The First Exclusive Short-Wave Tube

H ere is the tube the short-wave radio field has been waiting for. Designed and engineered expressly for short- and ultra-short-wave receivers and transmitters, this new TRIAD T-30-S Binnegew Tube opens new fields for the experimenter, amateur and short-wave fan. It is a tube similar in size and shape to the Triad T-30, with the notable improvement of placing the plate lead of the tube at the top of the bulb, where it is connected to a metal cap. Thus it is now possible, for the first time in tube design for short-wave sets, to offer the experimenter a tube in which inter-electrode capacity is greatly reduced, efficiency greatly increased. Because the plate leads of the tube is far-removed from the grid and filament, and because the "goss" or glass stem on which the other leads are mounted is unusually wide, with correspondingly wide-spacing between grid and filament leads, this new TRIAD-T-30-S Binnegew Short-Wave Tube becomes more efficient as the frequency of the receiver or transmitter in which it is used is increased. It is not only a better tube for ALL battery-type short-wave receivers but also an excellent Transmitter Tube. Ideal for use by those who are experimenting in ultra-high-frequencies. Unusual results are secured and greater distances are covered when this new tube is used.

TRIAD T-10-S Transmitting Tube

A big breaker to the now battery-operated short-wave tube is the TRIAD T-10-S, a heavy duty tube of the "B" series, with plate lead brought to a metal cap at the top of the tube. This highly-efficient transmitting tube is in wide use among amateurs. It is capable of handling very high voltages. Protected against break-down between elements because the plate lead is at the top of the tube. More power-output, more DX, lower cost when you use the TRIAD T-10-S.

EXPLORE NEW SPACES REACH OUT WITH THIS NEW TUBE

TRIAD SPECIAL SHORT-WAVE TUBE

The new TRIAD-T-30-S Binnegew Short-Wave Tube can be used to replace present types of battery-operated tubes in any short-wave receiver. No change in wiring is necessary. The tube is simply plugged-into the detector or first audio socket and a lead is then brought from the plate terminal on the socket to the metal cap at the top of the tube. The voltages remain the same. This new tube uses a 2-volt filament that consumes but 0.06 ampere, assuring long battery life. Try one or more of these tubes in your present short-wave receiver. Note the difference. You will hear more DX stations, with increased volume. This new tube can also be used as an audio amplifier, as well as a detector, in short-wave receivers. When you buy or build your next receiver insist that TRIAD-T-30-S Tubes are included. No other tube has such low inter-electrode capacity. If you are experimenting with 5-meter short-wave transmitters, or if you are interested in ¼-meter ultra-high-frequency work, this new tube will solve many problems which have baffled the experimenter. Its price is $2.00. Sold by good dealers almost everywhere. If your dealer cannot supply you, write and ask for the name and address of the nearest TRIAD distributor.

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Calls Heard is to the Editor a source of interest to radio experimenter publications whether or not it's the editor. The editorial of the cause is almost a roll-call of old-timers active in the game and still their names are familiar to the. They will tell of their is that you may ask about are only a foretaste of wanting on your continued

HIGH-POWER

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DEPARTMENT OF THE

tion. After you want them, let us know, so that we may be encouraged in our efforts to help get them for you.
A New Short-Wave Tube

Designed Especially For Short-Wave Reception ... A New Tube of Greatly Increased Efficiency, Which Opens Up New Short-Wave Possibilities. Extremely Sensitive ... Highly Efficient. Gives Increased Results When Used In Any Existing Short-Wave Receiver.

By A. BINNEWEG, Jr., Editor

"RADIO" Magazine introduces in this issue for the first time a new, highly-efficient tube designed by the Editor in our laboratories. This tube has been developed especially for short-wave and ultra-short-wave use and will greatly increase the efficiency of any present short-wave receiver. This tube is not an experiment but a new, highly-efficient design, manufactured by one of the large tube manufacturers to our specifications. It is now available on the market and can be used in present short-wave receivers. In the same sockets, this new tube has proved its great value for short waves. Although of unusual value as a short-wave receiver tube, it has been used also for low-power transmitting sets, and has been found to be of very high efficiency, giving twice the output of larger power tubes.

Those now using short-wave receivers will be interested in trying this new tube. It is a special, general-purpose short-wave tube, functioning with unusual efficiency as detector and having advantages for use in the audio stages of short-wave sets. As a detector, it gives far greater signal strength from distant stations. It operates more efficiently at any signal level. It will bring in stations that cannot be heard with other tubes of the same type. The efficiency of the circuits in which it is used is increased, and circuit capacity is reduced to a very low value.

When used as a detector, the tuning condenser will cover a greater tuning range with a given coil. This means that sets designed around it can use smaller tuning condensers thus spreading the stations on the dial. This makes tuning easier. Any present sets will give better results when using this new tube. Because the internal losses have been greatly reduced, the output of the tube is increased and more distant stations can be heard. In actual tests, the results obtained from this new tube were surprising. Stations which cannot not be heard with ordinary tubes could be heard by simply using one of these tubes in the detector socket. The cost of it is only slightly more than a common tube having the same general characteristics.

This tube will also give better results at ordinary broadcast and audio frequencies. In short-wave audio amplifiers there is often what is called "fringe-howl". This howl can be eliminated usually by using one of the new short-wave tubes in the first audio stage of the set.

This new tube is of especial interest to those building their own short-wave receivers. A large number of short-wave receivers now in use consist of a relatively small number of tubes. The increased results from this new tube are especially noticeable on such sets.

Experimenters, short-wave designers and radio amateurs will be very much interested in it. The losses inside a tube increase as the frequency at which it must operate is increased. By a special construction, the short-wave and ultra-short-wave losses have been greatly reduced.

The increased results at ultra-short waves is really amazing. Engineers tested these new tubes in a 5-Meter Transmitter which normally uses power tubes. With only very slight changes, the efficiency was greatly increased and with less input these tubes gave as much output as the power tubes.

Grid Bias (as regenerative detector) — None.
Plate Current — 2.5 to 3.1 milliamperes.
Inter-element capacities greatly reduced.
Short-wave efficiency greatly increased.
Standard 4-prong base. Grid and filament leads to base as in ordinary Type '30 tube. Plate probing on base not connected. Plate grid of tube connected to cap on top of plate. This tube operates in the same respects similar to a type '30 tube.

How to Use This Tube in Your Present Set — Use as Detector or Audio Amplifier

1. Remove the '30 tube used as detector in the receiver. If a tube other than a Type '30 is used, increased results can be obtained by using one of these new tubes, but some minor changes are necessary. These are necessary to provide a 2-volt D.C. filament supply. An AC detector can be substituted if desired.

2. Connect the new tube in the same way as the '30 tube in the receiver.

3. Use the new tube as a detector or audio amplifier.

4. The new tube will give greatly increased results.

Grid Bias (as audio amplifier) minus 4.5 to minus 13.5 volts, depending upon plate voltage.

Plate Voltage (as Short-Wave Detector) 22.5 to 45 volts.

Plate Voltage (as Short-Wave Detector) 180 volts maximum.

Plate Voltage (as Audio Amplifier) 20.0 volts.

Filament Voltage (D.C.) — 0.60 milliamperes.

Characteristics similar to Type '30 Tube.

Data on New Short-Wave Tube.

RADIO FOR JUNE

www.americanradiohistory.com
8-Year-Old Jean Hudson Is Licensed Radio Amateur Passes Govt. Examination With 80% Rating—Copies 25 Words Per Minute on the Typewriter—Blindfolded

The Story of the World’s Youngest “Y.L.”—As Told By ED. THOMPSON, W3CQS

How would you like to be the world’s youngest licensed radio amateur? Little Jean Hudson, of Laurel, Delaware, is only 8 years old but she is a licensed radio amateur! She can talk about standard frequencies, harmonics, traffic handling and QSO’s! Moreover, she knows radio laws and regulations and can copy code at a speed of 25 words per minute on a typewriter while blindfolded!

Considerable has been written about the achievements of this little Y.L., but it remained for Ed. Thompson (W3CQS) to give the full details of this unusual accomplishment. Ed. is the lucky amateur who received the first QSL card from little Jean.

Jean’s father is a veteran Morse operator, an ardent radio amateur and one of the world’s proudest dads. He has held amateur licenses for a number of years. Ronald, his 14-year-old son, is another radio member of the Hudson household. He also holds an amateur license, and his call is W3AXP. Dorothy, an older sister, is now preparing herself for a license.

The entire Hudson family, except the mother, are radio amateurs. Imagine a houseful of radio operators! Plenty of radio apparatus required! “Cleaning up after the children” means placing the various radio parts in their proper places, of course. It’s some task, getting them away from their radio outfits, when bedtime approaches! Although the odds are heavily against her, she too, is becoming radio-minded. What else can she do, but join in the QRM and QSO’s at the dinner table and talk about the captivating subject of amateur radio?

But let’s get back to 8-year-old Jean: She was born in San Gabriel, California, the land of sunshine. At the age of 4, Jean and other members of the family, moved to Laurel, Delaware. It was here that she first became interested in radio. At the age of 6, Jean displayed an interest in amateur radio. Telegraph keys and other radio equipment fascinated her. Soon she had learned to send and receive code.

Jean’s Dad was quick to discover her radio ability, and devoted much time to teaching her about transmitters and receivers. On April 26th, 1933, Jean and her Dad journeyed to Fort McHenry, Baltimore, so she could take the examination for amateur radio operator. Sitting on a large Webster’s dictionary, so she could reach the large examination table, Jean was given the code test. She passed it with speed to spare! Her answers to the questions in the examination papers were so good that she received a rating of 80%!

She was examined under the direction of Mr. L. C. Herndon, Radio Examining Officer of the 4th Radio District; the work here is in charge of Mr. George E. Sterling.

Jean uses the touch system on the typewriter, and she will talk to you while she types. “It is really amazing”, said Inspector Sterling, “I had no idea how efficient she was”.

The first “QSL” card of the world’s youngest “Y.L.” operator. A reproduction from the original. It was mailed on May 1st, 1933, at 10 A.M. from Laurel, Delaware, and addressed as follows:

Ed Thompson’s ham and egg station W3BAK
Salisbury, Maryland
312 College Ave.

The QSL card pictures the transmitting “headquarters” of Jean Hudson and the receiving station of W3CQS. Here is Jean’s comment, clearly shown on the card: “I sent her an SOS Message which she took without the slightest trouble in the world.”

The first “QSL” card was mailed from Laurel, Delaware. It is here that she first became interested in radio. At the age of 6, Jean displayed an interest in amateur radio. Telegraph keys and other radio equipment fascinated her. Soon she had learned to send and receive code.

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(Please turn to Page 27)
The Engineering Staff of "Radio" Develops a 520-K.C. Amateur Superheterodyne of Unusual Selectivity—Using New 2A7, 2B7 and 2A5 Tubes

By RICHARD C. BARRETT
Research Director of "Radio"

C ONSIDERABLE publicity has lately been given to shortwave superheterodynes among amateurs and experimenters. "RADIO" laboratories, under the direction of the author, has undertaken to develop a type and which has all the advantages of previous receivers and has in addition several new features of its own. Among these is the use of the latest tubes, inclusion of a quartz-filter unit, and the use of an RF pre-selector for obtaining high sensitivity and freedom from "image interference." The design is comparatively inexpensive with respect to shielding which, in previous designs, was generally quite expensive.

With the extreme degree of selectivity obtained from the quartz-crystal filter unit, it is possible to achieve a true "single-signal" effect which no "super" is able to secure without it. With a tuned stage of RF ahead of the first detector, high sensitivity is reached. It is desirable that weak signals should be brought to a high ratio of signal-to-noise, a valuable feature for the radio-frequency resistance. The tuned circuit (LC) is such a feature in the phone band, as well as on the 40- and 20-meter amateur C.W. bands.

The inductance associated equipment consists of an RF amplifier of the Type 5A8, a sufficient gain at frequencies as high as 14,000 KC, with properly designed circuits and careful mechanical design.

Therefore a Type 58 tube was chosen for the tuned pre-selector RF stage, and consideration was also given to mechanical and electrical design of the associated equipment to realize a maximum gain. The tuned circuit (LC) of this stage must furnish as great an RF voltage as possible to the grid of the associated tube. This is obtained through the use of low power-factor ("low-loss") equipment, and a reduction in radio-frequency resistance.

The coil forms are of the plug-in type and the cores are wound with special dielectric material having a low power-factor. Materials suitable are Isolantite, "Micalite," Pyrex Glass, "R-39" and Celluloid.

It was decided to use plug-in coils for changing bands, because the losses introduced by switching arrangements is high. Switch-contact resistance is therefore removed from consideration. The sockets selected for the coils have contacts of the "side-wiping" type which are self-cleaning. The capacity between the prongs of a tube socket furnishes a leakage path. The success or failure of the amplifier mentioned depends upon this and other small factors to a great extent as will be shown later.

Returning to the tuned circuit (LC) of this amplifier: From an electrical standpoint, to produce on the grid of the RF tube, a high voltage, one must have a high LC ratio; that is, a large inductance and a small capacity. When this is the case, and considering the inductance, the coils were designed for large inductance in the LC circuit. They are wound with double-silk covered copper wire and, for the higher frequencies, are space-wound. It is known that beyond a certain wire size there is no advantage in increasing the diameter of the wire because of "skin effect." Coils wound with large sizes of wire such as No. 14 and No. 12 are not necessary of lower low than coils wound with No. 20 or No. 22 gauge. These would be an advantage in winding coils with silver wire of equal gauge.

