per sq."
Tensile Strength	6,500 lbs. per sq."	6,500 lbs. per sq."
Effects of Water	None	None
Effects of Chemicals		
Acids	None	None
Alkalis	None	None
Effects of Oil		
Mineral	None	None
Organic	None	None

**Depending upon frequency and temperature.*

CBS Leases Theatre; Admission is Free

The Columbia Broadcasting System has leased for one year the Hudson Theater, 139 West Forty-fourth Street, New York City, and will use it for presentations of programs from the theatrical district of the city. The public will be admitted free to listen to performances while the programs are being transmitted. The broadcasting company is in possession of the premises already.

The theater has a large stage and a seating capacity of 1,087.

It is recalled that in 1930 the National Broadcasting Company set up a studio on top of the New Amsterdam Theater Building in the Times Square district. This has been used ever since as a pickup for programs of a certain type. Usually the public has been admitted free.

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.

Controlling Regeneration

PLEASE SHOW some good methods of controlling the regeneration in a short wave receiver. I prefer the use of a variable condenser in the plate circuit of the regenerative tube, but it does not seem to control well enough. Kindly give suggestions.—B.R.L.

In the illustration on this page you will find three different arrangements, each one offering variations. At the left there is the usual variable by-pass condenser. If this regenerates too strongly, the tickler return can be connected to the resistance, although this does not leave much control. The middle figure is more practical. There is the usual condenser which can be controlled. If this should not be large enough to insure regeneration on the lower frequencies covered by the tuner, there is an extra condenser which can be connected in parallel with the variable condenser. In this way it is possible to use a smaller variable condenser, and this will give a better control of the regeneration at all settings of the tuner. In the figure on the right is shown how the regeneration can be controlled by means of screen voltage variation. This is really a good way. It often happens that the regeneration cannot be controlled because there are too many turns on the tickler winding, or because the coupling between the tickler and the tuned winding is too close. These two should be adjusted so that regeneration will be satisfactory on the lowest frequency covered by the tuner. Just how the regeneration behaves depends largely on how the tuned circuit is coupled to the antenna, and to what kind of antenna. This is one reason why no two circuits act the same way in respect to regeneration

* * *

Effect of Shunt Resistance on Tuning

IF THERE is a resistance across a tuning condenser, either due to leakage or a resistor inserted to serve as grid leak, what is the effect on tuning? Is it necessary to put the same shunt across every condenser in a gang tuner in order to make circuits track?—W.E.

The shunt resistance increases the effective capacity by $(1/Rw)^2C$, where R is the resistance across the condenser having capacity C and w is 6.28 times the frequency. The increase is so small that it does not have to be taken into account in most instances. If the resistance is as low as 10,000 ohms the increase in the capacity at one million cycles per second, the tuning condenser being 100 mmfd., is only 2.5 mfd. But if the resistance across the condenser is decreased below 10,000 ohms, the change in the effective capacity is very rapid. Cases occur where it is necessary to take account of the increase in the capacity. If the resistance is only 1,000 ohms, for example, the increase in the capacity is 253 mmfd. This resistance would also add 717 ohms to the tuned circuit, so there would be no selectivity left. The 10,000-ohm resistance would only add about 250 ohms to the circuit. But even this would spoil the selectivity. One million ohms across the condenser would add 2.5 ohms, which is tolerable. Since the shunt resistance changes both the capacity and the resistance in the tuned circuit, it is important to keep the shunt resistance as high as possible. When a low resistance must be used as a grid leak, it should be connected in series with the grid lead, for then it adds neither to the resistance of the tuned circuit nor to the capacity.

* * *

Inductance Standards

WHAT IS the best way of getting inductance standards which can be used for measuring other inductances? Would it be possible to compute the inductance of coils closely enough? What formula is required if it is practical?—T.R.E.

The best way to get standards of inductance is to purchase them from a company that specializes in laboratory instruments. It is, however, possible to wind inductances so that they can be computed accurately. First of all, it is necessary to have a true form that can be measured accurately. If it is a cylinder, it should be a perfect cylinder turned on a sensitive lathe. In the second place, the wire used in winding this inductance should be fine, No. 40 enameled, for example. This wire should be put on the true form evenly and the spacing should be equal to the diameter of the turns, measured over the insulation. That is, the turns should be as close together as possible. The inductance formula given on page 4, Jan. 20, 1934, issue of RADIO WORLD can be used. The correction terms are extremely small because of the use of fine wire closely wound. A greater accuracy will be obtained if the diameter is small and the coil is long. While inductances may be computed accurately enough for many applications, it is by far better to purchase the standards. The fine wire coil, though its inductance may be known accurately, would have a very high resistance, and it would not be so good in tuned circuits.

* * *

Changes of Tuning in Super

WHAT causes squeals to appear in a superheterodyne that has been lined up so that the tracking is very good? I have built a sensitive superheterodyne which I can line up so that there are no squeals at all, but in a few days they appear, and then it is necessary to adjust the padding again.—T.B.F.

There are two main causes for changes in the tuning, temperature variations and moisture changes. Both change the capacity and the effective inductance of any tuned circuit. Such changes may occur in each of the intermediate circuits, in the oscillator, and in the radio frequency tuner. Perhaps the greatest changes occur in the oscillator. At least, the changes occurring in it will produce the greatest effect on the detuning. One commercial set now has introduced a thermostatic control of the oscillator capacity, which is arranged so that when the frequency is increased as a result of temperature changes, the capacity is increased to compensate for it, thus keeping the frequency nearly constant. This is satisfactory to prevent changes with temperature. But the changes due to moisture remain. The set should be kept in a dry place where the moisture is the same from day to day.

* * *

C Bias Supply

IF THE power tubes in a receiver are 2A3s and a C supply is to be constructed for them, what is the best rectifier that can be used? I know that it is not practical to use heater type tubes because the bias does not become effective until the power tubes have ben active for some time, during which they draw a very heavy current.—W.R.U.

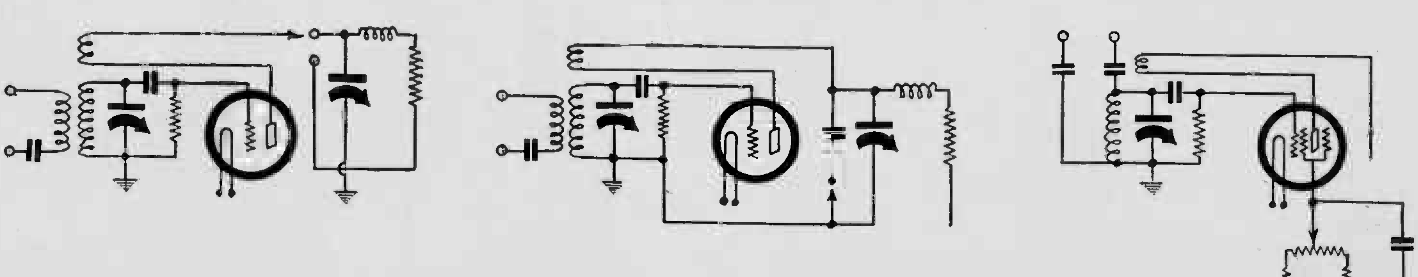
Any filament type tube will be all right, provided that the required filament voltage is available. If the voltage is 2.5 volts, the 226 tube is available, for that requires 2.5 volts. Even a 2-volt tube can be used, such as a 30, for example, by putting a resistor in series with each leg. It is possible to connect the rectifier across the filament winding of the power tubes. If this is done, there should be no other connection to the filament, for if there is, a short circuit might develop. If the center of the filament winding is used for return, the rectifier filament is centered as well. When the same filament winding is used for the power tubes and the C bias rectifier tube, the choke coil filtering the rectified voltage should be put in the negative leg. It is the only place where it can be put. Very little current need be drawn from the C rectifier.

