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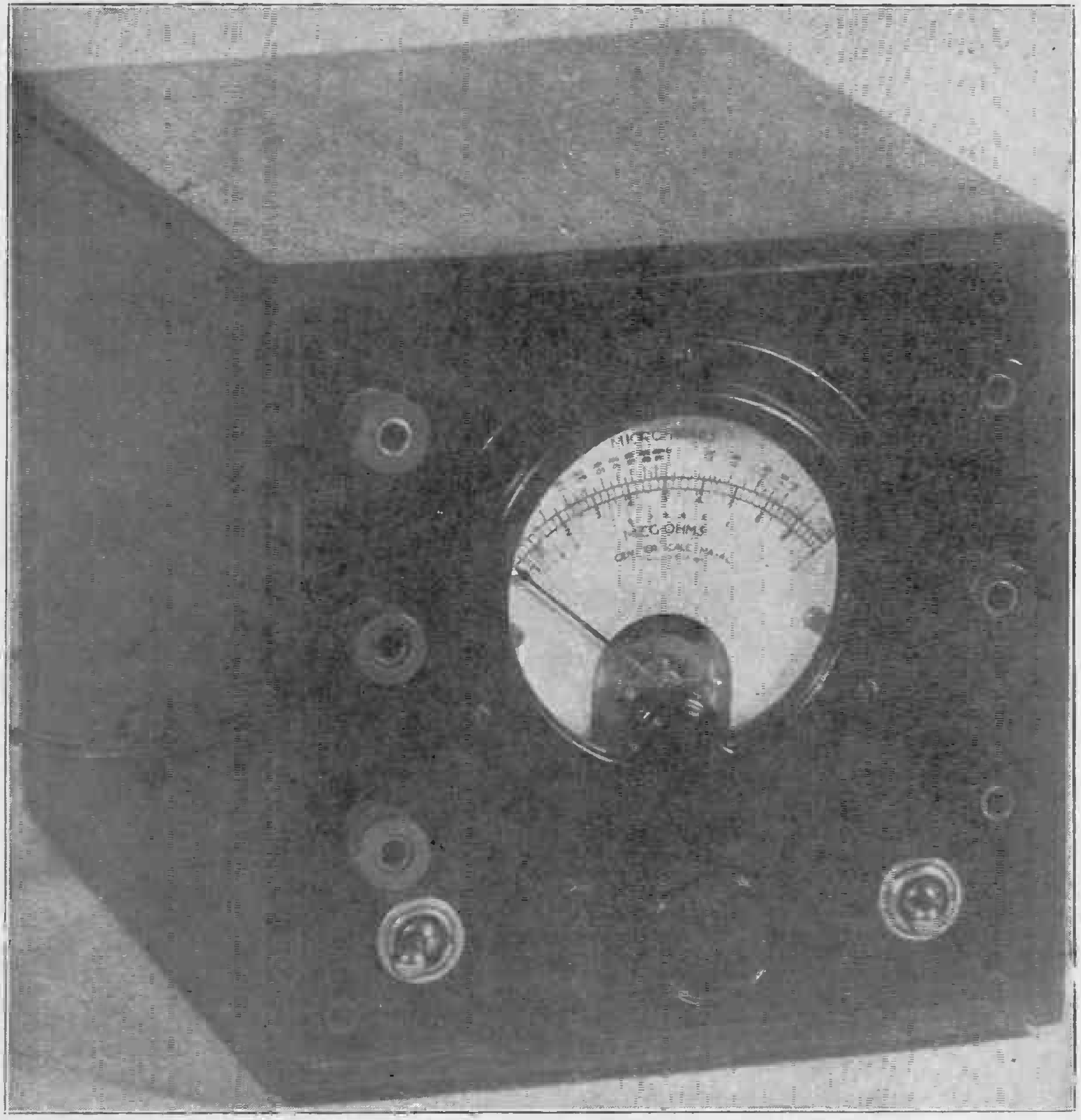

A resistance-capacity meter. See page 3.