To further increase the voltage on the grid of the RF tube, the input "loading" due to the antenna must be kept as low as possible. The antenna introduces losses into the circuit. Inductive coupling is that coupling. The inductive coupling is used as low as possible consistent with other requirements. The input is designed to use the "doublet" antenna, with transposed feeders, if it is desired.

The shielding of the input coil was also a problem. Space requirements had to be considered as well as coil efficiency. Good compromise was to use shielding spaced half the coil's diameter from the coil. This spacing introduces inappreciable resistance into the tuned circuits, and is consistent with good practice.

By shielding the tube and the coil separately in round shield cans, a good arrangement of shielding was possible at low cost without taking too much space. By-passing of screen-grid and cathode-bias resistors should be done with a good grade of condensers having 0.05 mfd., or higher, capacity. All grounded return circuits should be brought back to the point of origin, and not merely connected to the chassis at any point. There are often differences of potential in the chassis of a receiver, and the author has actually noticed differences of potential as high as several millivolts between two points on a metal chassis which was supposed to be "grounded". This is a point which should be remembered, for later considerations having to do with intermediate amplifier stages.

The above factors are perhaps well known to most readers. One is inclined to neglect some of these factors because, individually,
they are perhaps of small moment. The writer here wishes to remind the reader of a convincing statement made by a well-known radio engineer.* These comparatively small losses are not always simply additive in their effects. That is, if 2% is gained at one point; 3% at another; 1% in another; and 2% in yet another, the total effect is not the sum of these, or an 8% gain, but is 2x2x1x25%, or a total of 12%, differing from the previous result by 4%. Percentage gains in efficiency are multiplying factors. Every small detail of circuit design, mechanical and electrical efficiency, should not be overlooked. A single low-loss part will not improve a receiver 100% or anywhere near this amount. Every part associated directly and indirectly should be carefully checked with respect to losses.

Selectivity

A requirements for any amateur receiver is selectivity. The amateur bands are becoming more crowded every day. The only solution is more selectivity in the receiver. Theoretically, a one-KC channel selectivity is the ideal for c.w. reception providing that signals are from crystal-controlled transmitters. Phone signals require a 5-KC channel to give understandable speech. One-KC selectivity is possible in a correctly designed super, by using a quartz-crystal filter or resonator.

The tuned RF stage ahead of the first detector provides, in addition to increased receiver sensitivity sufficient selectivity to prevent "image interference", which gives rise to "two-spot tuning".

The use of a quartz-crystal is one of the main features of the "Stenode" broadcast receiver. The purpose of it is to furnish high RF selectivity. The sharp filtering action of a resonant quartz-crystal is perhaps the most practical method of obtaining extreme selectivity in a short-wave receiver. For phone, provision must be made to switch the crystal out of the circuit.

The quartz plate used in this receiver is cut from a pure Brazilian crystal, and is "X-cut" to a frequency of 520 KC. This intermediate frequency was chosen because there is freedom from interference on the amateur 20-meter band. This frequency is sufficiently outside the broadcast band to allow the receiver to be used as a straight broadcast set with suitable coils.

The crystal-filter unit consists of an intermediate transformer, with the "padding condenser" removed from the primary side of the plate circuit of the first detector. The small midget condenser shown in the diagram as "C" is for the purpose of neutralizing the capacity of the crystal holder, and its adjustment will be described in the next issue. The crystal holder should be of the air-gap type, having a 0.01" gap. This value is not critical but the top plate must be parallel with the bottom one. It is suggested that a silvered crystal with re-ground edges, and a very light spring contact on its top surface could be used instead.

Two stages of intermediate amplification are used for maximum gain and selectivity consistent with stability. The 2A7 tube, known as a Pentagrid converter, functions as first detector and oscillator. It is designed to perform simultaneously the function of a mixer tube and oscillator. Through its use, the independent control of each function is made possible within a single tube. The action of this type in converting a radio-frequency to an intermediate-frequency depends on independent control of the electron stream by three electrodes, including the cathode, connected in the oscillator circuit, and by a fourth electrode (grid) to which the radio signal input is applied. As a result of this arrangement, two groups of electrodes will produce variations in the electron stream between cathode and plate. Since the electron stream is the only connecting link between the two controlling functions, there is "electron coupling". The second detector is the new 2B7 tube which is of the duplex-diode type having an additional audio pentode in the same bulb. In the completed receiver, the diode is used as a full-wave rectifier; it was successfully used as a half-wave rectifier in the laboratory model. The advantage of the full-wave connection is that no filtering is necessary after the detector to suppress the carrier component appearing in the detector plate circuit. With the half-wave arrangement, such filtering would be required at added expense.

The pentode section of the 2B7 is used to drive the 2A5 tube in the audio power stage. This is accomplished by means of resistance coupling. The output of the 2A5 is sufficient to drive a large dynamic speaker at full volume without distortion.

A 2B7 was selected for its diode characteristics which are such as to prevent "cross-modulation" and overloading of the second detector. It gives linear detector action. These factors give freedom from distortion at large outputs.

A summary of main features discloses many new ones:

1-Tuned RF, amplifier ahead of first detector.

2-Crystal selectivity filter.

3—"Electron-coupled" oscillator and first detector, combined in one bulb, giving "factory conversion", lower cost of parts and more complete isolation.

4-Second detector with linear characteristics giving great output to latest type pentode audio amplifier.


6-Freedom from "image interference." Better signal-to-noise ratio.

7—Low-loss plug-in coils and other improvements.

The next issue of this magazine will contain detailed constructional plans and specifications for building this latest superheterodyne. The following issue will give full operating instructions.*

*Short-Wave Manual by Don C. Wallace.
A NEW 5-METER PORTABLE
COMBINED TRANSMITTER AND RECEIVER

By FRANK C. JONES

SUMMER vacation time is at hand and many amateurs may have an opportunity to use portable transmitters and receivers to advantage. Five meter sets offer a convenient communication scheme for use between camps or parties if not situated too far apart. The following set is suitable for use up to five or ten miles in hilly country, and between hill tops or mountains is capable of distances of several times that amount. One such transmitter and receiver has been used several times for communication between Berkeley and San Francisco amateurs over distances of from ten to fifteen miles. Occasionally, small hills have intervened between the transmitter and receiving station without preventing a successful communication.

The circuits shown in Fig. 1 have proved very satisfactory for general use on the five meter band and can be built up complete into a compact unit 6" by 6" by 5" high. The batteries could of course be in a separate container and for most purposes dry cells and heavy duty B batteries would be desirable. The receiver plate current totals slightly less than ten milliamperes and the transmitter draws from 20 to 30 when operating.

The transmitter of Fig. 1 consists of the popular tuned plate, fixed tuned grid circuit which is quite efficient on either five or ten meters as well as the other amateur bands. The single tube seems to give about the same output as a push-pull scheme and the actual efficiency is probably a little better. At least it simplifies a portable transmitter and gives sufficient power output for most conditions when only using a single tube oscillator. Modulation is obtained in a very simple manner by applying an audio voltage on the grid and so producing a form of grid modulation which is understandable.

In Fig. 1 the plate coil consists of 4 turns of No. 12 or No. 14 wire on 1/8" diameter spaced about 1/2" between turns. The grid coil consists of 5 to 6 turns of No. 16 or No. 14 wire on 1/8" diameter spaced so as to allow oscillation in the five meter band at good efficiency. The spacing which determines the tuning of the grid circuit depends on length of connecting leads and also whether a type 31 or 34 tube is used. Naturally, these coils and plate grid tuning condenser should be as close to the tube socket as possible and still maintain right angle coupling between the coils.

This transmitting circuit has the advantage of not requiring any radio frequency chokes and is easily adjusted to maximum output by varying the grid inductance while coupling a flashlight bulb in a small single turn coil to the plate coil. Modulation can be noted also by watching the flashlight bulb.

Schedule of Parts
Frank C. Jones 5-Meter Portable Transmitter and Receiver
A—Half-Wave Antenna.
C1—25 mmf. variable.
C2—0.0005 mfd.
C3—0.006 mfd.
C4—0.001 mfd.
C5—0.5 mfd.
L1—2 turns.
L2—4 turns.
L3—6 turns.
L4—2 turns.
L5—2 turns.
M—Microphone.
R1—10,000 ohms.
R2—4 ohms.
R3—0.1 megohm.
R4—5,000 ohms.
R5—0.05 megohms.
R6—50,000 ohms.
S1—Transmitting switch.
S2—Transmitting switch.
S3—On-Off switch.
T—Mike Transformer.

5-METER TRANSMITTER AND RECEIVER

RADIO FOR JUNE
For this scheme of modulation the light usually becomes dimmer when speaking.

The microphone should be a rather sensitive single button "band mike" of a type similar to those used on ordinary telephones. The microphone transformer may be of any standard type or as has been used here, an old dynamic loudspeaker output transformer with the low impedance winding connected to the microphone battery. Even a bell ringing transformer will function though the frequency characteristic is usually poor.

The antenna coil consists of two turns closely coupled to the plate coil and so the feed or fed antenna can be of either the Zepp or untuned type. The latter is usually desirable as the feeders can be of any length and the efficiency is high. Such a feeder system may be made of a pair of No. 18 or No. 20 enamelled wires spaced 3 inches by means of ¼" dowel rod tied to the wires by means of string. The feeder should fan out to the antenna about 2½ feet from it and connect each wire one foot each side of center. The total antenna length will vary from about 8 to 8 ½ feet depending upon the portion of the five-meter band to be used.

The receiving circuit is probably the most interesting part since it is a very simple form of super-regeneration and is apparently very sensitive. Its only disadvantage is its ability to act as a small transmitter which will interfere with other receivers within a mile or so. It seems to radiate about twice as much energy in the form of mush and whistles as the average three-tube super-regenerative set most probably because the plate voltage is rather high.

As can be seen, the detector circuit consists of only one oscillator and the values of grid condenser and leak, and plate by-pass condenser are such as to cause a blocking action producing super-regeneration and the familiar loud audible hiss when no signals are being received. The circuit apparently functions as an ordinary oscillator in which the grid leak is too high to allow the electrons on the grid to leak off at a rate to give a constant value of grid voltage. This causes a change in average plate and grid potentials because but the plate current is decreased and the mutual conductance of the tube decreases. The grid condenser and leak values determine the rate of discharge of the number of cycles per second that this occurs which is at some audible rate. Apparently the plate circuit must maintain a fairly low impedance path to filament at this audible frequency or rate of grid discharge, because the plate by-pass condenser needs to be at least .003 and .006 mfd. seems too large. With either resistive or inductive coupling to the audio amplifier, no super-regeneration will take place without a fairly large plate by-pass condenser.

In the circuit shown, this by-pass condenser doesn't have any effect on the r.f. portion since it is behind the r.f. choke. Without the r.f. choke the circuit would be the familiar Hartley system and it would be necessary to adjust the ratio of plate and grid turns quite accurately. The r.f. choke may be made by space winding 30 turns of No. 36 or No. 54 SSC wire on a ¾" dowel rod to cover a length of about 3 inches.

To provide less r.f. "strain" on the choke and grid leak, the grid condenser is not placed exactly in the center but is over one turn towards the grid which seems to be nearer the nodal point of the oscillator circuit. The grid side of the coil consists of 2 turns ¾" diameter of No. 14 or No. 12 wire twisted to a similar coil of 4 turns for the plate side. With such a coil properly turn-spaced, the five-meter band can be covered with a two-plate midget tuning condenser.

Resistance coupling in the receiver is suggested to reduce the plate voltage to both tubes and reduce radiation. The audio amplifier could have the plate run through the head set directly to the 45 volt tap on the B battery instead of through resistance coupling as shown. The detector plate resistor seems rather low but too high a value will stop super-regeneration by reducing the effective plate voltage to less than 75 volts or so.

The adjustment and operation of these circuits are similar to those of any five-meter sets and can most easily be done by comparison with some existing five-meter station in order to locate the band properly. Once the receiver is calibrated over the five-meter band, the transmitter adjustment is simple and probably a quite familiar operation to most amateurs interested in five-meter experimentation.

If the F.R.C. lifts certain restrictions on the amateur ten-meter band, this same set can be used on that band by increasing coil turns as checked at station W6AF recently.

FORECAST FOR JULY

A Hot Month for the Short-Wave Amateur and Experimental. Red-Hot Ideas from the Editorial Desks of "RADIO"...

AMONG THEM...

A 1-Tube Short-Wave Receiver That Fits in Your Coat Pocket. Take it with you on your vacation.

5-Meter Test Results With the New Binneweg Tube, Showing Circuits and Constructonal Details.

Complete Constructonal Plans for Building "RADIO"S" 520-KC. Crystal-Filter Super-Heterodyne.

How to Build the Coast-to-Coast 80-Meter C.W. Transmitter, which uses two small tubes.

A 4-Tube Pentode Short-Wave Receiver That Costs Less Than $20, Which Has New Type Selectivity Coils.


Second Installment of Super-Heterodyne Instruction Course for Beginners.

Another Simple Radi o-Telephone Transmitter for the 80-Meter Band, with Pictorial Illustrations.

More Answers to Questions for License. Reports From the Calibration Laboratory of "RADIO".

A Flat-Curve Audio Amplifier. Instructions for New Factory Receivers.