* * *

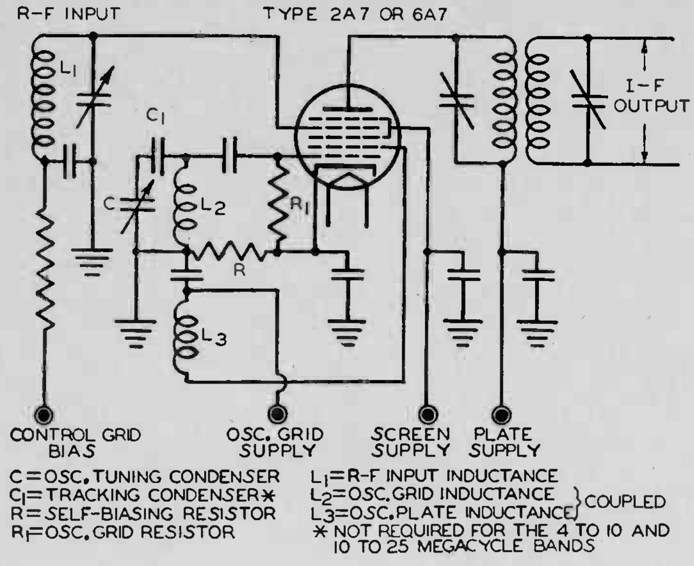
Starting Hum in Amplifier

In A high power amplifier I have built there is a terrific oscillation or hum when I first turn on the switch. This lasts a few moments and then dies down gradually. What is the cause of it and how can it be remedied?—D.R.

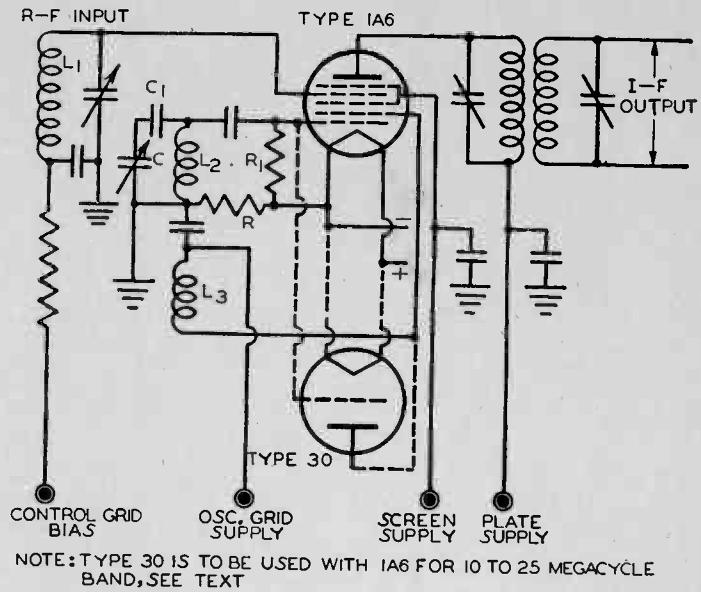
The trouble is motorboating while the circuit is warming up. It stops when all the tubes have settled down to stable equilibrium. Without knowing the specific circuit it is not possible to suggest any specific remedies. However, it is usually possible to stop motorboating by filtering one of the plate circuits involved by means of a resistance and a by-pass condenser. Put the resistance in series with the plate coupling resistor and the condenser between the junction of the two resistors and ground, or the cathode. If the output impedance



Method of controlling the regeneration in a short wave receiver. Control by choking condenser and screen voltage are satisfactory.



The 2A7 or 6A7 used as mixer in a broadcast superheterodyne. These tubes will work in the short-wave bands, too, even unto the highest usual frequencies.



The mutual conductance of the triode section of the 1A6 does not compare with that of the 2A7 or 6A7, and therefore a 30 may be paralleled.

of the tube is the primary of a transformer, a choke coil should be used instead of the resistance. The condenser used must be so large that there is a negligible drop in the low audio frequency response.

* * *

Need of Beat Oscillator

IS IT really advantageous to have a beat note oscillator in a short wave receiver? Does it help to pick up stations or to make them stronger? Is it of any use in tuning in interrupted continuous waves—F.R.L.

Yes, it is really advantageous to have such an oscillator in the set. First of all it helps to locate stations on the dial. Many stations that are weak can be passed over very easily, but when there is a beat oscillator there is a squeal as the intermediate frequency runs through the oscillator frequency whenever there is any carrier present. Ten times as many stations might be located by means of the beat oscillator as with the same circuit without this oscillator. It does not help to make the signals any stronger. As a means for receiving interrupted continuous wave signals it is absolutely essential. Such stations could not be received without a beat oscillator. The beat oscillator makes the circuit into an ordinary heterodyne receiver, counting from the plate of the first detector. The beat oscillator, of course, has to work at a frequency close to the intermediate frequency of the circuit.

* * *

Pentagrid Converter Tubes

KINDLY GIVE ME the values for the 2A7 and show also how the 1A6 may be made to oscillate at high frequencies of the short-wave spectrum.—U. G.

The 2A7 and 6A7 have the same connections and constants. The 2A7 is for 2.5 volts on the heater, usually a. c., the other normally for storage battery use (6-volt battery), though a. c. is of course practical. It is assumed this type of tube is to be used as pentagrid converter in a superheterodyne, as that's what it was made for. The diagram at left shows the connections. The heater symbol is familiar. The right-angled symbol above it is the cathode, and is connected to grounded B minus through R, a 250-ohm resistor. Across this resistor is a condenser of 0.1 mfd., the capacity repeated throughout the circuit unless otherwise specified. The oscillator control grid is next on the way up (Grid No. 1 by terminology), then the effective plate of the oscillator, which is really a grid and so called Grid No. 2. The horizontal U-shaped symbol represents the screen, which consists of two interconnected grids, one between the oscillator's Grid No. 2 and the control grid of the pentode (Grid No. 4), and the other between the pentode plate and the pentode control grid. L1 is the secondary of the input i-f transformer, with around 200 mmfd. across it, the return being made through a resistor (250,000 ohms), to the a-v-c circuit if a. c. is to be applied to the pentode, as well it may be, especially for squeal-reduction. The tuning condenser is the one built into the transformer secondary and is adjusted once. C is the oscillator tuning condenser, normally 0.00035 mfd., C1 is the padding condenser, which for 175 kc may be 850 to 1,350 mmfd. and for 465 kc i-f. may be 350-450 mmfd. For high frequencies no padding capacity is needed. The condenser from L2 to R1 is the grid condenser, 0.0002 mfd. or 0.00025 mfd. R1 is the grid leak, different values for which may be tried, depending on the screen voltage, although 50,000 ohms is the usual value selected for broadcast frequencies. L2 is the oscillator's tuned secondary and L3 is the primary or tickler. "Oscillator grid supply" refers to the positive voltage for Grid No. 2, the concomitant plate of the triode, and the voltage may be around 100 volts. The screen supply may be the same, but never should be higher than the oscillator grid supply. The plate supply may be 250 volts, but for battery use of the 6A7 of course would be no more than 180 volts, due to B batteries or a B generator as in automobile sets. For the 1A6 to oscillate in its triode section for the high frequencies you refer to, either omit the grid leak and condenser, or put a 30 tube in parallel with the triode of the pentagrid, as illustrated at right.