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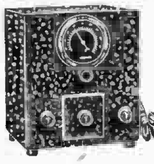

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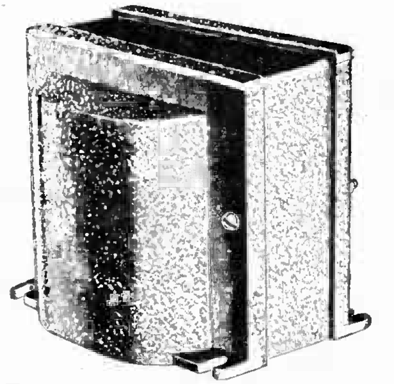

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"The Inductance Authority"

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

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

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

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

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

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

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

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

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

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

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

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

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THIRTEENTH YEAR

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Resistance-Capacity Meter

Direct Reading Instrument, for 0.0001 Mfd. to 10 Mfd. and 50,000 Ohms to 10 Meg. Designed by Edward M. Shiepe

By Calvin L. Woodstock

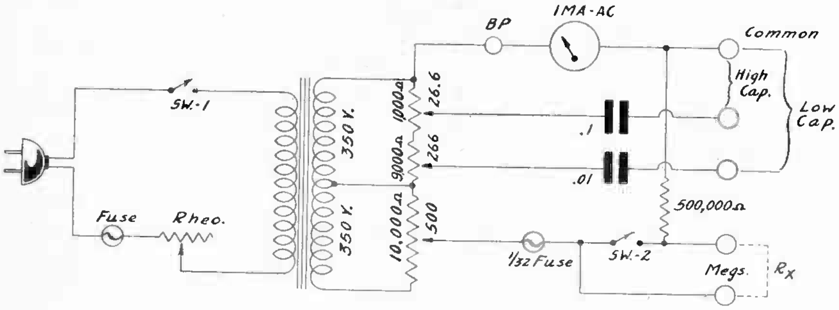


FIG. 1

The circuit diagram of the direct-reading resistance-capacity meter developed by Edward M. Shiepe.

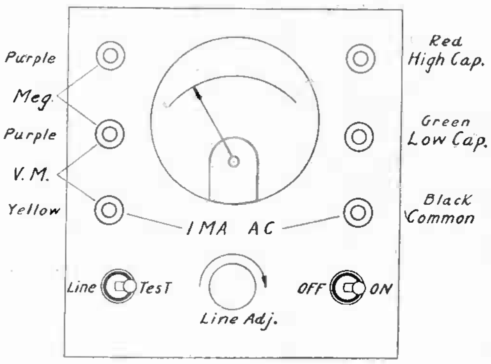


FIG. 2

Sketch of the front panel together with the color code for the terminals.

THERE are countless methods of measuring resistance, capacity, inductance, and other electrical quantities, but most of them require a certain amount of arithmetical work before the desired quantity is known. Nobody wants to use such a method, first, because of a common aversion against mathematics, and, second, because of the inconvenience of stopping in the midst of an experiment to compute that which should have been observed at a glance. The only satisfactory type of instrument for any routine measurement is a direct-reading one.

Almost any meter can be made direct-reading if the necessary trouble is taken to prepare a scale which will make it so. Take, for example, the resistance-capacity meter developed by Edward M. Shiepe and shown as to circuit in Fig. 1. This diagram is the circuit of a direct-reading meter of two ranges, megohm meter of one range, and a 0-1 a-c milliammeter.

The Scale

Such a circuit in conjunction with a properly-made scale on a suitable milliammeter will be direct reading. The scale for this particular instrument is shown in Fig. 3. In reality it contains four scales on one dial. The bottom scale, reading from right to left, is for megohms; the main, or center, scale, reading in the conventional direction, is for alternating current milliamperes; the two upper scales are for capacities, one scale being ten times that of the other.