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RADIO FOR JUNE

RADIO DEBATE

VALUABLE PRIZES TO THE WINNERS

EACH month "RADIO" will print a Question to be Debated among its Subscribers and Readers. This Question will be on a timely subject of general interest. You are invited to join the "RADIO" Debate Club. Send in your answers to these Questions to the Debate Editor, care of this Magazine. Become a regular participator in the audio stage of Debate.

The Question to be Debated will be printed on this page. Readers will supply the answers. The writer of the best answer to each month's Question will receive a prize. The writer of the five best answers will receive a valuable prize. This month's prize is a Binneweg Short-Wave Tube. Five of those will be awarded. No members of the staff of "RADIO" are permitted to compete for those prizes.

This month's Question is as follows:

A short-wave experimenter has an ordinary short-wave receiver. In this receiver a standard battery-type detector tube is used. Reception is satisfactory but certain stations are not heard. All conditions remaining the same, the detector tube in the set is replaced by a new tube of the same type but designed especially for short-wave use. Stations are now heard which were not heard when the first tube was used. How much more efficient is the receiver when using this new detector tube?

Send your Answers to DEBATE EDITOR, "RADIO" Pacific Building San Francisco, California

RADIO FOR JUNE

www.americanradiohistory.com
Radio courses are too often just a series of facts about radio. To an average beginner in the subject, there is very little connection between these facts. This is true because such courses do not start from the foundation and give sufficient explanation of the underlying principles. For this reason the operation of radio receiving and transmitting sets is hard to understand.

Today, electronics is better understood so it is easier to explain what it does and why it does it. Scientists have found out many new facts about it. These facts were not as well known when most radio books were written. The average person thinks that no one knows what electricity is, but this is no longer true. With the information that electricity is made up of electrons, it is possible to give simpler explanations of radio effects which are usually difficult to understand. Beginners in radio will be very interested in this radio course because it will explain how radio circuits and sets work in a way they can understand.

Radio courses and books give the impression that short-wave radio is something new and strange, and not especially connected with ordinary radio. This course will include short-wave radio. The lessons will begin with an explanation of principles underlying radio and will later show how these can be applied to short-wave radio. Hence the reader is advised not to become discouraged but to follow these lessons every month in this magazine. Remember! Present radio sets may later be displaced by different designs, but the principles of their operation will remain the same. Therefore, the principles explained in the first lessons are important and should be learned.

What Are "Lines of Force"?

Every electron has invisible "lines" coming out from it. These lines go straight out from the electron in all directions. The lines are spaced at equal distances apart. When, for any reason, the lines are pushed aside, they will try to return to their original places. They act like they were made of rubber. Just like a stretched rubber band, they try to get back to their original place. In other words, they exert a "push" when they are disturbed. Because they exert a "push", they are called "lines of force".

These lines can exert a force so they are called "lines of force". Every electron has these "lines of force". Every electron has the same number of lines of force coming out from it.

Have you ever seen a cartoon showing somebody's head with the hair standing straight up? An electron with its "lines" looks something like that. An electron's lines go out in all directions as shown in the drawing of Fig. 1. Every electron is the same size and has the same number of lines. These lines are spaced at equal distances apart and go straight out in all directions.

What is a "Field"?

The lines coming out from an electron make up what is called a "field". See the drawing of Fig. 1 again. All the lines taken together are the electron's "field". Near any electron there will be a "field", because every electron has many "lines" present. The lines of any electron make up the electron's field. Every electron has its own "field". Anything very near to an electron is said to be in the electron's field. This is just another way of saying that anything near an electron is touched by lines of force.

A field can exert force. Every line of force can exert a force. So to say that there is a field is simply means that something is present; so force can be exerted anywhere in an electron's field.

Every one of force acts as if it were entirely by itself, or acts separately. Therefore, if one line exerts a certain amount of force, two lines will exert twice as much force, three lines will exert three times as much force and so on. More lines, more force. Suppose that a particle of a certain size is placed in an electron's field, and disturbs the lines of force. It will be acted upon by a force. If the particle is placed very near the electron, the lines are pushed aside and force will act on the particle. There will be a greater force trying to bring the lines back into place again, because the lines are closer together near the electron and more of them will be displaced.

The force exerted on the particle will depend upon the number of lines disturbed. If the particle is placed near the electron, where the lines are close together, more force will be exerted upon it. If it is placed farther away from the electron, the lines from the electron are farther apart, less of them will be displaced, and less force will be exerted on the particle. The force exerted at any point in a field is said to be the strength of the field at that point. The strength of a field at any point depends upon the number of lines of force at that point. As the distance from an electron increases, the strength of its fields decreases, because the lines become farther apart.

Force Between Electrons

If two electrons are placed close together, they will try to move apart. Two electrons close together "push" against each other. This is caused by the "lines of force" that every electron has around it. The lines from an electron act like they were made of rubber. For this reason, when two electrons are brought close together, the "lines" from each electron "push" on the other electron. A force is created that will push the electrons apart if they are free to move.

The force with which two electrons try to push each other apart will increase as the electrons are brought closer together.

This is true because each electron displaces the lines of force of the other one. See Fig. (Please turn to Page 26)
Superheterodynes: Questions Frequently Asked About

By the Technical Editors

Question—What is a Super-Heterodyne?

Answer—A superheterodyne is a receiver in which amplification is accomplished at three different frequencies, namely, the frequency of the received signal, which is termed "Radio Frequency"; a frequency lower in value than the radio frequency, termed "Intermediate Frequency"; and a frequency associated with the frequency of the received signal and the intermediate frequency, which is termed "Audio Frequency." It might be mentioned that some of the more elaborate receivers of this type employ as many as ten or more stages, but those commonly used outside of commercial practice usually employ but one.

Question—What is the Amplifier?

Answer—A frequency produced in an electrical circuit as the result of the impressed upon that circuit of two different frequencies is called a HETERODYNE FREQUENCY. One of the original frequencies may be said to HETERODYNE the other.

Question—What is an INTERMEDIATE AMPLIFIER?

Answer—An intermediate amplifier is one functioning at a frequency lower than the original received frequency and yet above the audio frequency range. It is termed an Intermediate Amplifier because the frequency of amplification is intermediate to radio and audio frequencies. In practice intermediate frequency amplifiers are designed to function at a single predetermined frequency, since component circuits can be designed to produce greater and more faithful amplification at a definite predetermined frequency than over a relatively wide range of frequencies. The frequency chosen for intermediate amplification is usually lower in practice than the original received frequency because greater amplification can be obtained at such a lower frequency due to fewer difficulties introduced at such a lower frequency by the capacity, distributed and stray capacities.

Question—Why is more than one intermediate stage used in a Superheterodyne?

Answer—Several intermediate stages are used in preference to one for two reasons; first, because of the added selectivity thus obtained; and, second because of the additional gain which each stage provides. Fewer intermediate stages are necessary in modern practice than were necessary in the earlier stages of superheterodyne design because of improved radio frequency design and the elimination of the great gain stage permissible as a result of the introduction of new high-gain tubes.

Question—What is a MIXER in a superheterodyne?

Answer—the mixer, or first detector tube, in a superheterodyne is the tube upon which together with its associated circuit is impressed the original received radio frequency signal and the frequency produced by a local oscillator or source of radio-frequency energy. In the circuit associated with the mixer tube are produced the heterodyne frequencies resulting from the impression upon it of the received signal and the intermediate frequency. The output of this tube is connected to the intermediate amplifier which is designed to select and amplify at one of the heterodyne frequencies produced in the first detector circuit, the heterodyne frequency usually chosen in practice is that frequency existing between the received and locally-generated frequencies and hence lower in value than either of them.

Question—What is \"BEAT FREQUENCY?\"

Answer—Beat Frequency is the same thing as heterodyne frequency. It is a frequency equal to the difference between two original frequencies impressed upon or present in a circuit.

Question—Why is a superheterodyne more selective than other known types of receivers?

Answer—Because of two basic reasons; first, because of the greater number of cascaded stages than would be possible to use at either radio- or audio-frequencies, and, second, because a circuit can be designed for maximum amplification at a single predetermined frequency and more effective suppression of undesired adjacent frequencies. It is possible to produce as great and as uniform amplification and as effective suppression of undesired frequencies if it must function at a number of frequencies over a relatively wide range.

Question—Why is an OSCILLATOR used in a superheterodyne?

Answer—We have said that amplification is accomplished in a superheterodyne at a frequency different from that of the original received signal. This frequency must be produced in the receiver. We have found that it can be so produced by impressing upon a circuit in which it is present a frequency differing from it by a frequency equal to the frequency of one which we wish to accomplish amplification. Therefore, we provide a local oscillator or generator of radio-frequency energy which is capable of producing a frequency differing from the received frequency by the amount of frequency at which amplification is to be affected.

Question—What does an Intermediate Stage consist of?

Answer—An Intermediate frequency stage consists of a vacuum tube, with an associated circuit consisting of inductance in the form of coils and capacity represented by condensers. The usual practice is to insert a condenser shunted across an inductance in the input circuit of the tube and a condenser shunted across an inductance in the output circuit of the tube, variable over a limited range such that the two circuits consisting of these condensers and their associated inductances can be made to respond to the frequency at which amplification is to take place. It is, of course, necessary to so choose the values of inductance and capacity that the circuits can be made to resonate at the desired frequency.

Question—What is RESONANCE?

Answer—Resonance is the condition which exists in an electrical circuit, consisting of inductance, capacity and resistance, when maximum response exists in the circuit to a single frequency which is called the \"natural period\" of the circuit. This condition exists when the total reactance of the circuit is a minimum, or, in other words, when the inductive and capacitive reactances are equal and the effective resistance of the circuit becomes its D.C. resistance. When resonance exists, current and voltage are in phase.

Question—What is a BEAT NOTE and why is it used?

Answer—When any two dissimilar frequencies are brought together in a circuit either by tuning or modulation there are produced new frequencies equal to the sum and difference of the original two frequencies. These are known as BEAT FREQUENCIES or HETERODYNES and if the new frequencies lie in the audible range, i.e., 16 cycles to 12,000 cycles, they constitute a BEAT NOTE or whistle, which is heard in the loud speaker or headphones. A beat note is used in superheterodyne receivers, first, as the sign or difference of the signal frequency and the local oscillator frequency heterodyning to produce a frequency equal to the intermediate frequency amplifier, and, second, to cause by regeneration, or by the application of another local oscillator signal in the second detector plate circuit, an audible heterodyne which is amplified by the audio frequency amplifier.

Question—What is IMAGE FREQUENCY?

Answer—Image frequency is that frequency which is twice the intermediate frequency, and which will cause "two-spot" tuning, i.e., finding the signal on two separate spots on the dial. Image frequency is interference from another station separated by the signal frequency.

Question—What is a FIRST DETECTOR used in a superheterodyne?

Answer—Because the modulation product of the signal frequency and the local oscillator is a complex wave form of which the envelope is maximum amplitude on both positive and negative peaks at the same instant of time, merely carrying out, and sum or difference of half of this wave form or side-band is eliminated by rectification (detection) there will be no resultant audio component.

Question—What is a WAVE FORM?

Answer—A wave form is the shape or amplitude of an alternating current or voltage of any frequency or mixture of frequencies. One-half of a wave form consists of positive peaks and the other half of negative peaks, with reference to zero voltage, and either side of the zero voltage line can be considered a side-band.

Question—What is meant by \"SINGLE SIGNAL\" effect?

Answer—In single signal tuning of a C.W. radio, one side-band of the audio tone is eliminated, i.e., the rejection of one side band is accomplished by offsetting the beat frequency of the oscillator about 1000 cycles so that with an extremely selective intermediate frequency amplifier the beat note goes through the full audio range on one side of zero beat but is cut off sharply on the other side.

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Radio for June

Questions Frequently Asked About Superheterodynes Answered in Understandable Terms

Questions on Various Subjects Will Be Answered Each Month

By the Technical Editors

Radio welcomes expressions of opinion as to the subjects to be discussed on this page. Let us hear from you.
A 160-Meter Radiotelephone
Using "Western Electric Type" Modulation
Tuned-Plate, Tuned-Grid, or Crystal Control

The Federal Radio Commission's Regulations Permit the Use of a Radiotelephone of This Type on the 160-Meter Band Where Frequency Stability Is Not of Paramount Importance, Thus Allowing Operation of a Simple Oscillator, Such As Is Shown in the Accompanying Article. Operation On This Band Is Permissible to All Classes and Grades of Amateur Operators. This Radiotelephone Can Be Used Either With Or Without Crystal Control. When Not Used With Crystal Control It Becomes a Tuned-Plate Tuned-Grid Transmitter.

The radiotelephone transmitter to be described is suitable for use almost anywhere. It has a normal range of from 20 to 30 miles under average conditions. The maximum range cannot be stated definitely; it may be a thousand miles or so at night, in a favorable location. The location of the set, the skill of the receiving operator and the sensitivity of his receiving set, are important considerations if the actual maximum distance is to be stated even approximately. The entire set can easily be built by anyone with ordinary tools. The parts and tubes used are quite inexpensive and can easily be procured.

The transmitter is designed to operate only in the "160-meter band", and as this is an "unrestricted" band, there are more possibilities. This band is comparatively free from QRM. The problem of frequency stability is not as great importance here. Antenna systems for these frequencies can easily be erected, and with ordinary care, reasonable results will be obtained.