* * *

Stabilization of Hartley

IS THERE a simple way of stabilizing the frequency of the Hartley oscillator? If so, how?—W.H.C.

If the frequency is to be variable, there is no simple way; but if the frequency is to be fixed, the stabiliziation of the Hartley is just as easily accomplished as that of any other oscillator. If C is the capacity of the tuning condenser (fixed) use a capacity of the same value for grid condenser. Then in the plate circuit connect a coil having an inductance equal to four times the mutual between the two coils. This assumes that the coil is tapped at the center for the cathode. A coil having a shape factor of 1-to-1 has a coefficient of coupling equal to 0.31. If the inductance of the entire coil is L, then the inductance to be added in the plate lead is 0.473L for the particular coupling given. If the grid condenser can be varied at the same rate as the tuning condenser, the oscillator would be stable for all frequencies to which the circuit tunes, but the difficulty is in tuning the grid condenser. But it is not impossible, for it only requires that both sides of the condenser be insulated.

* * *

Use of Gaseous Discharge Tube

IS IT possible to make an oscillator with an 885 tube, adjust its frequency to 10,000 cycles, and control this with a higher frequency that is accurately known? It seems to me that the rate of oscillation can be controlled by the control grid even though the frequency impressed on the grid is higher than the discharge oscillator frequency.—E. R. H.

We have not heard that this has been done yet, but it seems feasible, provided that the fundamental of the gaseous discharge oscillator does not differ too much from the standard frequency. It would also be necessary to adjust the control voltage carefully, so that the discharges will not occur at improper times. You will find an article in this issue explaining how a multivibrator can be used to produce harmonics all of which are controlled by a higher frequency that is accurately known.

* * *

Quartz Crystal Audio Oscillator

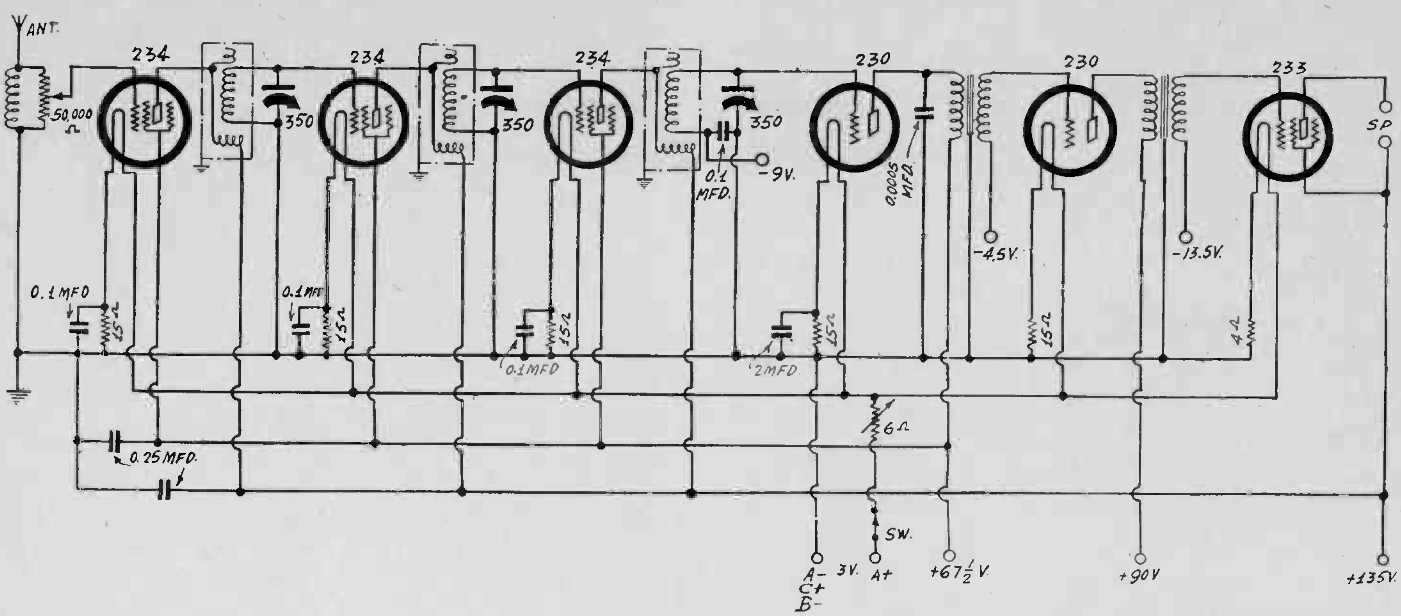
CAN a quartz crystal be used for an audio frequency oscillator to generate a standard frequency in this range? If not, what do you suggest?—W.B.L.

A beat note audio oscillator has been described by Dr. August Hund of the Bureau of Standards. He cut a notch in the crystal so that it would oscillate at two different frequencies at once, giving a beat that fell in the audio range. In the regular way a low enough frequency cannot be obtained with a quartz crystal. Two separate quartz crystals could, of course, be used to produce a beat note oscillator that fell in the audio band. A magnetostriction oscillator could be used in the audio range. An electrically driven tuning fork oscillator would also make a good standard. If the frequency is to be highly constant it would seem that either a beat note oscillator of the quartz crystal variety or a magnetostriction rod oscillator would be best because they are small enough to be placed in a constant temperature chamber of reasonable dimensions.

* * *

Choke-Primary Coupler

PLEASE LET ME KNOW about the choke-primary type of coupler for tuning, the one with a turn or two around the secondary for the capacity effect, to provide



Compensation for the rising characteristic of tuned-radio-frequency receivers may be introduced by using coils that have primaries resonating at some low frequency outside the broadcast band, these chokes capacity coupled by a turn or two of wire to the tuned secondary.

coupling, so the choke is not inductively related to the rest of the circuit. Is there any advantage in this in a tuned-radio-frequency receiver? How about a superheterodyne? Any difference?—O. W. C.

If all of the couplers are alike the system is all right for tuned radio frequency receivers, that is, assorted coils must not be used, due to difference in their inductive characteristics with frequency. The object is to build up the amplification at the low radio frequencies. As is well known, the amplification drops considerably as the lower limit of tuning is approached. This is usually defined as an increase in the amplification as the frequency of response is incrased, hence is referred to as the "rising characteristic." It is particularly true of t-r-f systems, because all the r-f amplification that exists is at the carrier level. The advantage of boosting the low radio-frequency response is of course at the expense of the high radio-frequency response, but since t-r-f systems tend to become regenerative or oscillatory at the higher frequencies, stabilization may be introduced, and the low-frequency boosting enjoyed, by using this type of coil. The moment that the drain from the high end becomes too great for the circuit design, the radio-frequency resistance increases enormously in that region, and selectivity suffers badly, since selectivity may be regarded as inverse resistance. In a superheterodyne, due to the tremendous amplification at a single level (the intermediate frequency, which is itself a radio frequency), there would be scarcely any good reason for including these special coils. The diagram of a t-r-f set herewith shows their use.

* * *

Renders Access to a Set

FOR THE CONSTRUCTIONN of a device to make access possible for resistance measurement by the point-to-point method, as well as voltage and current measurements in the usual manner, is it practical to use a couple of switches and some sockets, and if so please give a suggestion?—I. R. D.