The useful resistance range is from 50,000 ohms to 10 megohms, the current range from zero to one milliampere, and the capacity range from 0.0001 to 10 mfd. This capacity range is so wide that practically all capacities that are likely to occur in radio receiver work will fall within it.

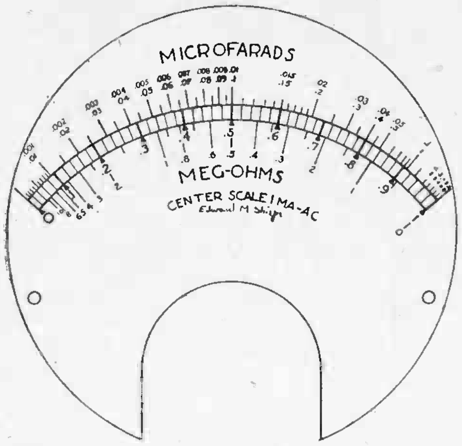
The scale in Fig. 3 has been hand calibrated with high accuracy. First it was laid out on a large sheet of paper and then the drawing was reduced to the required size of the face of the meter, the actual reduced size being that of the illustration.

Adjustment of Circuit

The correctness of the readings will depend on the line voltages, and it is necessary to ascertain that the voltage as impressed on the primary of the transformer is the same every time as it was when the data for the scales were observed.

FIG. 3

Scale for the resistance - capacity meter. The top row is for 0.0001 to 1.0 mfd., the next lower one for 0.001 to 10 mfd., the center one for current and the lower one for 50,000 ohms to 10 meg.



Since the voltage of the line will vary from day to day and from hour to hour, a rheostat is connected in series with the primary for making adjustments. Regardless of what the line voltage may be, within the limits of probable variation, it is possible by means of the rheostat to adjust the primary voltage so that it is always the same. The equality is tested by depressing a switch, Sw1, and making an observation on the milliammeter. If the reading has deviated from the standard, the rheostat should be adjusted until the normal reading is brought back. This test should be made just before every other reading, or frequently when many readings are made in rapid succession.

While there appear to be three potentiometers in the circuit, Fig. 1, they are not such in the sense that they are available for adjustment from the dial. They are for primary adjustments of the meter and should never be tampered with.

Sw2 is a safety switch, for it cannot be left on. As soon as it is released, it will snap open. Such a switch can be made out of a regular toggle switch by removing one spring.

Capacity Measurements

The two upper binding posts on the right in Fig. 1 are for high values of capacity. The applied voltage is 26.6 volts, effective value, and there is a 0.1 mfd. condenser in series with the circuit. The scale for this circuit runs from 10 mfd. to 0.001 mfd. The upper right post and the third are for small values of capacity, from 1 to 0.0001 mfd. In this circuit the applied voltage is 266 volts, effective value, and there is a 0.01 mfd. condenser in series.

The two lowest binding posts in Fig. 1 are for resistance measurements. In this circuit there is a voltage of 500 volts. This should be adjusted so that the milliammeter reads full scale when Sw2 is closed, that is, when Rx is shorted, and when the primary voltage across the transformer is the normal value. To make this adjustment initially requires additional equipment, unless an arbitrary primary voltage is used. This will work if it is adhered to. Since the voltage in the circuit is 500 volts and the milliammeter should read full scale when Rx is shorted, there should be a 500,000-ohm multiplier resistance in the circuit.

Milliammeter Application

On the left of the milliammeter in Fig. 1 is a binding post marked BP. The object of this is to permit the milliammeter to be used independently of the rest of the circuit. If an alternating current, not exceeding one milliampere, is to be measured, it can be done by utilizing the BP and the common terminals. The meter can also be used for measuring high alternating voltages, not to exceed 500 volts. If a voltage is to be measured, it is applied across the BP and the upper of the Rx terminals. Using this terminal throws the half-megohm resistor in series with the voltage.