The use of receiving tubes throughout, reduces the cost to a point lower than for most other transmitters. The Class-B Modulation system allows a reasonably high percentage of modulation. The tubes used are Type 59, having 7-prong bases. These tubes were selected because of low cost. They are easily obtained and can be used for the various purposes. This tube is now available from all manufacturers.

This tube is now available from all manufacturers. The 160-meter transmitter is constructed in such a way that it can be used for various purposes. It is a simple grid power, amplifier, tube with an indirectly heated (heater-type) cathode, which requires 2.0 amperes at 2.5 volts. Its base is of medium size, and has 7 prongs. Separate leads are brought out from each of the tube's electrodes. With suitable grid connections, this tube can be used as a Class A Triode, as a Class A Pentode, or as a Class B Triode. The characteristics when used in these various ways are as follows:

<table>
<thead>
<tr>
<th>CLASS A TRIODE CONNECTION</th>
<th>Grid Voltage</th>
<th>Amplification Factor</th>
<th>Screen Current</th>
<th>Load Resistance</th>
<th>Power Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 grid</td>
<td>2.0 Volts</td>
<td></td>
<td>90 ma.</td>
<td>6,000 Ohms</td>
<td>6.0 Watts</td>
</tr>
<tr>
<td>No. 2 grid</td>
<td>2.0 Volts</td>
<td></td>
<td>20 ma.</td>
<td>3500 Ohms</td>
<td>2.0 Watts</td>
</tr>
<tr>
<td>No. 3 grid</td>
<td>2.0 Volts</td>
<td></td>
<td>3 ma.</td>
<td>800 Ohms</td>
<td>1.5 Watts</td>
</tr>
</tbody>
</table>

For use in the radio transmitter described here, the Class A Pentode connection is used, which requires No. 3 grid (adjacent to the plate) to be tied to cathode, thus acting as a "suppressor"; No. 2 grid acts as a screen grid and No. 1 as a control grid. The actual connections for the various grids to the socket terminals are shown in the accompanying diagram. The use of a crystal-controlled pentode permits relatively high radio-frequency power output with a single tube, and the high amplification factor requires only a small crystal output. A high plate voltage can therefore be used, considerably higher than the manufacturer's rating for a Class A pentode audio amplifier. A triode requires more input from the crystal. If the crystal tubes at light load, the change in frequency due to crystal heating is less. Any danger of breaking or cracking the crystal from this cause, when used in the power tube oscillator circuit, is greatly reduced; in fact, all such danger is eliminated if the protective device shown in the diagram is used. This consists of a Type A tube, the filament of which protects the crystal. If the crystal is overloaded, the tube filament will burn out thus preventing damage.

If the crystal is selected that has its frequency at the middle, or well away from the edges of the 160-meter band, there is no need for a temperature control. As a radio-frequency oscillator, the plate dissipation of the tube can be assumed to be about 10 watts under ordinary conditions.
With an average antenna, about 10 watts output can be obtained. Under some conditions, a greater output is possible but this is not recommended. The values stated are for an average, normal, continuous dissipation. During modulation by the audio-frequency system, the actual peak power in the antenna may be several times the normal, or unmodulated power output. This peak power will run the oscillator tube beyond normal and probably 50 to 100 per cent of it will have to be radiated from the tube. If the tube is overloaded, its life will be short, although sweet.

The tube shown in the diagram allows the use of a Type 59 tubes in parallel. Sufficient audio energy is delivered to give reasonably complete modulation to the carrier, and a good, strong signal is put on the air.

This system for using the Type 59 tubes as Class B has the advantage of simplicity. A single-button microphone arrangement allows the use of the simplest and most inexpensive parts, which can be easily obtained.

The microphone need not be a high quality instrument. The tone quality produced by it will not be as good as a condenser, high-quality carbon, or other expensive microphone. However, the speech output is satisfactory, and elabo rate input amplifiers are not required in this modulator.

The hookup of the power-supply is shown in the diagram, and it is of almost conventional design. The entire 'power supply' for the transmitter and the '4.5 volt 'C' battery for the microphone current) is obtained from the A.C. power lines. The rectified output of the plate supply, the filament, or heaters, are operated from a step-down transformer. Separate filament and plate transformers are recommended. The tubes are of the heater type and require time to obtain their full operating temperature. With high voltage on them, there is danger of tube failure if the plate voltage is applied to the tubes before the cathodes have reached operating temperature. The time necessary depends on the build of the device, but from 30 seconds to 1 minute should be allowed for ordinary tubes before the plate voltage is applied. The heater current should be left on while the transmitter is in use. A switch in the primary of the plate-supply transformer can be used to apply the plate voltage. This permits the tube to go into oscillation the output. Possible tube failure from this cause is also eliminated.

The plate supply should be capable of withstanding large peaks of current. The total current to the two modulator tubes may run as high as 400 milliamperes or so, plus the 75 or 100 milliamperes delivered continuously to the oscillator. The power transformers should be capable of delivering about 500 milliamperes during peak loads.

The choke should also be capable of carrying this current. The power supply must be of substantial proportions since the maximum load will probably run as high as 200 watts on peaks. The high plate current requires a mercury vapor rectifier-tube capable of handling a large overload. The tube used is a type 83 which has the following characteristics:

- Filament Voltage: 5.0 volts
- Filament Current: 3.0 amperes
- A.C. Voltage: 500 MAX. Per Plate
- Inverse Voltage: 1000 volts max.
- D.C. Current: 250 MA. (Continuous)
- Peak Current: 800 MA.
- Voltage Drop: 14 volts

This tube can be arranged to handle the entire plate load; its high overload capacity will withstand the modulation current peaks. The filter chokes in the diagram is of the conventional type with choke output from the rectifier tube. Choke output must be used with tubes of this type, or the life of the tube will be short. This filter system provides a smooth DC plate supply. There is no hum on the carrier.

The condensers used in the filter system are of the dry-electrolytic type. They are connected in series since the normal operating voltage is close to the maximum rated voltage. This reduces the strain on the condensers. Two series groups are used. Series connection reduces the capacity; however, the capacity of electrolytic condensers is quite high.

Construction of Transmitter

The arrangement of the parts is shown in the drawings. The apparatus is mounted on a shelf, the arrangement looking like a small table. This allows mounting the power unit underneath and the radio-frequency and modulation system on the shelf. The plates are mounted on a small bakelite panel at the front of the set. A 0-500 volt D.C. voltmeter, a 0-300 volt milliammeter and a 1.5 amp., thermocouple antenna ammeter are used. The dials of these meters are optional. The antenna ammeter is the most costly meter of the three but it indicates the output of the set. It is perhaps the most important.

The plate coil consists of 40 turns of No. 16 enameled wire wound on 2 inch diameter form. The coil forms are arranged with a small air space between each turn; this increases the insulation. The secondary or antenna coil is wound over the plate coil. Small bakelite strips are cemented to the inner winding which is the primary coil. The side pieces are ¼ inch wide and 3/16 in. long. These are held in place with Dupont's Household Cement. (Amroid Glue, or white lacquer can also be used. The outer (secondary) coil is wound over these strips. It consists of 16 turns of No. 14 enamelled wire. This coil is mounted in the aerial and ground (or counterpoise), and is used to couple the antenna to the oscillator impedance.

The coil is tuned by a 0.005 mfd. receiving type condenser which is fastened to the base of the black metal strips. A knob permits tuning the condenser, while the set is in operation, without danger to the operator. An "isolatite" socket (optional) is used for the 59 oscillator. Ordinary sockets are used for the modulator tubes.

The modulation transformer is of special construction. The core pieces have the usual "E" and "T" shapes, as shown in the diagram. This transformer has two windings; a "low" and a "high" winding. The "low" winding consists of 900 turns of No. 26 enameled wire; it is connected in the plate circuit of the modulator tubes. The "high" winding consists of 900 turns of No. 26 enamelled wire; it is connected in series with the plate supply of the 59 oscillator tube.

The windings are wound in layers, carefully insulated between the layer, and from each other, and all terminals are brought out to a connection strip. When the transformer is connected, it will be found that slightly better results are possible if the "polarity" of the two windings is correct. This can be tested for by interchanging the leads on either the low or high winding. Listen with a monitor to see which connection gives best results. When assembling the core, the "E" sections are placed in the core, and the "T" sections laid flat against the "E" pieces. A pair of core clamps holds the core together. A slight air gap is provided between the "E" and "T" pieces. This provides a "gap" in the magnetic circuit to prevent core saturation due to the DC current flowing in the primary.

The choke coils for the filter are made of the same kind of core material, as assembled in the same way, but 600 1/3 in. in thickness. The single winding is made of No. 24 enamelled wire wound in layers. Strips of bakelite or bakelite are also provided for the chokes to give a gap in the magnetic circuit.

The filament transformer is wound on smaller core material. A 1-in. stack of core iron is used for this transformer. The primary consists of 900 turns of No. 25 enam. (Please turn to next page)
eled wire, wound in layers, and two sec-
ondaries, one having a 2.5-volt, 6 ampere
rating, for the heaters of the type 39 tubes; the
other winding is rated at 5.0 volts and 3.0 amperes (for the 85 filament). The 59
filament winding consists of 22 turns of No.
12 enameled wire. The rectifier heater wind-
ing consists of 45 turns of No. 14 enameled
wire. This heater winding must be very well
insulated for it has the full plate voltage on
it when the set is operating.

The plate-supply transformer includes a
core as shown in the drawing. The silicon-
steel core is built up to 2 in. in thickness.
The primary winding consists of 300 turns of
No. 20 enameled wire. The secondary
consists of two windings with 1800 turns of
No. 28 enameled wire in each. The center
tap connects to the mid-point between the
two windings. The two outer ends of the
full winding connect with the plates of the
'83 rectifier tube.

Tuning and Adjustment
Of 160-Meter Radiotelephone

The tuning and adjusting of the trans-
mitter is quite simple. First check all
wiring carefully. Before connecting the
plate voltage in test work, allow the tubes
to heat up for about 30 seconds.

For preliminary testing, insert a 5000-ohm
resistance in series with the plate supply
to the tube. The modulator tubes are removed
from their sockets. Turn the condenser in
the plate circuit slowly over its entire range,
or to the point at which a drop in plate cur-
cent is noted. This drop will be quite sharp.

Parts Required for
160-Meter Radiotelephone

K-1—165-Meter quartz crystal and
holder.
C3, C4—2-1/2-mfd. Cardwell Variable
Condensers, Receiving Type.
L1—Utility B.F. Choke.
L2-L3—R.E.L. 2242 Coil Form. (Plug-
In.)
R1—15000-ohm Electrolyt. Resistor.
R2—5000-ohm Electrolyt. Resistor.
C1—8200-mfd. F. Condensers.
C3—8200-mfd. Fixed Condenser.
C4—400-mfd. F. Condenser.
C6—Coil of 20 ft., 12 turns, 24-ga.

Plate-supply transformer includes a
core as shown in the drawing. The silicon-
steel core is built up to 2 in. in thickness.
The primary winding consists of 300 turns of
No. 20 enameled wire. The secondary
consists of two windings with 1800 turns of
No. 28 enameled wire in each. The center
tap connects to the mid-point between the
two windings. The two outer ends of the
full winding connect with the plates of the
'83 rectifier tube.

It indicates resonance of the plate circuit to
the crystal frequency.

If results are satisfactory, the 5000-ohm
resistor may be removed and the entire plate
t voltage applied. The current will rise con-
siderably but it should not go over 50 or 60
milliamperes.

Connect the aerial and counterpoise to the
secondary or aerial coupling coil, and slowly
move the aerial condenser until a reading is
obtained in the aerial ammeter. Carefully
tune the aerial condenser until a maximum
aerial current is obtained. The adjustment of
the plate tuning condenser should then be re-
checked. It will usually require a slight read-
justment to bring the plate current to a
final minimum setting. A slight readjustment
of the aerial tuning condenser will then also
be required. Usually about two or three trials
will give satisfactory operating conditions.

It will sometimes be found that the aerial
will not respond to the frequency of the oscil-
lator circuit. If the aerial is very large, it
may be necessary to insert another series
condenser. This may be a 0005 mfd, air con-
denser. If the aerial is too large, it may be
necessary to reduce its dimensions, or those
of the counterpoise. If the aerial is very
small, it will be necessary to connect in a
coil to "load" it to the wavelength required.
A coil of about 30 turns of No. 14 wire, wound
exactly like the plate tuning coil, will serve.
For very small aerials, it will be neces-
sary to add as much as 40 or 50 turns, but
this is unusual.

After the oscillator in the set is tuned, the
modulator tubes can be inserted in their
sockets and the 'mike' spoken into. If con-
ditions are normal, the aerial current will in-
crease slightly when a prolonged 'Ah-b-b-b-
bleep' is spoken into the microphone. The maxi-
mum increase is about 10 per cent for a loud
sound. Such an increase shows a high per-
centage of modulation.

If desired, a Type 47 pentode can be used
instead of the 59, and Type 46 tubes can be
used as modulators instead of the 59's. These
 tubes should be connected so the proper op-
erating conditions will result.

If it is not desired to use a crystal in the
oscillator, another 0005 mfd. condenser, shunted by a coil consisting of 40 turns on a
2-in. diameter form, can be used in place of
it. This coil can be wound with smaller wire
if allowance is made for inductance change.
The circuit diagram of the transmitter shows
this optional tuned circuit in dotted lines.