Yes, this is a well-known, but not yet commercialized method, as it simply makes access possible and lets you supply the meters. Two switches would be needed. One would be the simple double-pole, n-throw type, n representing the number of throws, usually nine being the limit, for voltage and resistance measurements. The other switch would consist of n throws, and would be double-poled, with facilities for putting across each pair of poles another section of the same switch that opens a circuit the moment the companion section of the switch closes the meter circuit. Thus the opening service renders access to current-carrying lines, such as the plate, for current measurements. When the switch leaves this position it restores the continuity directly, instead of establishing it through the meter. Two sockets will suit general purposes, one of the dual-seven-hole type (medium and small seven-pin bases fit into it), and the other a combination, also, but for four, five and six pin tubes. Besides, a connecting cable and plug, called analyzer plug, are needed. Thus, to use the instrument, remove the tube from the set and put in the proper socket of the tester. Put the analyzer plug into the vacated receiver socket (using an adapter, if need be), and then connecting the meter across the output posts of the tester and work the switches. The layout for such a device is illustrated herewith.

* * *

Invariable Capacity

HOW can an air condenser be constructed so that its capacity will not vary as the temperature changes? Is the variation in capacity mainly due to changes in the dimensions in the supports of the plates or to changes in the distance between the plates?—W.R.V.

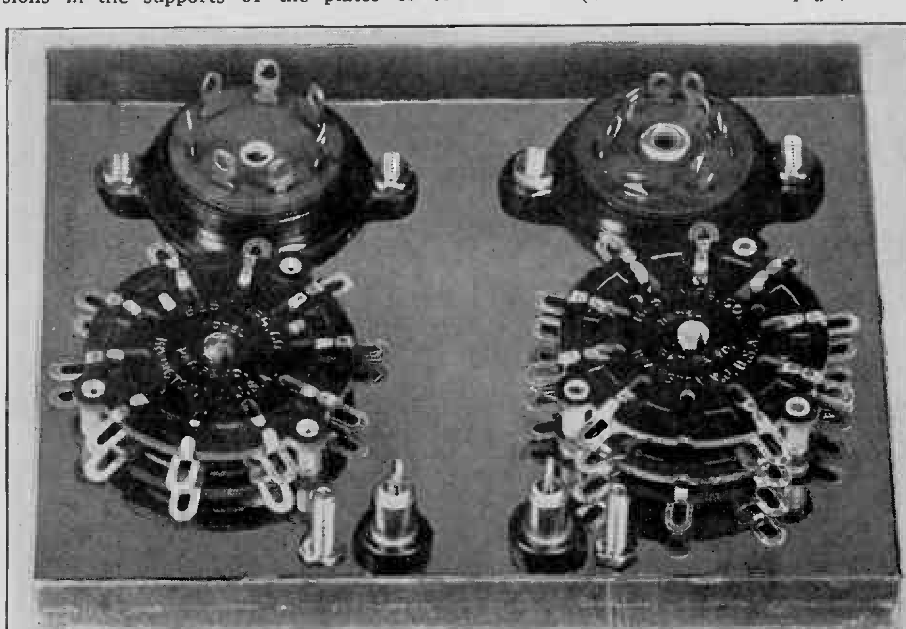
It is difficult to say which causes the greater change in the capacity, the variation in the supports or that in the dimensions of the plates. The changes due to variations in the effective area of the plates must be very small, but changes in the distance between the plates should have a large effect. Whether the distance increases or decreases as the temperature increases depends on the mountings and the spacers. To make a condenser that does not change appreciably the spacers should be made of a material that neither expands nor contracts. Invar is an alloy that remains constant and fused quartz is an insulator that is practically invariable.

* * *

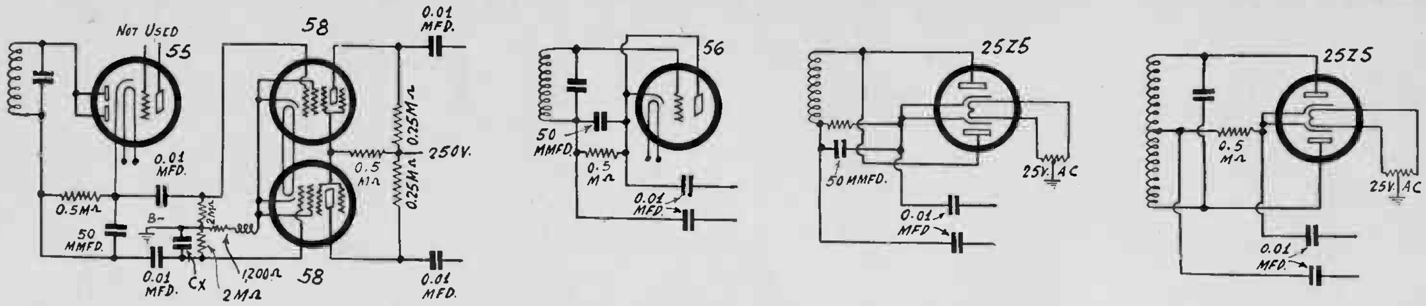
Vibration of Condenser Plates

IS THERE any danger that the condenser plates in an oscillator of a superheterodyne will vibrate as a result of shocks and so modulate the output? I have suspected that this is the trouble with my set,

(*Continued on next page*)



An arrangement such as this may be utilized for constructing an accessor, a device that renders access to a receiver or power pack for the usual measurements, but does not contain the meter or meters, since the constructor, it is assumed, will use the instruments he has.



An experimental circuit for push-pull resistance coupling is shown at left. Nice balance, requiring sensitive a-c instruments, must be effectuated before results are good. The 56 as a diode is shown second from left. At extreme right is the 25Z5 as full-wave detector, and to the left of it as half-wave detector. All push-pull resistance-coupled circuits, it must be stressed, are experimental.

(*Continued from preceding page*)

but I am not sure. If it is, what can be done to stop it?—B.B.H.

There is not only danger from this in a superheterodyne but in a radio frequency receiver. Of course, the trouble will be accentuated in the oscillator. About the only way to stop the trouble when it occurs is to cushion the condensers. Sponge rubber cushions are all right. Of course, it is not always practical to mount the condensers in that manner. But if the oscillator condenser cannot be mounted that way, the whole set always can be, and that is about as effective.

* * *

Frequency of Multivibrator

HOW is the frequency of a multivibrator determined? Is it possible to compute the frequency from the constants of the circuit? —W.R.T.

Many different expressions have been given for the computation of the frequency of a multivibrator, but no two give approximately the same results. Yet they are all called approximate. The best way of getting the frequency is to measure it.

* * *

Feeding Power Tube Through Resistor

IS IT all right to feed a power tube through a resistor if the resistance is equal to the optimum load resistance for that tube, and then take the output from a transformer the primary of which is coupled to the plate of the tube by means of a condenser? I have tried this idea and have not had much luck with it. If it is not all right, why is it not?—R.E.J.

It is not all right. A choke of negligible d-c resistance should be used in place of the resistor. The resistor causes too much drop in voltage and power cannot be supplied fast enough to supply the demand of the load.

* * *

The 48 as Triode

WHAT is the amplification factor of the 48 power tube when it is used as a triode, that is, when the screen is tied to the plate?—G.H.

According to the curves for the 48 published in the last week's issue of RADIO WORLD, the amplification factor of the tube under these conditions is 3. This is clear, for it requires a change of 15 volts in the plate voltage to compensate for a change of 5 volts in the grid bias, the plate current being kept constant.

* * *

Piezo Microphones

IS IT possible to make microphones with Rochelle salt crystals? I understand that it is possible to make loudspeakers with these crystals.—R.E.T.