The a-c milliammeter is protected by two fuses and one spring-back toggle switch. The first fuse is in the supply line and is a general protector. The second fuse is a 1/32-ampere little fuse which is used especially to protect the meter against accidental overvoltage. Sw2 is also a protector in a sense. There is not protection for the meter when it is used either for current or voltage measurements, and customary precautions must be taken.

Construction

The front cover illustration shows a panel view of the assembled and completed instrument. In this, the knob directly below the milliammeter controls the primary circuit rheostat, the switch at the lower right corner controls the primary current, and the switch at the lower left corner controls the short across the unknown resistance. The upper two binding posts on the left give access to the resistance meter, while the lower two give access to the 0-500 voltmeter. That is, the middle of the left binding posts serves twice. The lowest on the left is BP and the lowest on the right is the common. Hence these two are the terminals for the milliammeter.

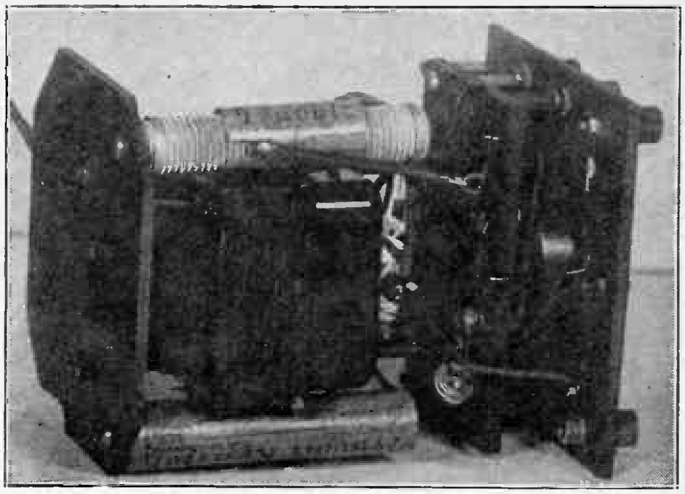


FIG. 4

An internal view of the finished instrument, showing the locations of resistors and the transformer.

The highest and the lowest posts on the right serve the high capacity range meter, while the middle and the lowest serve the low capacity range.

Fig. 4 shows the tester with the box removed. In this the locations of voltage transformer and some of the potentiometer resistances are indicated. Small parts are held on a shelf under the meter but mounted by means of brackets to the main panel. The dimensions of the panel are 5x5 inches. The box in which the tester is housed is 5x5¼x7¼ inches, and is made of ply wood. A sketch of it is given in Fig. 5.

Switch Standardization Attempted

The efforts to standardize on a switch for shifting to different wave bands have not been completely successful, one reason being that the switch somewhat dictates the circuit, and it always has been hard to get a group to agree on a circuit. However, there is a recognition of some technical requirements in the more or less standard all-wave switch now being offered by some manufacturers.

One example viewed consisted of two widely-spaced decks at front for the oscillator plate and grid windings. The idea was to keep them as far away as possible from the other decks, to avoid unintentional coupling. Then the switch has three more tiers, for one primary and two secondaries, for short waves. But one of the tiers permitted double-contacting for one band, or five positions on one side and five on the other, of the same tier, for simultaneous positions. The purpose was as follows:

For broadcasts a stage of t.r.f. was necessary, for short waves not quite so necessary. By using tuned impedance for broadcasts the extra side of this double tier was worked without requiring an extra deck on the switch. The moving arm was a blank for this side on short waves, hence the antenna moved over to the short-wave coil.