If the crystal is not used, stability is less.
In this case the proper adjustment of the
grid circuit determines the operating fre-
quency.

The frequency emitted by the transmitter
should be carefully checked with a calibrated
monitor. To use a transmitter without a cali-
brated monitor and frequency meter
should not be attempted; it is too easy to get
outside of the band and cause trouble.

No transmitter, of course, should be op-
erated without proper station and operator's
licenses.
The Superheterodyne—Its Theory and Operation
A One Year Course of Instruction—Lesson One
By D. B. McGown

THERE has been much interest in the superheterodyne type of receiver and much discussion pro and con of its merits. How does a superheterodyne differ from a simple detector? The simple detector is often used in audio amplifier combination, or a receiver of the tuned radio frequency type? What are its advantages and drawbacks? How does it operate? As reasonable as these questions are, direct replies to them are often evaded even by men of the industry who should be able to answer them in relatively simple language. Too often answers are couched in such general language as "It is more sensitive" or "It operates more satisfactorily," a poor answer to a poor question. In spite of the vagueness of generally available information the superiority of the superheterodyne has come to be more or less generally accepted by an interested public.

Believing that there are many who would like to have a better understanding of this popular type of receiver, we present in simple language a discussion of superheterodyne theory and operation.

Before undertaking a more technical discussion of the superheterodyne let us briefly consider its historical background. This type of receiver was developed during the World War by Major Edwin H. Armstrong to meet the need for a receiver capable of intercepting the largest possible number of enemy messages and having a degree of sensitivity which would permit signals beyond the range of present equipment to be made audible. While the modern superheterodyne bears very little physical resemblance to the original model the fundamental operating principles are quite similar and refinements have been principally in the design and arrangement of component parts and tubes. The superheterodyne has for some years received the attention of many investigators, engineers and scientists and it is to their efforts that we owe the highly perfected receivers we enjoy today. If it is to be properly understood and general use of them is not permitted. As a result, we have had perfected, to a high degree, many types of receivers, among them that known as the tuned radio frequency type. We shall have occasion to consider the latter type of receiver in connection with our study of the superheterodyne.

Let us begin our discussion by defining certain terms which we shall have occasion to use frequently. Try to visualize or form mental picture of the actions which take place in radio transmitting and receiving circuits. To do so, will, the writer believes, greatly assist in understanding the subject.

At the start, let us distinguish between direct current and alternating current, and direct and alternating voltages. Voltage, while the analogy is not a perfect one, may, for the purpose of creating a simple mental picture, be likened to electrical pressure. It may be of constant value and continuous in one direction. It may alternate in direction and go through repeating cycles of changes in value from zero to a maximum value, in one direction, and through zero to a maximum in the other direction to repeat the cycle. Each series of changes in value between zero to a maximum in both directions and back to zero constitutes a "cycle" and the "frequency" is the number of completed cyclic changes taking place per second. Thus the greater the number of cycles per second the greater the frequency. Under certain special conditions which we shall have occasion to mention voltages can exist in a circuit without flow of current in the circuit.

In general, a voltage which acts continuously in one direction will produce current flow only in a circuit consisting of continuous electrical conductors and current so produced will likewise flow in one direction only and will be spoken of as a direct or continuous current. If the voltage in such a circuit remains constant in value the current will, in general, likewise remain constant in value. If the voltage in the circuit is always in the same direction but goes through repeated cycles of changes in value between zero and a maximum the resulting current will be a pulsating direct current and it may or may not be in phase with, that is, go through its changes from zero to maximum simultaneously with the voltage. A break in the continuous electrical circuit such as a switch or a condenser will prevent flow of current.

A voltage which alternately reverses in direction and goes through repeated cycles of changes between zero and a maximum in on direction, then through zero to a maximum in the opposite direction and back to zero is an alternating voltage and will, in general, cause an alternating current to go through the same reversals in direction and the same cycles of change. These conditions under which such a voltage may exist in the circuit and no current flow. Such an alternating current and voltage may or may not be in phase, that is, they may or may not go through their maximum and minimum values simultaneously with respect to time. Elements in the circuit which constitute an open circuit to direct current do not necessarily prevent the flow of alternating current. A circuit which consists fundamentally of two conductors separated by an insulating medium, does not necessarily prevent the flow of alternating currents. Although we digress slightly it might be mentioned that for a voltage of given frequency the larger the capacity of a condenser series with it, the more freely the current will flow, while for a condenser of given capacity in a series circuit the higher the frequency the more freely current will flow.

In order to illustrate and permit easier visualization of alternating voltages and currents it is customary to show them on paper by means of lines and circles. Refer to Figure 1. "A" may represent either a direct voltage or current of constant value. We have two reference axes—a horizontal axis O-X by means of which we represent time and a vertical axis O-Y by means of which we represent values of either voltage or current as the case may be. The intersection "O" of the horizontal and vertical axes represents zero voltage (or current) and zero time. By zero time we mean that moment in time which we use as a starting or reference point. Different distances along the vertical axis O-Y represent different values of current (or voltage). The farther we progress along O-Y from "O" the greater the current (or voltage) represented. In dealing with direct currents we are concerned only with distances along O-X, these are considered "positive" to distinguish them from distances along the extension of O-Y beyond O-X; these we are considered "negative" (the opposite of positive) and are used to represent currents (or voltages) opposite in direction to those represented by distances along O-Y above O-X. Let us divide the axis O-X of "A" into a number of equal parts each of which is to represent one second in time. Let us likewise divide the O-Y axis into a number of equal parts each of which is to represent one volt, if we are representing voltage, one ampere if we are representing current. Now if we draw vertical lines through the points dividing our horizontal or time axis O-X, and then measure upward along each of these lines a distance representing, according to the scale we have chosen on axis O-Y, the value of the current (or voltage) at the instant considered (time is measured from the "Origin" or point "O," along the x-axis), we shall determine a series of points. If we draw a continuous line through these points it will represent the current (or voltage) which is equal to picture. Since a direct current (or voltage) is constant in direction the line (also called a curve, although in this case, as we shall see, it is a perfectly straight line) representing it will lie entirely above the axis O-X and distance, from axis O-X, along vertical lines cutting this axis, for different values of time. The line drawn through the points located by making such measurements will be the straight line OM parallel to the axis O-X. "OM" therefore represents a direct (continuous) current or voltage, the value of the current or voltage in this case being between 3 and 4 as determined by the distance along O-Y and the scale chosen for O-Y. (The next lesson will appear in the following issue)
The new 53 is a heater-cathode type of tube combining in one bulb two high-mu triodes designed for Class B operation. It is intended primarily for use in the output stage of a-c operated radio receivers. In such applications, the 53 is often used in providing a power output of 10 watts at a plate voltage of 300 volts. The triode units of this tube have separate external terminals for the electrodes except the cathode and heater, so that circuit design is similar to that of Class B amplifiers utilizing individual tubes in the output stage.

Besides its usefulness in the output stage, the 53 may also be adapted to the driver stage by connecting the two triode units in parallel. The tube then serves as a Class A amplifier and possesses characteristics such that it can deliver to a 53 in the Class B output stage adequate power with high gain and low distortion.

INSTALLATION

The BASE pins of the 53 fit a standard 0.855 in. pin-circle diameter seven-contact socket which may be installed to operate the tube in Amplifier or in a fixed output position. Base connections and external dimensions of the 53 are given in Outline Drawing No. 205-62-1.

The UBL of this tube will become very hot under certain conditions of operation. Sufficient ventilation, therefore, should be provided to circulate air freely around the tube to prevent overheating.

The HEATER is designed to operate at 2.3 volts. The transformer winding supplying the heater circuit should be designed to operate the heater at this recommended value for full-load operating conditions at average line voltage 115 volts.

The CATHODE should preferably be connected directly to a mid-tap on the heater winding. If this practice is not followed, the heater may be biased negative with respect to the cathode by not more than 45 volts.

The GRIDS for Class B and for Class A service should be connected so as to give results tube characteristics suited to the particular service. Detailed information on connections is given under APPLICATION.

APPLICATION

Combining two triode units designed for Class B operation in a single bulb, the 53 is intended primarily for use in the Class B output stage of A.C. operated receivers. It may also be used as a Class A amplifier (with triode units connected in parallel) to drive the 53 in the output stage.

As a "Class B" POWER AMPLIFIER, the 53 is used in circuits similar to those utilizing individual tubes in the output stage. It requires no grid bias but since the Smythmu feature of the triode units reduces the steady plate current at zero bias to a relatively low value.

During operation of this tube as a Class B amplifier, the grids of the two triode units are alternately swung positive each half cycle. Considerable power is required to do this under ordinary conditions. If, however, the secondary emissivity of the grids were made nearly equal to unity, the required power to swing the grid positive would be appreciably decreased. Tubes possessing this feature can be constructed, but the secondary emissivity is not independent of signal voltage and frequency of operation. Furthermore, secondary emission behaves erratically during the life of the tube. Thus, to have a Class B tube which will give uniform results throughout its life, it is preferable from the tube design standpoint, to eliminate secondary emission instar so as possible even at the expense of lower efficiency. Unless tubes for use as Class B amplifiers are capable of producing uniform results throughout their life, it is practically impossible to design circuits to utilize them.

The D.C. plate current required in Class B circuits fluctuates under normal operating conditions. As a result, therefore, the heater circuit should have good regulation to maintain proper operating voltages regardless of the current drain. For this purpose, a suitably designed power unit should be employed. The rectifier tube should have reasonably good regulation over the operating range. In some circuits, a vacuum-type of rectifier tube can be used, while in others a mercury-vapour type may be needed to provide the required regulation. As a factor in obtaining good regulation, the filaments of the transformer windings should have low resistance. In the design of a power supply for a Class B amplifier, consideration should be given to economical voltage drop and power loss. Also, the power supply should be designed to take care of the average power demands with sufficient regulation to maintain the demands.

As previously pointed out, the grids of the 53 are alternately operated sufficiently positive to cause grid current to flow in their input circuits. This feature imposes a further requirement on the preceding amplifier stage. It must supply not only the necessary input voltage, but must be capable of doing so under conditions where appreciable power is taken by each grid of the Class B amplifier tube. Since the power necessary to swing the grid positive is partially dependent on the plate load of the Class B tube, and since the efficiency of power transfer from the preceding stage is dependent on transformer design, it is apparent that the design of a Class B audio power amplifier requires that more than ordinary attention be given to the factors produced by the component parts of the circuit. These effects may be produced in the first-stage amplifier by the design factors of the power-output stage. For this reason, the design of a Class B amplifier with its driver stage is somewhat more involved than for a Class A system, and must be checked for each stage independently.

A complete discussion of design features for Class B amplifiers would be rather extensive, but certain outstanding points may be mentioned. The interstage transformer is the link interconnecting the driver and the Class B stage. It is usually of the step-down type, that is, the primary input voltage is higher than the secondary voltage and transmits the grid currents to the grids of the power output tube. Depending upon conditions, the ratio of the primary of the interstage transformer to one half its secondary may range between 1.5/1 and 5.5/1.

The transformer step-down ratio is dependent on the following factors:
1. Type of driver tube
2. Type of power tube
3. Load on power tube
4. Permissible distortion
5. Class of power output (peak power).

The primary inductance of the interstage transformer should be essentially the same as if the transformer were wound with no load, that is, into an open grid. Since power is transferred, the transformer should have reasonable power efficiency. It should be noted that interstage transformer losses are often critically dependent upon the circuit constants which should, therefore, be made as nearly independent of frequency as possible.

This amplifies partially the importance of a stage coupling transformer and to the loudspeaker. Since it is difficult to compensate for leakage reactance of the coupling transformer without excessive loss of b-f, one solution is to design the transformer so as to be as low as possible.

No specific type of driver tube chosen should be capable of handling sufficient power to operate the Class B amplifier stage. Allowance should be made for transformer efficiency. It is therefore important to note that the driver tube be worked into a load resistance higher than the normal value for optimum power output as a Class B power amplifier, since distortion produced by the driver stage and the power stage will be present in the output.

The following notes on Class B Amplifier circuits are of value from the design standpoint:

The LOAD ON THE DRIVER TUBE or tubes is chosen higher than for undistorted power rating to hold overall distortion to a minimum. For a single triode driver, its minimum plate load resistance is only 2 to 4 times the plate resistance of the driver tube. For a push-pull triode driver stage, its minimum plate load resistance is approximately equal to the plate resistance of an individual tube. This ratio for push-pull operation is permissible practically because of elimination of second harmonic distortion. This minimum plate load is the value used for calculating peak power transformer efficiency.

The INTERSTAGE TRANSFORMER with high step-down ratio causes low distortion in the Class B input circuit, but limits the available signal. A satisfactory transformer design makes use of grid distortion to cancel a part of the distortion produced in the plate circuit of a Class B stage. For this reason, the transformer step-down ratio must not be too great. Resistance losses of the primary and secondary may be distributed on the basis of the most economical design. It is important that only one-half of the secondary furnishes power at a time.

The LOAD VALUES FOR THE CLASS B AMPLIFIER stage given under Rating and Characteristics will change slightly with available input if maximum output and low distortion are desired. It is important that only one of the two parts of the output transformer furnishes power at one time.

For CLASS "A" AMPLIFIER triode operation of the 53, the two grids are connected together at the socket; likewise, the two plates. These connections place the two triode units in parallel. Operation of the tube is then similar to any Class A power amplifier triode. Refer to Rating and Characteristics for operating conditions.