Piezo crystal microphones are on the market. You ought to be able to get them through your radio dealer.

* * *

Push-Pull Resistance Diagram

IN A RECENT ANSWER to a question on push-pull resistance coupling you did not show the complete wiring. It is requested now, at least up to the output stage. Also show the 25Z5 as full-wave and half-wave detector.—I. H. G.

The diagram at left on this page shows the 55 diode for half-wave detection, the output from the load resistor being delivered to the grids of the driving 58's for the push-pull relationship. The stopping condensers looking out of the 58 circuits lead to the power tubes.

Prof. Morecroft Dies

John H. Morecroft, professor of electrical engineering at Columbia University, and author of the most popular technical radio books, including "Principles of Radio Communication," died at 53 in Pasadena, Calif., where he had gone on special leave so that he might improve his health. He was a man of slight stature and had become run down from overwork.

When he left New York City he was greatly moved by the demonstration of affection and well wishes from his co-workers and students, and tears were in his eyes as he said good-bye at the railroad station, as if he half knew he never would return alive. In California his progress was not as good as was hoped. He attended the Columbia-Stanford football game, where he rooted, although at great physical effort, for the team of the college at which he was such a distinguished professor. He told his victorious football players at Rose Bowl that he "hoped" to be back in the classroom with them February 7th. When he returned from the game to his cottage he started to cough a little. A physician hurriedly called in said the professor had pneumonia.

Born in England, John Harold Morecroft came to this country when a boy and attended primary and high school in Syracuse, N. Y. He was graduated with honors from Syracuse University in 1904 with a degree of electrical engineering.

At this university he taught electrical engineering and also civil engineering and attained a professorship. He got his B.S. degree there in 1907 and went to Pratt Institute, Brooklyn, N. Y., as instructor in electrical engineering. At the same time he was studying at Columbia University under Prof. Michael I. Pupin. Soon he became an instructor in electrical engineering at Columbia, following scholastic honors, including a scholarship, and rose to the professorship in 1909.

Prof. Morecroft was a submarine defense scientist in the Navy during the World War. He was a past president of the Institute of Radio Engineers, the recipient of many honors, including degrees and medals, from universities and learned societies, and one of the outstanding authorities on radio communication.

The Review

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

Questions

1. If an audio oscillator is constructed, and a small audio transformer used, one winding in grid circuit, other in plate circuit, and if there is no condenser across the primary or secondary, will the tube oscillate, even though this condenser is not externally applied, and in view of the fact that without capacity there can be no oscillation? If the tube oscillates, why?

2. What is the most serviceable simple, inexpensive way of measuring a-c voltages of radio frequencies? How could such a device be suitably calibrated? What would the calibration disclose, rms or peak values, and why? If one set of values is known could the other be determined without measurements?

3. If the frequency-calibrated scale is used, can the proper inductance be applied with a tuning condenser of proper maximum capacity, to make the tuning track the scale? If so, why? If not, why not?

4. Will the neon tube oscillate at radio frequencies?

5. How can audio modulation be established by beating, and at the same time serve as a relative check of the radio frequency?

6. State a method of frequency stabilization that uses two equal plate coils and the reason for stability.

7. If a tone control is placed across the voice coil of a dynamic speaker, will it have much effect? If so, why? If not, why not?

8. What is the most economical way of powering the filaments of a receiver using 2-volt tubes?

9. State briefly the important factors of the new rating of the 48 tube and say what sort of a tube it is.

10. In what way does the quality of the reproduction depend on the width of the scanning slit of a sound-track film?

11. What is the cross-section shape of a quartz crystal in the rough?

12. State the axes on which a quartz crystal oscillates.

13. Define the difference between the quartz crystal oscillation and the Rochelle salts crystal oscillation, and contrast effects.

14. What is a sweep oscillator and what is the principle of oscillation in the present tube (885) used for such purposes?

15. If one frequency is exactly twice the other, what is the formula for the distributed capacity, and is it necessary to know the absolute values of the frequencies or the value of the inductance?

Answers

1. The tube will oscillate even without external condenser, and even though without capacity there would be no oscillation, as there will be sufficient self-capacity in the windings.

2. A vacuum tube voltmeter. This may consist of a three-element tube, battery-operated, with filament voltage adjustable to the specified value each time measurement is to be made, and with B voltage as usual in the plate circuit, a current meter used in this circuit for measurement, and a negative battery bias introduced until plate current is apparently cut off. Then a-c voltages from the 60-cycle line may be introduced, and an a-c voltmeter put across the input to the VTVM, grid to C minus, and changes in plate current noted as the a-c voltages are changed. Then a curve may be drawn, constituting the calibration. The values will be peak values if a peak voltmeter measured the input, rms values if an rms voltmeter measured the input. If one calibration is known the other can be computed, as the peak value is 1.41 x rms and the rms value is 0.707 x peak.

3. No, the tuning will not track the precalibrated scale unless the same capacity, make and style of condenser is used as was used in the calibration, since the scale is an expression of the frequencies resulting from specific capacity in circuit as specific positions of the dial. For tracking, the scale, condenser and coil all must be matched, and any divergence on any one renders the combination practically useless.

4. Yes.

5. Audio modulation can be established by beating, if a second radio frequency of oscillation is introduced into the test oscillator, this second frequency being about the same as that generated by the test oscillator, or an harmonic of the second frequency equalling that of the test oscillator. By the harmonic method, if the second oscillation is of a low enough relative frequency, the steps in the test oscillator where beats are heard are integral multiples of the low-frequency oscillator. For instance, if the low-frequency oscillator is 50 kc, then a broadcast band test oscillator could be checked for 550, 600, 650, 700, 750, 800, 850, 900, 1,000, 1,050, 1,100, 1,150, 1,200, 1,250, 1,300, 1,350, 1,400, 1,450, 1,500, 1,550 and 1,600 in the present broadcast band.

6. Build an oscillator with tuned winding in the plate circuit, use a step-down ratio in the grid circuit, see that no grid current flows, and put in series with the plate tuning another coil equal in inductance to that in the tuned winding, but completely out of the inductive field, connected from stator of tuning condenser to plate. Frequency stability results because the phases are opposite in the two circuits, one coil being series-tuned, the other parallel-tuned, and this absence of phase shift constitutes frequency stability.

7. The tone control will have very small effect, because the impedance in the voice-coil circuit is itself extremely low, and the impedance reduction introduced by the intended tone control is negligible.

8. Use a 6-volt storage battery and connect three 60-milliampere 2-volt filaments in series, once for three, twice for six tubes, etc., and for supplying a 2-volt tube of greater current drain, use a series resistor to drop the battery voltage to 2 volts.

9. The 48's new ratings are an increase in the mutual conductance to 3,800 and 3,900 micromhos, bias voltages of minus 19 and minus 20 volt for plate supply of 96 and 125 volts, respectively, and full 2-watts output rating. The tube is of the 30-volt heater type, for use as pentode power output. The tube may be used as a triode, with different characteristics and ratings, by tying plate and screen together.

10. The narrower the film the more will the high frequencies be brought out. When the width of the slit, measured in the direction of the length of the film, is equal to half wave length there is no reproduction. This happens again when the slit is one wave, or any whole multiple of half a wave. The slit must be so narrow that the half wave length for the highest frequency sound to be reproduced is small compared with the width of the slit. The drop in intensity is rapid as the half wave is approached and it suffices to place the first cut off just above the highest frequency to be reproduced. The more rapidly the film moves, the longer will be the wave for a given frequency. It is for this reason that films were speeded up when sound was placed on them. It is more practical to do it this way than to make the slit sufficiently narrow.