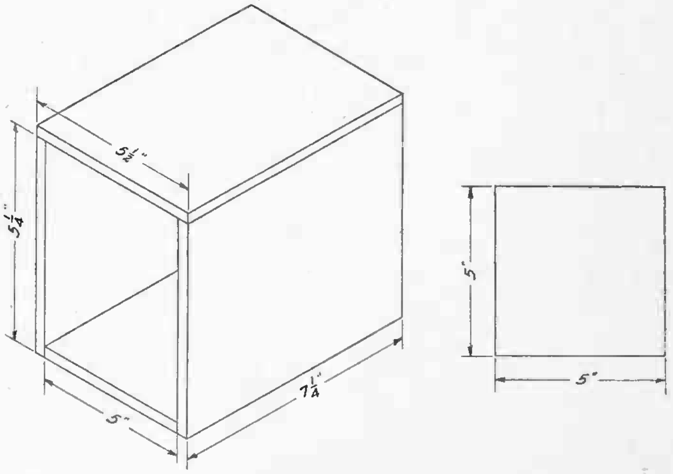


FIG. 5

Dimension drawing of the plywood box in which the resistance-capacity meter is housed.

Resistance, Capacity, Voltage

Temperature, Moisture, Inductance, Parallax Affect Oscillator Frequency

By J. E. Anderson

THE inter-electrode capacities are not the only variables that account for changes in the frequency of an oscillator. The grid and plate resistances also enter into the frequency of oscillation, not in a first order manner like the inter-electrode capacities, but nevertheless in an appreciable way. These resistances change considerably with temperature, which may change because of variations in the ambient temperature, in the filament supply, in the plate supply, and in the amount of power drawn from the circuit.

Resistance Variation

Changes in the inter-electrode capacities and in the tube resistances are most noticeable in an oscillator because there are concomitant changes in frequency, but they are also present when the tube and tuner are used in an amplifier. The fact that the frequency changes shows that the frequency of resonance changes, and the change is just as great when the tuner is used for a radio-frequency selector as when it is used as a frequency-determining resonator. The consequences, however, are not so great, for when a small relative change occurs in the frequency of resonance in a radio-frequency tuner there is only a slight change in the intensity of the received signal, but when the same change occurs in the high-frequency oscillator in a superheterodyne, it may be sufficient not only to tune out the station desired but to tune in some other station. Indeed, there may be several stations between the one desired and the one on which the tuner finally settles. Especially is this the case when the signal frequency is very high.

In view of the importance of a high stability of frequency in short-wave oscillators, every precaution should be taken to secure it. First of all the circuit as a whole should be operated so that the changes in the voltages on the oscillator are as small as possible. That is, there should be no change in the filament or heater voltage, no change in the plate voltage, and no change in any other voltage on the tube. In many ultra-high frequency circuits the stabilizing means are about exhausted when these precautions have been taken, but in lower frequency circuits there are many additional means for stabilizing the frequency.

Other Variable Factors

All changes in the resonant circuits are not due to changes in the capacities of the tubes. One other source of variation is the self-inductance of the conductors inside the tube, those which are subject to the same temperature variations as the capacities. As a rule, an increase in the temperature will increase the inductance of a conductor or of a coil, and for this reason the frequency of resonance will decrease. In an oscillator the frequency of oscillation will decrease from this cause. However, this variation is not invariable in either the inductance or the capacity. Other causes of change in the resonant frequency are the condenser and the coil in the external circuit; and these may be very complex for even shielding material in the neighborhood of the resonant circuit will affect the capacity and the inductance.

In nearly all tuners there is a compression type trimmer condenser in shunt with the main tuning condenser, and with the coil. This trimmer rarely retains its capacity because changes in moisture and temperature will change the tension or the compression. When the tension screw lengthens as the temperature increases, as it will, the electrodes separate a little and the capacity decreases. The change is particularly large if the tension is very large, that is, if the capacity is set at maximum. Changes in the trimmer condenser capacity are especially serious on the high frequencies, for then the trimmer capacity is a large percentage of the total.

Even the tuning condenser capacity changes with temperature. So does the self-capacity of the coil, and the inductance of the coil, and the capacities of so-called fixed condensers which are used for stopping a direct current or for by-passing. It might be argued that it makes no difference how the capacity of a stopping or by-pass condenser changes when that condenser is not in the resonant circuit. To the extent that the condenser is not in the resonant circuit it makes no difference, but the fact is that all inductances and capacities in the circuit are in the resonant circuit, not directly or in full, perhaps, but indirectly and in part. The change of any capacity, or inductance, or resistance in the circuit will affect the resonator in some degree. Under certain conditions that degree may be vanishingly small, but under others it may be large.