As a Class amplifier triode, the 53 may be employed in the driver stage of Class B amplifier circuits, and thus reduce the number of tube types necessary in a receiver. When operated in this way with a plate supply of 300 volts and corresponding grid bias, the 53 is capable of supplying a power output up to 500 watts at 0.5 megohm with self-bias. With fixed bias, however, the resistance will be between 20000 and 40000 ohms.

The D.C. resistance in the grid circuit of the 53 operating as a Class A amplifier may be 50 megohms or more with self-bias. With fixed bias, however, the resistance should not exceed 0.1 megohm.
**TENTATIVE CHARACTERISTICS**

**RCA-53**

**TENTATIVE RATING AND CHARACTERISTICS**

- **Heater Voltage (A.C. or D.C.)** 2.5 Volts
- **Heater Current** 2.0 Amperes
- **Overall Length** 4 11/16 in.
- **Maximum Diameter** 1 13/16 in.
- **Bulb** ST-14
- **Base** (Refer to Outline Dwg. No. 925-4246) Medium 7-Pin

**CLASS "B" POWER AMP**

- **Plate Voltage** 300 max. Volts
- **Dynamic Peak Plate Current (per plate)** 125 max. Milliamperes
- **Average Plate Dissipation** 10 max. Watts
- **Typical Operation**
  - **Heater Voltage** 2.5 2.5 Volts
  - **Plate Voltage** 250 300 Volts
  - **Grid Voltage** 0 0 Volts
  - **Static Plate Current (per plate)** 14 17.5 Milliamperes
  - **Load Resistance (plate to plate)** 8000 10000 Ohms
  - **Nominal Power Output** 8 10 Watts

*With average power input of 350 milliwatts applied between grids.*

**OPERATION CHARACTERISTICS**

- **Input Class A-5**
  - **Type** 53
  - **Grids and plates in parallel**
  - **Input Transformer-Voltage Ratio** 1/2 Sec. = 5.25
  - **Output Load, Plate to Plate** 10000 Ohms

- **Output Class B-5**
  - **Type** 53
  - **Input Transformer-Voltage Ratio** 1/2 Sec. = 5.25
  - **Output Load, Plate to Plate** 10000 Ohms

**Cunningham C-53**

**CLASS "A" AMPLIFIER—AS DRIVER**

(The two grids are connected together at the socket: likewise, the two plates.)

**Operating Conditions and Characteristics**

- **Heater Voltage** 2.5 2.5 Volts
- **Plate Voltage** 250 294 Volts
- **Grid Voltage** 5 6 Volts
- **Amplification Factor** 35 35
- **Plate Resistance** 11300 11000 Ohms
- **Mutual Conductance** 3100 3200 Micromhos
- **Plate Current** 6 7 Milliamperes

**TENTATIVE RATING AND OUTPUT**

**INPUT TRANSFORMER -VOLTAGE
PRIM. = 4.0**

**OUTPUT LOAD, PLATE TO PLATE = 10000 OHMS**

**OPERATION CHARACTERISTICS**

- **Input Class A-5**
  - **Type** 53
  - **Plate Voltage = 294 Grid Voltage = -20**
  - **Output Class B-5**
  - **Type** 53
  - **Plate Voltage = 300 Grid Voltage = 0**

- **Input Transformer-Voltage Ratio** 1/2 Sec. = 5.25
- **Output Load, Plate to Plate = 10000 Ohms**

**TENTATIVE RATING AND OUTPUT**

**INPUT TRANSFORMER -VOLTAGE
PRIM. = 4.0**

**OUTPUT LOAD, PLATE TO PLATE = 10000 OHMS**

**OPERATION CHARACTERISTICS**

- **Input Class A-5**
  - **Type** 53
  - **Plate Voltage = 250 Grid Voltage = -13.5**
  - **Output Class B-5**
  - **Type** 53
  - **Plate Voltage = 300 Grid Voltage = 0**

- **Input Transformer-Voltage Ratio** 1/2 Sec. = 5.25
- **Output Load, Plate to Plate = 10000 Ohms**

**OPERATION CHARACTERISTICS**

- **Total Harmonics (Percent)**
  - **Plate Current (Percent)**
  - **Grid Current (Percent)**

**RADIO FOR JUNE**

19
The New Doerle Short-Wave Receiver

Using the New T-30-S Tubes, Band-Spread Tuning and Other Features

By WALTER C. DOERLE

ANYONE intending to build a short-wave set is naturally interested in what it will cost. The cost of a set will depend upon the kind of parts that are purchased. However, this writer wishes to impress upon the reader that cheap parts are the cause of most of the failures of short-wave sets constructed by those new to the game. Sometimes discarded parts are used, but as a general rule, only parts designed for short-wave use should be used. The cost of a set of parts that will give good results will be about $10.00. The head-phones (if you need them) will cost a couple of dollars more. The set requires two 4-volt B batteries and two common dry cells; in other words, the set to be described uses two-volt tubes. Although common type 30 tubes can be used, the writer especially recommends the new tube developed by Mr. Binneweg of this magazine. Unusually fine results are obtained with these tubes.

It must be impressed upon the reader from the start that, in order to obtain satisfactory results, every connection in the set must be soldered. Use a good soldering iron and be sure its point is well "tinned." To "tin" an iron first heat it (or allow it to heat, in the case of an electric iron) to a satisfactory temperature. File the tip of the iron clean, and apply some flux. If rosin-core solder is used, melting a little of it on the iron will usually be sufficient to "tin" it. Be sure the iron is "tinned." The "tin" on the iron conveys the heat to the joint.

If you have some rosin, or can get some, place a piece of it in a cloth and reduce it to a powder by pounding through with a hammer. Dissolve the rosin, or as much of it as will dissolve, in common alcohol. The undissolved rosin will remain at the bottom of the container. Keep this soldering flux in a small, well-corked bottle. When using it, apply a little of the fluid to the joint with a small brush. When this flux is used, common wire solder can be used.

To solder a connection, first make sure that the wires will hold together by themselves. Twist them together so they will hold while you are soldering. Hold the "tinned" tip of the iron against the joint and apply a little flux to it. When the joint is well heated, touch the solder to the end of the iron and let it flow over the joint. Remove the iron. As the joint cools, you will notice that a point is soon reached at which the solder "freezes." When "frozen", the joint is completed. Be sure the solder flows freely over the joint and actually makes a good connection. It should be almost impossible to pull apart the wires of the joint which is properly soldered. Be sure every joint in the set is carefully completed. The above information will be very useful after the set to be described has been wired up.

Why Plug-in Coils Are Used

ORDINARY short-wave sets have "plug-in coils." Different coils are needed so that the set will tune to different wavelength ranges. A common tube-socket is used to plug the different coils into the circuit. The prongs on short-wave coil forms fit into ordinary tube sockets. To change to a different wavelength range, plug in a new coil. The coils with the greatest number of turns will give ranges of higher wavelengths when plugged into the coil socket. The particular coil used determines where the set "starts" its tuning, and the tuning-condenser connected allows the set to tune over a definite wavelength range. The band-spread condenser is connected directly across the main tuning condenser and allows one to tune more slowly or provides a "band-spread" effect as it is called. This condenser allows tuning more closely than is possible with only the large condenser.

Constructing Coils for the Set

EACH coil used in this set consists of two windings. The main winding, which determines the wave-length to which the set will tune is called the secondary winding. The other winding usually has less turns, and does not have much to do with the wavelength to which the set tunes. This winding is called the "tickler." Each coil has a secondary and a tickler winding. These windings make connection with the prongs on the base of the coil forms. The letters on the tube socket into which the coil forms plug, are shown in Fig. 1.

Be careful to follow the coil specifications exactly. The construction of the coils is as shown in Fig. 2. Fig. 2-A shows the construction of the Antenna Condenser.

The windings on each coil form are made by winding turns of wire around it. Use No. 28 double cotton covered (D.C.C.) wire for coils A, B, and C. Use No. 28 enamel covered wire for coil D. Both coils on the winding form are wound in the same direction around the coil form. The distance between the inner edges of both windings (distance "d" shown in Fig. 2) should be 1/4 in. for all coils. The top winding on the coil forms should be about 3/8 in. from the top of the coil form.

It is often difficult for beginners to wind their own coils. It may therefore be advis-
able for them to purchase a set of short-wave coils already wound. If you do not care to take chances, and wish to be sure of results, purchase a set of such coils. Four coils, with two windings on each coil, are needed for this set. The exact number of turns to use in each of the windings on each coil will be found in the "Coil Turn Table".

**SHORT-WAVE** "chokes" can be purchased for a small sum, but the reader may desire to make one. The details are given in Fig. 3. Use No. 36 enamel covered wire. Wind all windings in the same direction. This radio-frequency choke coil consists of three windings in series wound on a 3/8-in. wooden dowel.

Most of the other parts necessary for the set must be purchased. Mount the three condensers used in the set at equal distances along the horizontal center line of the panel. A vernier dial will aid tuning, but can be purchased later if desired. Mount the parts on the baseboard or sub-panel as shown in Fig. 4. To wire the set, connect each wire in its position as shown in Fig. 4. Solder all connections carefully.

In the new Binneweg Tube, there is no connection to the "P" prong on its base, so the "P" socket terminal remains unused. The plate of the tube connects with a cap on top of it. The plate lead is not connected directly to the cap on the tube, but is soldered to a **COIL TURNS TABLE**

<table>
<thead>
<tr>
<th>For New Doerle</th>
<th>Turns in Doerle Secondary Tickler Receiver Winding</th>
<th>Winding Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>COIL &quot;A&quot;</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>COIL &quot;B&quot;</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>COIL &quot;C&quot;</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>COIL &quot;D&quot;</td>
<td>50</td>
<td>12</td>
</tr>
</tbody>
</table>

These four coils will cover the entire short-wave range including everything to be found on short-waves. Range: 15 to 200 meters.

Stations are first tuned in on the main tuning condenser. When found, the band-spread condenser is tuned. The beginner should learn to tune the set by first using the coil having the largest number of turns. This coil will bring in police and amateur stations.

**How to Tune the New Doerle Receiver**

**SHORT-WAVE** sets are easy to tune. The tuning (or "secondary") condenser changes the wavelength, while the regeneration-control maintains the receiver at the proper sensitivity or volume setting. When tuning over the range given by any particular plug-in coil, tune both condensers at the same time, for best results. The main tuning, or secondary condenser, will change the wavelength, while the regeneration-control will maintain the set at the best operating point. For any position of the tuning condenser, the best position for the regeneration control is such that a "hiss" is heard in the headphones or speaker.

Try setting the main tuning condenser at some convenient position and then tuning only the regeneration control, slowly, over its entire range. When the regeneration-control approaches the best operating point, a "hiss" will be noticed, just at the position at which this hiss occurs is the most sensitive condition for the receiver. However, if the tuning condenser is moved, the regeneration-control must again be readjusted to keep the receiver at its most sensitive point. It is therefore seen that the best way to tune both controls at the same time. A little practice will give the required skill.

If the set does not go "squelch" at the sensitive point, but hums or clicks instead, the detector plate voltage may be too high or the grid leak may have the wrong value. Stations are located by their "squelches". Even foreign stations may give a surprisingly loud squelch. When found, turn the regeneration-control down as low as possible, to clear up the signal, then readjust both tuning and regeneration again until the signal is heard plainly.

This receiver is also equipped with a band-spread tuning condenser for finer tuning.
A New 6.3-Volt Power Tube and Two New Duplex-Diode Triodes Are Coming—Here Are the Tentative Characteristics:

<table>
<thead>
<tr>
<th>DISCUSSION</th>
<th>DISCUSSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCA RADIOTRON</td>
<td>CUNNINGHAM</td>
</tr>
<tr>
<td>RCA-6A4</td>
<td>C-6A4</td>
</tr>
<tr>
<td>POWER AMPLIFIER PENTODE</td>
<td>(6.3-Volt Filament)</td>
</tr>
<tr>
<td>TENTATIVE RATING AND CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td>Filament Voltage</td>
<td>(A.C. or D.C.)</td>
</tr>
<tr>
<td>Filament Current</td>
<td>0.3 Ampere</td>
</tr>
<tr>
<td>Plate Voltage</td>
<td>100 135 165 180 max. Volts</td>
</tr>
<tr>
<td>Screen Voltage</td>
<td>100 135 165 180 max. Volts</td>
</tr>
<tr>
<td>Grid Voltage</td>
<td>-6.5 -9 -11 -12 Volts</td>
</tr>
<tr>
<td>Plate Current</td>
<td>9 14 20 22 Milliamps.</td>
</tr>
<tr>
<td>Screen Current</td>
<td>1.6 2.5 3.5 3.9 Milliamps.</td>
</tr>
<tr>
<td>Plate Resistance</td>
<td>85250 52600 48000 45500 approx. Ohms</td>
</tr>
<tr>
<td>Amplification Factor</td>
<td>100 100 100 100 approx.</td>
</tr>
<tr>
<td>Mutual Conductance</td>
<td>1200 1900 2100 2200 Micromhos</td>
</tr>
<tr>
<td>Load Resistance</td>
<td>11000 9500 8000 8000 Ohms</td>
</tr>
<tr>
<td>Power Output (9%)</td>
<td>% of total harmonic distortion</td>
</tr>
<tr>
<td>Maximum Overall Length</td>
<td>4 11/16 in.</td>
</tr>
<tr>
<td>Maximum Diameter</td>
<td>1 13/16 in.</td>
</tr>
<tr>
<td>Bulb</td>
<td>ST-14</td>
</tr>
<tr>
<td>Base (for connections, see Note 1)</td>
<td>Medium 5-Pin</td>
</tr>
</tbody>
</table>

Note 1: Pin 1—Grid; Pin 2—Plate; Pin 3—FILAMENT; Pin 4—Screen. Pin numbers are according to RMA standards.