11. Hexagonal.

12. The quartz crystal will oscillate on its X, Y and Z axes, hence is cut on any one of these to have oscillation on the desired axis. The Z axis is the long one, from tip to tip. The line through the Z axis at right angles to the plate faces of the hexagon is the Y axis. The line through the Z axis and through the vertrices of the hexagon is the X axis.

13. The quartz crystal is a mechanical oscillator. The Rochelle salts crystal is an electric oscillator, because piezo-active. The quartz crystal oscillates only in a given plane, but the Rochelle salts crystal may oscilate in a twisted direction.

14. A sweep oscillator is a device for moving the cathode ray beam horizontally in an oscillograph tube, or an oscillator for establishing a time axis for the phenomena under observation. A present use is to have a gas-discharge tube, the principle of operation being the alteration of the breakdown voltage of the tube by changing the grid bias.

15. If one frequency is exactly twice the other, neither the frequencies nor the inductance need be known, but the distributed capacity may be derived from the capacities in circuit alone. The formula is

$$Co = (C_1 - 4C_2)/3$$

where Co is the distributed capacity, C_1 is the larger capacity (used at lower frequency) and C_2 is the smaller capacity.

FINANCIAL REPORTS

Crosley Radio Corporation: Net profit for the nine months ended Dec. 31, 1933, after Federal taxes, depreciation, royalties and other charges, $344,452, which equals 63 cents a share on 545,800 no-par capital shares. For the same period of 1932 there was a net loss of $255,231. Net profit for the quarter ended Dec. 31, 1933, after deduction of same charges, $175,647, which equals 32 cents a share. This compares with $64,894, or 12 cents a shart in the preceding quarter, and $45,469. or 8 cents a share in the fourth quarter of 1932.

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.*

C. Berry, 460 Upper James St., Hamilton, Ont., Canada.
L. H. Taylor, 5017 Highland Ave., Downers Grove, Ill.
A. Lemarie, 60 Queen Anne Road, Bogota, N. J.
Chas. Mick, 143 Shaw St., Garfield, N. J.
Roy L. Johnson, 328 Rogers Hotel, Minneapolis, Minn.
L. Lindstrom, 4440 - 33rd Ave., S., Minneapolis, Minn.
W. H. Boadle, Radio Service (instrument makers, oscillators to be used in coil manufacture), 29 Collingwood St., Lower Hutt, New Zealand.
Walter A. Smith, 22 Kussuth St., Biddeford, Maine.
Dr. Carlos J. Piedrahita, Registrador de la Propiedad, Sancti Spiritus, Cuba.
Glenn Maley, 748 Center St., Enderlein, No. Dak.
Frank Sokol, 8 Electric Street, Worcester, Mass.
O. Odstrcil, Sachsenberg 30, Cesky Tesin, Czechoslovakia.
R. Langhoff, 307 E. Cayuga St., Tampa, Fla.
Raymond R. Riley, 107 Wallace St., Ft. Wayne, Ind.
Fred Neal, Neal Radio Service, 305 McDanel St., Kinston, N. C.
C. H. White, Room 221, Centennial Annex, Springfield, Ill.
C. B. Storey, 1713 - 13th Court, North, Birmingham, Ala.
W. W. Swanson, c/o The First National Bank, Highmore, So. Dak.
F. Koen, 408 Pine St., Sweetwater, Texas.
Charles Sherman, 167 Central Ave., East Providence, R. I.
R. A. Manly, 400 Park Ave., Goldsboro, N. C.
Jos. Belick, 65 Front St., Box 133, Coplay, Penna.
W. Carroll Vaden, 711 E. 12th St., Georgetown, Texas.
Walter C. Cox, R5, Box 522, Santa Rosa, Calif.
Frederick Ludemann, 1400 Webster St., Dayton, Ohio.
C. J. Snyder, 114 Arch St., Little Rock, Ark.
William H. Brannon, Jr., P. O. Box 983, Owensboro, Ky.
James S. Haglund, 23 Andre St., S.W., Grand Rapids, Mich.
Hugo Menzel, Rte. 3, Box 804, San Jose, Calif.
Roy H. Bauman, 205 Liberty St., Batesville, Ind.
Ira S. Hines, Box 393, Riverdale, Md.
D. E. Shelhy, Day or Nite Radio Shop, 213 W. Main St., Medford, Ore.

Station Sparks

By Alice Remsen

What a Cold Will Do!

I suppose everybody is complaining about colds this time of the year. I caught one and the blamed thing did me out of a nice job—a radio program which suited me so well it might have been made to order; commercial, too; isn't that a shame! Of course, the cold's all better now so that it doesn't matter; oh, well, better luck next time. However, still have my Wednesday morning program on WEAF and chain. A great many of my readers have been kind enough to listen and to drop me a line; and please let me say right here—that all song requests will be granted in the order received; so don't get impatient. One of my correspondents requested "Down Arizona Way." Sorry I can't seem to get on the track of this song; if you have a copy will you kindly mail it to me, or tell me where I can get one?. . . .

GERTRUDE STEIN'S LATEST

February 8th marks the world premiere of Gertrude Stein's new opera, "Four Saints in Three Acts." CBS will broadcast the performance of this remarkable work. It is quite probable that the majority of listeners will listen in bewilderment, for Miss Stein has a style of her own, which has been pronounced by many as "ridiculous and unintelligible"—but while the words are to a large extent without meaning, the lines are always rhythmic and well adapted to singing. The artists will be colored; their faces will be painted silver, which, to say the least, is rather a remarkable proceeding. . . . Folk who have been accustomed to hearing the mellow voice of David Ross announcing the Old Gold programs are in for a disappointment with the new series. David cannot go to Hollywood, and so his voice will be missing; however, a young man has been picked from 140 aspirants; his name is Ken Niles; he is a twenty-seven-year old Californian, and the Pacific Coast's most popular announcer. For the past eighteen months young Niles has been chief announcer and production manager of Station KHJ, Los Angeles. . . . The Amco Oil "American Revue" felt the need of comedy, after one or two weeks without the inimitable patter of George Beatty; so the sponsors placed Georgie Jessel as a featured guest star of the program. . . . Jeannie Lang and her giggle will be back on the air again February 9th, with the new "Marvelous Melodies" revue, starring Jack Whiting and Jack Denny's Orchestra; each Friday 9:30 p. m. EST. Jeannie's last job on the air was with Silver Dust. . . .