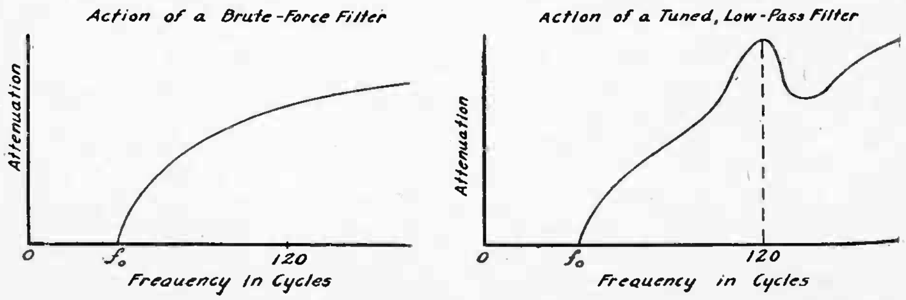
Fixed capacity condensers, those with mica as well as paper dielectric, vary in capacity both with respect to temperature and moisture. In either case the separation between the electrodes is changed, the dimensions being increased with increased heat or moisture.

That the frequency changes in a high frequency oscillator or radio-frequency tuner may be considerable is often seen on calibrated tuning dials. The calibration may be done accurately one day, yet the next it will not be correct. A check on the temperature and humidity will disclose that either or both have changed.

In calibrating a dial it is important to take account of any possible parallax between the fixed index and the scale gradations. If there is considerable distance between the two, it is necessary to read the scale from exactly the same point of view every time, for if the eye moves one way or the other the reading will be different. If the calibrated device is one of high precision, precautions must be taken to avoid errors of parallax, either by removing the parallax or by rendering it harmless. It is removed by reducing the distance between the index and the scale zero, which may be done exactly by optical means and very closely by mechanical means. If it is not practical to remove the parallax it can be rendered harmless. One way of doing this is to mount a mirror under the scale so that the index or pointer is reflected. The line joining the index and its image always cuts the scale at the same point, and this point is read when the eye is fixed so that the image is eclipsed by the index. Still another way is to have a thin, knife-edge point and then place the eye so that the pointer appears thinnest. The thinner and wider the pointer is, the less troublesome will be the parallax. Quite often the mirror and the knife-edge point are used together, but if this is to be better than either alone, it is necessary that the plane of the knife-edge be at right angles to the plane of the mirror.