Note 2: Transformer or impedance input-coupling devices are recommended. If, however, resistance coupling is employed, the grid resistor should be limited to 0.5 megohm.

<table>
<thead>
<tr>
<th>DISCUSSION</th>
<th>DISCUSSION</th>
</tr>
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<tbody>
<tr>
<td>RCA RADIOTRON</td>
<td>CUNNINGHAM</td>
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<tr>
<td>RCA-2A6</td>
<td>C-2A6</td>
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<tr>
<td>DUPLEx-DIODE TRIODE</td>
<td>(High-Mu Triode)</td>
</tr>
<tr>
<td>TENTATIVE RATING AND CHARACTERISTICS</td>
<td></td>
</tr>
<tr>
<td>Heater Voltage (A.C. or D.C.)</td>
<td>2.5 Volts</td>
</tr>
<tr>
<td>Heater Current</td>
<td>0.8 Ampere</td>
</tr>
<tr>
<td>Direct Interelectrode Capacitances—Triode Unit (appr.):</td>
<td></td>
</tr>
<tr>
<td>Grid to Plate</td>
<td>1.7 uuf.</td>
</tr>
<tr>
<td>Grid to Cathode</td>
<td>1.7 uuf.</td>
</tr>
<tr>
<td>Plate to Cathode</td>
<td>3.8 uuf.</td>
</tr>
<tr>
<td>Overall Length</td>
<td>4 9/32 in. to 4 17/32 in.</td>
</tr>
<tr>
<td>Maximum Diameter</td>
<td>1 9/16 in.</td>
</tr>
<tr>
<td>Bulb</td>
<td>ST-12</td>
</tr>
<tr>
<td>Cap</td>
<td>Small Metal</td>
</tr>
<tr>
<td>Base (for connections, see Note 1)</td>
<td>Small 6-Pin</td>
</tr>
</tbody>
</table>

Note 1: Pin 1—Diode Plate; Pin 2—Triode Plate; Pin 3—Heater; Pin 4—Heater; Pin 5—Cathode; Pin 6—Diode Plate; Cap—Grid. Pin numbers are according to RMA Standards.

Note 2: Resistance coupling is recommended for output circuit of the triode unit. A value of resistor suitable for 250-volt plate supply is 0.1 megohm.

**Announcement**

A TESTING and Calibration Laboratory has been installed for "RADIO". This new laboratory includes the latest equipment available. Mr. B. Molinari is in charge of the new laboratory. It enables the publishers of "RADIO" to conduct accurate measurements and tests on all equipment that will be described in the pages of this magazine.

The new laboratory will be at the service of readers and advertisers. Here is a partial list of instruments already installed for test purposes:

- Calibrated Radio-Frequency Oscillator, 20,000 k.c. to 10 k.c. (15 to 30,000 meters).
- Calibrated Beat-Frequency Audio Oscillator, 5 to 12,000 cycles.
- 1000-cycle Audio Oscillator.
- Capacity Bridge.
- Accurate Standards of Inductance and Capacity.
- General Radio Universal Resistor Bridge, allowing rapid measurement of Inductance, Capacitance and Resistance.
- Frequency Ranges: 0-500 cycles. 5-12,000 cycles. Power-Level Indicator.
- Vacuum-Tube Voltmeter having range of 0.3 to 150 volts. Measures R.M.S. or peak values.
- Attenuation Network for Radio Frequency Oscillator, which allows use as Standard Signal Generator.
- Amateur Band Frequency Meter.
- Power Supply Equipment and complete rack of A.C. and D.C. Meters.

This expensive apparatus allows measurements on radio equipment of all kinds. A Cathode-ray Oscillograph and a special ultra-high frequency oscillator will also soon be available. Special laboratory work at very reasonable rates. Write for schedule.
Question—I can receive some Police Radio stations on my broadcast set, but not all. I am told that this is quite a common condition; what is the reason for this? L.B.N., Fresno, Calif.

Answer—Some police stations are assigned 1712 kc. operating frequency, and whilemany broadcast sets were theoretically designed to cover only from about 1500 to 550 kc., they actually cover frequencies slightly higher than this, say up to about 1800 kc. If the receiver in use happens to be so built that it covers the 1712 kc. frequency you may hear some police stations operating on this frequency. There are, of course, stations, however, which operate in the vicinity of 2400 kc., and these can only be heard on special receivers or adapters, designed for the purpose. (1712 kc. is about 125 meters, and 2400 kc. is about 125 meters.)

Question—Every time the doorbell rings, I get a loud buzzing in the radio set. What can be done to get rid of it? I note that when the telephone bell rings this does not seem to happen. E.S., Scranton, Pa.

Answer—The usual doorbells in residences have mechanisms whereby the current is made and broken by the action of a moving "armature." The small spark made when the circuit is broken sets up feeble radio waves, which travel a few feet, and are heard in a sensitive radio set every time the bell is operated. This can usually be eliminated by connecting a fixed condenser of the "by-pass" type, across the contacts of the bell. The condenser capacity should be from $\frac{3}{4}$ to 1.0 mfd., and may have low voltage rating. Be sure it is connected across the contacts of the bell, from the moving armature to the adjusting screw; if connected across the terminals, there will be little or no effect.

The reason why you do not hear any noise from the telephone bell is that this type of bell operates on alternating current, which causes the bell armature to vibrate exactly the same way the alternating current changes, and no current is broken like in the battery-operated bell. Due to the more complicated generator needed, and also to the more expensive bell apparatus, the A.C. type of bell is not used for doorbell service.

Question—Sometimes, while tuning my receiving set, I hear code signals, usually with a rather rough, raspy sound. They are very sharp, and are lost at almost a hair's motion of the dial. They come in sometimes at two or three places in the broadcast band. I have a type of superheterodyne receiver. What is the cause of this? H.K.L., Berkeley, Calif.

Answer—The probable trouble is that the receiver you have is a type where the "oscillator" is so designed that it is not entirely free from harmonics. These harmonics occur at twice, three, four, and other multiples of the frequency your set's oscillator happens to be tuned to; for example, if your oscillator happens to be tuned to 1000 kc. (300 meters), there will be harmonics at 2000 kc. (150 meters), 3000 kc. (110 meters), 4000 kc. (75 meters), etc., and if there happens to be a powerful transmitter within a reasonable distance of your receiver, it will pick up these signals, and they will be heard just as if you were actually tuned to their frequency, although naturally with much less signal strength. Sometimes this condition gives trouble up to a hundred miles or so, from a powerful transmitter, and it may be quite objectionable. This is caused by the design of the receiver, and there is but little that can be done by you to get rid of such trouble.

Question—Why are such large output tubes used in the amplifier systems used in theater sound systems? I have been operating such a system for a long time in a theater here, and it seems to me that the amplifier system is unnecessarily large. As a test we recently set up a small "micorde" receiver on the stage, one night after the show, and this seemed to have plenty of sound volume to fill the entire theater; this used but a single pentode tube, and a small speaker unit. H.K.U., Dallas, Tex.

Answer—There are several problems to be considered here, a full discussion of which would take quite a long article. The primary point is that theater systems require a reasonable sound volume with an absolute minimum of distortion. To get such conditions, it is necessary that the tubes normally be run considerably below their condition of minimum distortion, for average reproduction, to permit much satisfactory and realistic reproduction of even moderately loud passages, which otherwise would be distorted. The test of the radio set is not conclusive, as this set would sound quite satisfactory, even if considerable distortion is present, as the set usually plays music at about one volume setting, and distortion is not as easily noted in most music as in voice reproduction. Also reproduction which would be accepted quite satisfactory from a radio set would not be satisfactory for general theater reproduction. A test with an empty theater also differs widely from a test made with a house full of people, who make considerable noise themselves, and also absorb a great deal of sound in their bodies and clothing.

Question—Why is it possible to receive many distant stations without an aerial of any kind? I find that I can connect the wire from the water-pipe "ground" to the aerial terminal of the radio set and get good reception, and plenty of distant stations come in very well, too. J.L.T., Provo, Utah.

Answer—Several factors enter here. In general, a water-pipe ground may or may not be a good earth contact, and also a water-pipe system may pick up a great deal of the earthborne portion of the wave from the distant transmitter. It may be that the connection where the pipe is actually in good con tact with the earth is several hundred feet distant, and in such case the pipe system is actually acting as an antenna. During the World War, experiments were made with the U. S. Navy to receive signals, and to reduce static, by receiving on long wire ariels made of insulated wire, buried in the wet marshy soil at certain naval stations. These wires received chiefly the portion of the radio wave that travels at, or just below ground level, and thus gave quite satisfactory reception, even from stations thousands of miles away. Such aerials are generally quite directive, and are used for general use, as well as requiring a good deal of space to install.

Question—How is it that on my midget receiver I can get good reception when it is connected in some sockets in the house and on some others it is not as good? I am using it without an outdoor antenna, as I have a coil of insulated wire in the top of the cabinet for an aerial. G.T.H., Chicago, Ill.

Answer—You will probably find that the coil of wire is doing very little good as a pick-up. You are probably getting most of the pick-up directly through the A.C. power line, and the lines themselves are acting as an aerial. The radio waves thus picked up on the power wires are then communicated to the radio set by capacity coupling in the set, and are amplified and detected just the same as if they were received from the regular antenna. It is also possible that some portions of the house are shielded from the pick-up, by the presence of steel lath walls, or other similar shielding.

Question—I am told I must get an amateur station and operator license, if I use a small transmitter with only a couple of receiving tubes. It is my understanding that the U. S. Government's authority extends only to interstate matters, and I am sure that my set would not send beyond the borders of the state. J.K.T., Sacramento, Cal.

Answer—The Federal Radio Laws covering the operation of amateur or other stations not generally included in the broadcasting transmitters that can send beyond the borders of the state in which they are located, but such transmitting stations which may interfere with the reception of signals originating outside of the state's boundaries, requiring that all transmitters be licensed, as it is easy to see that no matter how small the transmitter, it might cause interference with the reception of signals in a very sensitive receiving set located in the close vicinity, especially if the user of this set was trying to get signals from a distant station that might happen to be located outside of the state.
This receiver is a five-tube Super-Heterodyne incorporating a Dynamic Loudspeaker as a part of the chassis; two-point tone control; single heater type Penioe Output tube and the inherent sensitivity, selectivity and tone quality of the Super-Heterodyne.

The circuit consists of an R. F. stage, a combined oscillator and first detector in the RCA-2A7 tube, an intermediate stage consisting of a transformer only using two tuned circuits, a second detector, an output tube and a rectifier.

The line-up adjustments are made in conjunction with an external oscillator and an output meter. The line-up capacitors on the gang capacitor are adjusted for maximum output when the oscillator is coupled to the antenna and the set and oscillator are both set at 1400 K. C. The I. F. frequency is 175 K. C. and the two circuits that comprise it are adjusted for maximum output at 175 K. C.

RCA-VICTOR 5-TUBE SUPERHETERODYNE
**New Products**

**BRUNO CONDENSER MICROPHONE KIT**

From Bruno Laboratories comes the announcement of an inexpensive kit of parts for building your own condenser microphone. A microphone of this type can be used for broadcasting, public address, or wherever a microphone of good quality is required. It is said to be free from hiss and extraneous noises, when spoken into. Only the driver is needed to assemble the microphone. It is packed complete with instructions and also a hook-up for an efficient 2-stage amplifier.

**DELFT**

4-Tube Pentode Short-Wave Receiver. Range 15-200 Meters. Broadcast coils can also be supplied.

The latest product of Delft Radio Mfg. Co. is a new short-wave receiver of unusually small size, ideal for table and portable use. It is housed in a sturdy shielded metal cabinet, finished in an attractive shade of Duco. The four-tube circuit uses a power-pentode. This set can be supplied to use the new Binneweg short-wave tubes. An entirely new coil system is used which gives unusual selectivity and volume from distant stations. This company has specialized in the manufacture of short-wave receivers.

**W9USA In Operation**

W9USA is now on the air on 5630kc crystal CW and 3907kc fone. Operation on 7me and 14mc bands will begin, shortly. West coast reports on quality and reliability of either CW or fone signals will be appreciated by W9DE, Communications Mgr., as reliable schedules are desired for the period of the World's Fair.

All cards for W9USA-W9USB should be sent to 59 E. Van Buren St., Chicago, and not to the Century of Progress grounds.

**W9FO Moves**

W9FO is resuming operation on 7052kc crystal CW, after moving transmitter to a new location.