WHEN THEY ARRIVED ON EARTH

Would you like to send your favorite CBS star a birthday card? In case you would, here are a few birthdays for the month of February: Ben Alley, 11th; Jacques Fray, 18th; Connie Gates, 19th; Vera Van, 20th; Kenneth Roberts, 22nd; Davidson Taylor, 26th. . . . The Five Spirits of Rhythm, CBS's new colored quintet, all hail from St. Louis Mo., with one exception, and he comes from Hempstead, L. I. . . . Howard Marsh always had a secret yearning for a chance to blow a cornet in public. His wish was gratified on a recent "Meet the Artist" program; he didn't do so badly, either. But I think he'd better stick to singing. . . . Circleville, Ohio, honored its nomadic first citizen recently by tendering him an embossed certificate of his honorary life membership in its Chamber of Commerce. Clarinet-tooting Ted Lewis was the recipient of this honor; yes; Ted was born in Circleville—and he won't say how many years ago; his real name is Theodore Friedman. . . . Music lovers listened with pleasure recently when Lawrence Tibbett sang "Sylvia" over the radio. Oley Speaks wrote it in his boyhood home, Columbus, Ohio. In order that this song shall not become too hackneyed it is seldom used on radio sustaining programs—which is a good thing, for the beauty of its melody has been butchered by mediocre singers and jazz bands almost since radio came into existence. . . . The real folk music of the South, sung and played by untutored, non-professional natives of the hills and lowlands, will be presented under the direction of John Powell, noted Virginia composer and pianist, in a new and distinctive series of broadcasts over a National Broadcasting Company network, beginning Wednesday, February 21st, at 4:45 p. m., EST. The authentic songs and fiddle tunes, passing orally from generation to generation from old English sources, are the purest form of the Gregorian modes now extant. Most of the songs to be heard in the series never have been written down or harmonized. In the first broadcast from the NBC studios in Radio City, a large concert orchestra will play selections from the works of modern American composers to illustrate their use of the ancient folk songs as thematic material. Mr. Powell will explain the unusual tonal constructions of the earliest American melodies. Subsequent broadcasts will come from the studios of NBC affiliated stations in Richmond and Nashville, to which Powell will bring old-timers from the country districts to sing and play the ancient tunes just as they are done in lonely cabins in the hills and valleys of the South. I imagine they will be very interesting broadcasts. . . .

AL JOLSON ARRIVES

And so Al Jolson rejoins the Whiteman program on February 8th at 10:00 p. m. Al has finished his picture work in Hollywood, where he has been since October. Jolson has been recuperating from his strenuous picture work by making the trip East by boat via the Panama Canal; Paul Whiteman and Deems Taylor, noted composer, critic and master of ceremonies, will continue to be featured on the Kraft programs when Jolson returns. . . . Lew Palmer, the drummer and one of the featured soloists with Jan Garber's Orchestra, which broadcasts nightly over WGN, Chicago, and each Sunday over NBC, started his career in Georgetown, Kentucky. Lew is one of those clever kids; he not only drums and sings for a living, but he is a great little dancer, and first came into the entertainment field in a singing and dancing vaudeville act; he also appeared in several musical comedies. . . . If you did not hear Dorothy Parker on Alexander Woollcott's program recently, you missed a treat. Not only was her little waltz skit richly humorous, but her speaking voice brought a surprisingly colorful personality to the jaded microphone. Welcome to the air, Miss Parker! hope I hear you often—and oftener! thanks, Alexander, for a most precious guest! . . . Fred Waring has changed his middle theme song from "Smoothie" to "Breezin' Along With the Breeze." His opening and closing signature remains the same. . . . If there's any little boy pining for a dog, he can get one by writing to Peter Van Steeden, the maestro of the Jack Pearl program; a nice friendly mutt adopted Peter one night, and as Peter possesses a tender heart he took the doggie home with him; but alas, Peter's own dog resented the presence of a stranger; so there's a war on between the two purps, and Peter wants to find a good home for the stray. . . . Sally and Sue are still warbling on WOR three times weekly, but their schedule has been changed—it is now Monday, Wednesday and Friday at 3:15 p. m. . . . Fred Waring, in case you're interested, always weighs more on Sundays than he does on Thursdays. He reaches his high on Sunday evenings and his low on Thursday evenings. Here's how: long, arduous rehearsals for his mid-week broadcasts begin on Monday morning, and his working time increases steadily through Wednesday, which is a twenty-hour day for him; although he is slight of stature, he drops three to four pounds on that day alone; he rests, comparatively speaking, from Thursday to Sunday, during which interim the dropped avoirdupois returns to him; now with the Ford series under way twice weekly, it looks as though his slender frame is due for a "bear" market. . . .

PETER DIXON WRITES IT

It is Peter Dixon who writes that fine dialogue on the Borrah Minnevitch commercial over WOR. Peter is doing good work these days. Some lad; . . . There's a girl well known around the radio studios in New York; she is what is vulgarly termed a "song plugger"; but this young lady is more than that—she is an artist, a capable accompanist, a singer and actress; her name is Rae Zelda; in her spare time she makes harmony arrangements, rehearses various artists privately in their songs, plays the part of Sue in the "Sally and Sue" skits on WOR, makes the harmony arrangements for that program, holds down a job for at least nine hours a day—and on top of all that she keeps house—and is she a swell cook! Well, rather! Some gal, I'll say! . . . Gus Van has returned to the air via WJZ, each Tuesday at 7:45 p. m.; program is billed as "Gus Van and Company;" Arlene Jackson is the company.

SARNOFF ELECTED

David Sarnoff, president of the Radio Corporation of America, is now a director of the Metropolitan Opera Association, Inc., in New York City. Closer touch between radio and opera is expected to result.

A THOUGHT FOR THE WEEK

RADIO AND THE LEGITIMATE THEATRE seem to be locking horns again. The Actors Equity Association and the Legitimate Theatre Code Authority are attempting to block the plan of broadcasters to take over theatres for the purpose of giving free stage shows. The claim is that the regular theatres are having plenty of trouble in getting folk to go to the box office in sufficient numbers to keep the houses open and that radio as a general proposition is keeping enough potential theatre ticket buyers at home without the present prospect of free shows for those who might otherwise give managers a chance for their lives.

The whole matter is one that seems to be driving the legitimate folk to make efforts to stop the broadcasting chains from attempting further incursions into the amusement field, while at the same time it is acknowledged that the free shows will give employment to players who otherwise might increase the ranks of the unemployed. It's a pretty fight as it stands and wise minds are trying to work it out for the benefit of the greater number.

Now let's see what the Radio Code Authority will do about it.

SPECIAL GIFT LIST

Reliable Radio Tips

Watch for This Special Page Weekly

RELIABLE RADIO RUNS GIANT 1934 SALE!!

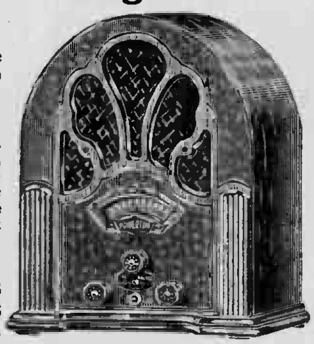
FOR A PRACTICAL GIFT SUGGESTS GIVING A RADIO—LET THE ENTIRE FAMILY ENJOY IT

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



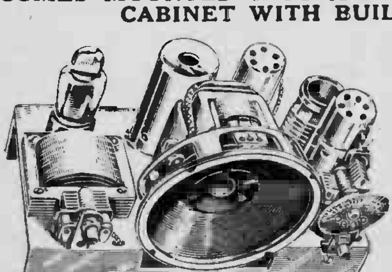
A practical gift for the entire family. The most advanced features are embodied in these receivers. Quiet, smooth, distortionless reception.

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

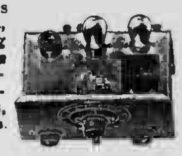


Looks like a midget broadcast receiver. Will tune in short wave stations from all parts of the world with ease. Uses four coils to cover the short wave bands from 15 to 200 meters. The built-in power supply is entirely free from hum or disturbing line noises. Uses an ultra-sensitive dynamic speaker to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

Wired and tested........$2.00 extra
Kit of tubes..............$2.50 extra
Cabinet only ....$1.50 extra

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**

EXTRA!

SHORT-WAVE SETS

ACCLAIMED THE IDEAL GIFT FOR RADIO-MINDED FOLKS

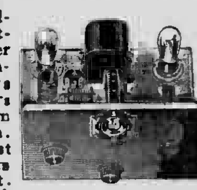
If you really want to please your radio-minded son, father, mother, brother, sister or friend this Christmas, give a short wave receiver. On this page are several very fine receivers for both the beginner and the more advanced short wave enthusiast, yet all at extremely low prices.