---

**AMATEUR ACTIVITIES**

**PROGRAM FOR ATLANTIC DIVISION CONVENTION**

Radio Association of Western New York
LAKE ERIE HOTEL
Buffalo, N. Y.
June 24 to July 1, 1932
TENTATIVE PROGRAM

- **Friday — June 24, 1932**
  - 8:00 A.M. Registration (open all day)
  - 8:00 A.M. License Examination (all classes) at Hotel, by W. M. Grinnell, Radio Inspector
  - 10:00 A.M. General Get Together
  - 10:00 A.M. Demonstrations, by Radio Manufacturers

- **12:00 M. LUNCHEON-“DUTCHE”**
  - 1:00 P.M. Afternoon Session—Floyd Miers, WSLN
  - Superhet-Receivers—C. L. Dickson, WSCUT
  - New Ideas—Amateur Receivers—D. A. Meek, W5CCH
  - General Discussion—Radio in Columbia, South America—Charles Robert Roby, W5BAM
  - RCA Victor Co., Inc.

- **4:00 P.M. Trustees Meeting for OBS—Don Farrell, WDSIP
  - 5:00 P.M. Demonstrations, by Radio Manufacturers
  - Arrangement—H. T. Barker, WSAD

- **6:00 P.M. DINNER-“DUTCHE”**
  - 7:00 P.M. General Session—H. T. Barker, WSAD
  - Test Receptions—Don Farrell, WDSIP
  - Broadcast Interference—J. V. Brotherton, W5RBN
  - Radio Examination, Fitalls—M. W. Grinnell Radioslip Inspector

- **10:00 P.M. Telephony, (actual demonstrations)
  - Dr. J. O. Perrine, Amer. Tel. & Tel. Mid-Nite**

- **Saturday — June 25, 1932**
  - 8:00 A.M. Registration (open until Banquet time)
  - 8:00 A.M. License Examinations, (amateur only) by W.M. Grinnell, Radio Inspector

- **2:00 A.M. Demonstrations, by Radio Manufacturers
  - 5:30 A.M. Musical Transmitters—L. D. Geno, WAPE
  - Radio Amateur—John J. Long, Jr., W6AAB-WSXBA
  - Broadcast Interference—J. V. Brotherton, W5RBN

- **12:00 M. LUNCHEON-“DUTCHE”**

- **6:30 P.M. BANQUET**
  - Toastmaster—Dr. Burton T. Simpson, W8HA
  - Fire郢: John W. H. Allen, Attorney at Law
  - Dr. Eugene C. Woodroof, ARRl Director
  - Mr. Milton W. Grinnell, Radio Inspector
  - Mr. A. A. Herbst, ARRl Treasurer

**Calls Heard**

W6CWW will list R-9 reception of Calls Heard at Oakland, California, each month in these columns. Only those stations whose signals are readable through local QRN, with QSA 4 to 5, and R8 to 9, will be listed, in order to give the owners of these stations an opportunity to judge the strength of their signals on the Pacific Coast. On May 5th, 6th or 7th, the following were reported R-9, loudspeaker reception, through local QRN, 80-Meter Band: VK4UJ, W1BIX, W9CGW, W9GQC, W9GDI, W9FYC, W9JJQ, W2BAS, W2BOY, W8JE, W3CIN, W7AKE, W6JHO, W6DWE, W6HYX.

A long list of calls-heard will appear in the next issue. QRX for yours. The calls were received on a Wallace receiver. For other types of receivers will be in operation in time to list all calls for the next report.

**Some Fine 80-Meter Reports**

(Heard on the Morning of May 15th in San Francisco.)

The operator on duty at the San Francisco "listening post" of "RADIO" overheard the following QSO's, and reports as follows:

W2EQ (to W6CWU). The signals from W2EQ were R8, through heavy QRN. However, the frequency varied slightly and several readjustments of the dial were necessary. W2EQ copied through W6CWU, W3CVQ... calling QO, several 6's came back, but were not answered by W3CVQ. The signals from W3CVQ were easily R9, plus, on loud speaker. This is one of the strongest Eastern signals heard on the Coast this season. W8HA (to W6CWU). A steady, powerful signal from Detroit. FB note, easily copied through heavy QRN. This signal R-8, loud speaker reception. Entire QSO copied. FB, W8HA.

W5DK (to W6CWU) R-9 plus signals, on loud speaker. Strongest Canadian signals heard in San Francisco this month. W5DK is a newcomer. For the next day for the walk and calls himself a "lbid." Not so, not so, W5DK... you're 100% OK. You can be proud of your signals and your QRI is all FB, SUCCESS!

W6IMP (to W6CWU) ... says he: "You are the first ham who welcomed me into the royal order of brassbounders." Well, W6IMP, when I heard you say that, it made me laugh back to 1907 when I first started in ham radio. The old-timers wouldn't chat with me, either, and I used to howl in shame when I heard the speed-burners talking to others and pass me up like a pack of dogs. Nothing makes me quite so much as when I 'connect' with some one who tells me—this is my first QSO. I'll never forget the days when the first ham answered me. I had a Ford spark coil, a storage battery, a zinc spark gap and a glass-plate detector. For QSO of W6IMP was with a fellow two blocks away and he walked to my house to tell me how "punk" I was coming in. It required six months before I was able to talk with a 1W2 ham. He had six blocks away. That was distance in those days. Look for my column in the next issue, I'll have more dope. I'm on 80-meters only. Been too lazy to change the coils for other bands. 73 to all whom I heard this morning "Listener-In."
S O MANY antenna designs have been proposed for the 160-Meter band that the reader becomes confused in his decision as to the best all-around antenna to use. A single wire, 132 feet long (or half this length) is commonly used by amateurs who are getting best results on the 160-Meter band. In addition to this antenna a single wire "counterpoise" (ground system) is used. This counterpoise is simply a 66-foot length of wire (or half this length if the antenna wire is 66 feet long) run in any direction, about 6 feet or more off the ground. The counterpoise can even be run at right-angles to the antenna wire. Both wires should be #12 enameled copper. A variable condenser, about 1000 μfd, is connected in series with the antenna wire and the antenna coil in the transmitter, and is used to tune the antenna.

A New Short-Wave Tube
(Continued from Page 6)
be replaced by this new tube, by providing a separate filament supply. This supply may be a small 2-volt storage cell, or two dry cells connected in series and provided with a 20-ohm resistor for reducing the voltage to 2 volts. The current drain is very small, so the battery will last a very long time. The time spent will be well repaid.
2. Remove the plate lead connecting with the tube socket, lengthen it if necessary, and fasten an ordinary screen-grid clip-cap connector to it.
3. Put the tube in the socket and clip the cap on the top of the tube.
No other changes are necessary. You will be pleasantly surprised at the increased sensitivity of your set when using the new tube. Remember, when building a set to use this tube, that the plate connection goes to the cap at the top of the tube. Other connections are exactly the same as for common Type 50 2-volt tubes.
The efficiency and sensitivity of superheterodynes, oscillators, regenerative receivers, vacuum-tube voltmeters and other laboratory apparatus, as well as ultra-short-wave sets will be increased by using this new tube. Increased results will be obtained by replacing any common detector tube by this new tube.
This tube is now being manufactured by the Triad Manufacturing Co., Inc.

The Complete Short-Wave Radio Course
(Continued from Page 12)
2. Displaced lines exert a force. When they are close together, the lines are closer together and there will be more of them displaced to cause force. The force exerted will therefore be greater. The force between electrons may be said to be greater near them because the fields are stronger. Two electrons "repel" each other as it is called, and the repulsion between them depends on their distance apart, becoming greater as the distance between them is decreased. Of course, if a number of electrons are brought close together, there will be forces exerted between all of them.
This is the end of the first lesson. The second lesson in this series will appear in the next issue of this magazine. Don't miss it! A complete course in short-wave radio from the very beginning! We appreciate constructive criticism. Do you wish longer lessons?

E. M. SARGENT
ANNOUNCES

—a New Shop and Testing Service for Amateurs.
—Short-Wave Sets Built to Order . . . Tested and Repaired.
—1931 Sargent Sets Rebuilt into Modern 16-Tube Circuits.
—Single-Signal Supers—QST Circuits Tested and Built.
—Estimates Gladly Given on all Work.
—See Next Issue of "RADIO" for Announcement of Sargent 6-Tube and 16-Tube Receivers.

E. M. SARGENT
721 McKinley Ave., Oakland, Calif.

RADIO FOR JUNE

www.americanradiohistory.com
BARRETT-MICALITE PRODUCTS

EXTREMELY LOW-LOSS COIL FORMS, SOCKETS, CRYSTAL-HOLDERS

A new coil-form, manufactured to supply the needs of the most exacting experimenter. Finest low-loss material. Moulded from mica and bakelite. Highly polished. Will not absorb moisture. Beautiful in appearance. Exceedingly large winding space (35”). Complete with black leads. If you want more efficiency from your receiver try a set of these coils. Sold by good dealers. If your dealer has no stock, write us direct.

S.S. & POWER CRYSTALS

The new BARRETT crystals for single-signal super-heterodyne and for transistors are known for their unusually large power output, for their precision in manufacture and for their accuracy. Power crystals, ground to my frequency in the 45-meter band, to within 0.05%, accuracy, $8.00, net. For 124-Meters, $9.00, net. For 240-Meters, $12.00, net. For 480-Meters, $14.00, net. Full 3” square “T” cut from best Brazilian quartz. Price per type Crystal Holders, moulded from mica, dust-proof, 90c, net. Direct order solicited.

BARRETT MANUFACTURING CO.
1392 Sixteenth Avenue
San Francisco, Calif.

RADIO FOR JUNE

World's Youngest "Ham"
(Continued from Page 7)

until I sent her an SOS signal which she took without the slightest trouble in the world."

Jean was required to draw a circuit diagram of an amateur radio transmitter and receiver, to explain the function of the apparatus and to answer questions on the radio laws and regulations.

She is a normal child; plays the violin in the school orchestra and is also a trumpet player. She is in the 3rd grade.

Jean's father has been a telegraph operator for 25 years. He is an ex-railroad train-dispatcher for the P.R.R. He has been an amateur for many years and is well liked by all his radio friends.

Amateurs in the vicinity of Laurel, Delaware, say they liked the O.M. even before they met him in person. He can copy fast as

An A.C.-Operated OSCILLATOR
For Only $16.80
Housed In Cast Aluminum Case

VENTURY
"Model K32 Oscillator"

A service man without a reliable Oscillator is a doctor without a stethoscope.

A MODULATED Service Oscillator to meet the exacting needs of the Radio Shop and Service Station. All electrical components are built with plenty of safety factor—may be operated indefinitely. Beautifully finished black crystal base. Heavy cast aluminum housing to insure maintenance of calibration.

ELECTRON-COUPLED—to maintain constant frequency regardless of line fluctuations.

Direct calibration of dial to fundamental frequencies, eliminating the confusion of harmonic selection. May be used as a harmonic generator for locating what wave bands.

Utilises the sturdy UY 224A tube.

Scale No. 1, for Intermediate frequencies—130 K.C. to 380 K.C.

Scale No. 2, for Broadcast frequencies and high Intermediate—490 K.C. to 1500 K.C.

One hundred per cent A.C. operation from 110 to 127 volt line. Six months' factory guarantee.

$16.80 Net Price (less Tube)

VICTORY SPEAKERS, INC.
711 E. 14th St.
Oakland, Calif.

The New Super Dwarf
A dynamic speaker that supplies the demand for a compact and efficient reproducer of very small size. This new and powerful "Dynamo Speaker" has been designed for maximum efficiency, in spite of its size. It is known as VICTORY S.D.1.

TONE FIDELITY

Tone Fidelity of an extremely high order has been accomplished by careful engineering and precise production. It is only 1 inches in diameter and 2 1/4 inches deep. Capable of reproducing volume and audio range. Field excitation requirements are from 2 to 4 watts. It can be supplied with output transformers to match specified tubes.

AUTOMOBILE SPEAKERS

Automobile and other types of standard dynamic speakers are also manufactured by VICTORY. There are sizes of 6", 8", 9", 11", 13" and a new 19" model for auditorium purposes and for outdoor public address use. Also a complete line of manufacturer's types for installation in high-class receivers. Automotive Speakers of all standard sizes. New type Power Speakers and AC Speakers for public address systems. Cutting -on new line of Victory speakers for handling continuous output when used with the latest amplifiers, Class B and Class A Prime.

Write for Complete Information

VICTORY SPEAKERS, INC.
7131 East 14th Street
OAKLAND, CALIF.

31/2" winding space. Easily drilled. One of the most efficient coil forms known. $4c, 4, 5, and 6-prong types. Mica-like Sockets to match, 4, 5, 6 or 7-prong. 48c, net.

3/8"

IEEAC

VICTORY

Universal Battery Converter

A motor-driven converter of maximum possible efficiency operating from storage battery. Provides 60-60 cycles AC at an outlet which may be connected to any 110 volt device . . . amplifiers, Neon signs, flashers, portable transmitters, sound trucks, boats, yachts, airplanes, radios, etc.

Made in two sizes as follows:

Model 60, 60-watt output. operates from 6-volt battery

DEALERS NET $16.80

Model 150, 150-watt output, operates from 12-volt battery

DEALERS NET $36.00

Stocked by Jobbers Everywhere

UNIVERSAL MICROPHONE CO., LTD.
Inglewood, Calif., U. S. A.

W3QCS

Ed. Thompson at his operating table. His station is an outstanding example of neatness and efficient arrangement of equipment.

"LIKE FATHER, LIKE SON"

Amateur Radio Station W3BAK, W3AXP. Dad's portion of the rig is at the right, Ronald's at the left. Dad signs W3BAK, son signs W3AXP. 14-year-old Ronald uses his outfit to keep in touch with home while he is at Boy Scout camp.
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