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

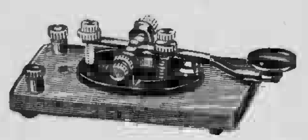
Beginners Twin Two-Tube Short-Wave Battery Receiver



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**

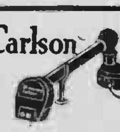
Wired..$2.00 extra Tubes.......$1.50
Batteries $2.50

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**

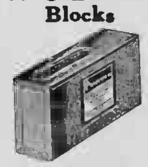
Stromberg-Carlson Phonograph Pickup



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**

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.

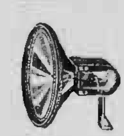
4 mfd 35c
8 mfd. 40c

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



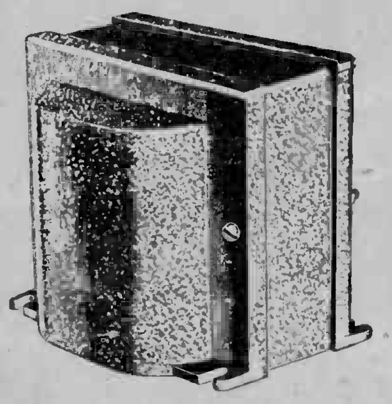
Not to be confused with the various models now on the market and labeled Farrand Inductors. These models are genuine factory-built Inductors.
Two models are available, a 12" model and a 9" model. Mounting brackets are placed on both models.
Price, 9" model........$3.95 Price. 12" model.......$5.95

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

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.

175 KC TUNING UNIT FREE

WITH SUBSCRIPTION

For use with 175 kc intermediate frequency. Unit includes four-gang condenser, three r-f coils, the proper oscillator inductance and 800-1,350 mmfd. padding condenser. Send $12.00 for two-year subscription and order Cat. SUTU-175, which will be sent postpaid.

Radio World
145 West 45th Street
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BOTH FOR ONE FULL YEAR

RADIO WORLD and "RADIO NEWS"

$7.00

Canadian and Foreign, $1.50 extra.

You can obtain the two leading radio technical magazines that cater to experimenters, service men and students, the first national radio weekly and the leading monthly for one year each, at a saving of $1.50. The regular mail subscription rate for Radio World for one year, a new and fascinating copy each week for 52 weeks, is $6.00. Send in $1.00 extra, get "Radio News" also for a year—a new issue each month for twelve months. Total 64 issues for $7.00.

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

As a GIFT

with a Subscription Order—

A Test Oscillator Accurate to 1%!

THE new model 30-N Test Oscillator produced by Herman Bernard has been improved by custom-making each coil to an inductance accuracy of 0.01 per cent (one part in 10,000), and using a non-warping etched metal scale, so that the guaranteed frequency accuracy is better than 1%. Bernard Test Oscillators are the only low-priced ones that carry any accuracy guarantee.

The features of the Model 30-N oscillator are:

(1)—Works on a.c. (any frequency), d.c. or B batteries, 90-120 volts, requiring no separate excitation of filament, hence is universal. Models for 180-240-volt use obtainable.

(2)—Has frequency calibrated dial, for lining up intermediates and broadcasts, 135 to 1,500 kc.

(3)—Contained in black crinkle finish metal cabinet, with Formica top panel having copper foil backing.

(4)—Constantly modulated in any and all uses.

(5)—Oscillator proper is isolated from cabinet, output is isolated from both oscillator and cabinet, and line is fused. Illustration above is one-third actual size, 5 x 5 x 3 inches. Weight only 3 lbs.

(6)—Oscillator ready for use when received.

(7)—Guaranteed frequency accuracy under all conditions, 1%. Calibration not disturbed by tube replacement.

The Model 30-N will be sent prepaid in United States or Canada, with tube inserted in socket, and direction booklet enclosed, on receipt of $12.00 for a 2-year subscription for Radio World (104 issues, one each week, at regular rate), plus $1.00 for the specially accurate calibration, total $13.00. For 180-240-volt use, Model 30-ND, $12.00 for subscription, plus $2.00 extra for precision and for special voltage, total $14.00.

RADIO WORLD
145 West 45th St., New York, N. Y.

"The Inductance Authority"

By EDWARD M. SHIEPE, B.S., M.E.E.

THE ONLY BOOK OF ITS KIND IN THE WORLD, "The Inductance Authority" entirely dispenses with any and all computation for the construction of solenoid coils for tuning with variable or fixed condensers of any capacity, covering from ultra frequencies to the borderline of audio frequencies. All one has to do is to read the charts. Accuracy to 1 per cent. may be attained. It is the first time that any system dispensing with computation has achieved such very high accuracy and at the same time covered such a wide band of frequencies.

A condensed chart in the book itself gives the relationship between frequency, capacity and inductance, while a much larger chart, issued as a supplement with the book, at no extra charge, gives the same information, although covering a wider range, and the "curves" are straight lines. The condensed chart is in the book so that when one has the book with him away from home or laboratory he still has sufficient information for everyday work, while the supplement, 18 x 20 inches, is preferable for the most exacting demands of accuracy and wide frequency coverage.

From the tri-relationship chart (either one), the required inductance value is read, since frequency and capacity are known by the consultant. The size and insulation of wire, as well as the diameter of the tubing on which the coil is to be wound, are selected by the user, and by referring to turns charts for such wires the number of turns on a particular diameter for the desired inductance is ascertained.

There are thirty-eight charts, of which thirty-six cover the numbers of turns and inductive results for the various wire sizes used in commercial practice (Nos. 14 to 32), as well as the different types of covering (single silk, double silk, single cotton, double cotton and enamel) and diameters of ¾, ⅞, 1, 1⅛, 1¼, 1⅜, 1½, 1¾, 2, 2¼, 2½, 2¾ and 3 inches.

EACH turns chart for a given wire has a separate curve for each of the thirteen form diameters.

The two other charts are the tri-relationship one and a frequency-ratio chart, which gives the frequency ratio of tuning with any inductance, when using any condenser the maximum and minimum capacities of which are known.

The book contains all the necessary information to give the final word on coil construction to service men engaged in replacement work, home experimenters, short-wave enthusiasts, amateurs, engineers, teachers, students, etc.

There are ten pages of textual discussion by Mr. Shiepe, graduate of the Massachusetts Institute of Technology and of the Polytechnic Institute of Brooklyn, in which the considerations for accuracy in attaining inductive values are set forth. These include original methods.

The curves are for close-wound inductances, but the text includes information on correction factors for use of spaced winding, as well as for inclusion of the coils in shields. The book therefore covers the field fully and surpasses in its accuracy any and all mechanical aids to obtaining inductance values.

The publisher considers this the most useful and practical book so far published in the radio field, in that it dispenses with the great amount of computation otherwise necessary for obtaining inductance values, and disposes of the problem with speed that sacrifices no accuracy.

The book has a flexible colored cover, the page size is 9 x 12 inches and the legibility of all curves (black lines on white field) is excellent.

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

Send $4.00 for 34-week subscription for RADIO WORLD and order Cat. PIA sent free, with supplement, post paid in United States and Canada.

115 DIAGRAMS FREE

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The 115 diagrams, each in black and white, on sheets 8½ x 11 inches, punched with three standard holes for loose-leaf binding, constitute a supplement that must be obtained by all possessors of "Trouble Shooter's Manual," to make the manual complete

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