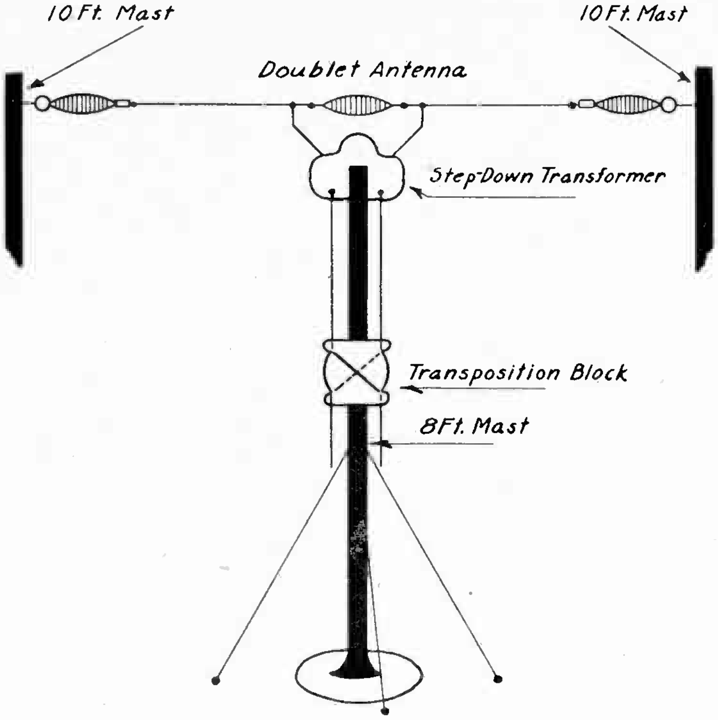
Increased Attenuation Shown in Curves

The curves herewith compare the brute-force filter to the composite filter that has a capacity tuning choke, besides condensers across the line. The brute-force, or common, method produces a regular curve. The tuned-choke aid is shown by the increased attenuation in the critically desired region of 120 cycles for a full-wave rectifier. Note how much higher up the attenuation factor is with the tuned choke method at right. Otherwise the curves would be equal.



The attenuation characteristic of a brute force section (left) and of a composite filter (right) having one section tuned to the hum frequency.

All Eyes on Antenna for Improved Results



The doublet antenna with method of outgoing connection.

The spotlight of interest moves along the radio receiver from time to time, and finally it lights on the antenna and stays there for a while, as it is doing now. The antenna is getting more publicity than any other part of the set or equipment. The all-wave antenna systems are partly responsible for this, but also are the special antennas for short waves, including doublets. And, despite this, a great many persons do not know what a doublet is. It consists of a uni-directional wire interrupted at center by an insulator, the take-off being from the ends of this central insulator. The other extremes of the wires—or there are really two separate wires of course—are held up by poles or masts. The leads from the terminals at center are twisted or otherwise transposed, as diagramed, and brought to the receiver, which would have two ungrounded coil posts for the connection.

All antennas have inductance, capacity and resistance. As a rule inductance is good, capacity is so-so and resistance is bad. This is a sort of street-corner discrimination about scientific constants, yet there is much truth in the matter-of-fact characterization.

The Analysis

Inductance is good because it is used as a parallel adjunct, hence supports input, builds up signal strength, makes for voltage amplitudes. Capacity is so-so because so much of it is present that we do not want, as for example as it appears across a coil as distributed capacity, even though we introduce an adjustable capacity and call it a tuning condenser. The tuner is the good, hence the mixture of good and bad makes for the so-so condition.

The resistance reduces the voltage, the selectivity and the efficiency, and is an expression of the circuit loss, hence is a bad thing, the only exception being in the case of the transmitter. Then it is desired to put forth as much as possible into the ether. The oscillator is set going and the current measured. Then the antenna is connected and the current is measured. The current has gone down. Perhaps it is necessary to put out more oscillator power to atone for this decline. Anyway, the reason the current has declined is that the antenna resistance has been introduced, and it is desirable in a transmitting antenna to have this as large as practical, for it is a measure of the radiation.

Most Loss, Most Gain

One may regard the radiation as a loss from the oscillating circuit, so the greater the loss, the greater the gain, if you get what we mean.

Otherwise—and few of us are concerned with transmitting antenna problems—we want the antenna resistance low, all resistance to radio frequencies low as can be, because then we get more out of the set. How can we help reduce the resistance?

In the diagrams R represents resistance, C represents capacity and L represents inductance, the conventional symbols. In A we have an antenna connected to a coil across which is a tuning condenser C, one side of L and C grounded. It has been stated that capacity is so-so, good in some respects, not so good in others. But the Marconi antenna, which is the grounded type commonly used, or the dipole, or ungrounded type, as represented by the doublet, provide pickup of transmitted signals because of their capacity. These antennas are condensers, the upper branch being one plate and the lower branch the other. What is the lower branch? Why, ground is. The carriers sweep along the ether—whatever the ether may be—and when they encounter a condenser consisting of antenna (upper plate) and ground (lower plate) the current or voltage fluctuates between these two, and a coil in parallel picks up this energy and transfers it along the receiver.

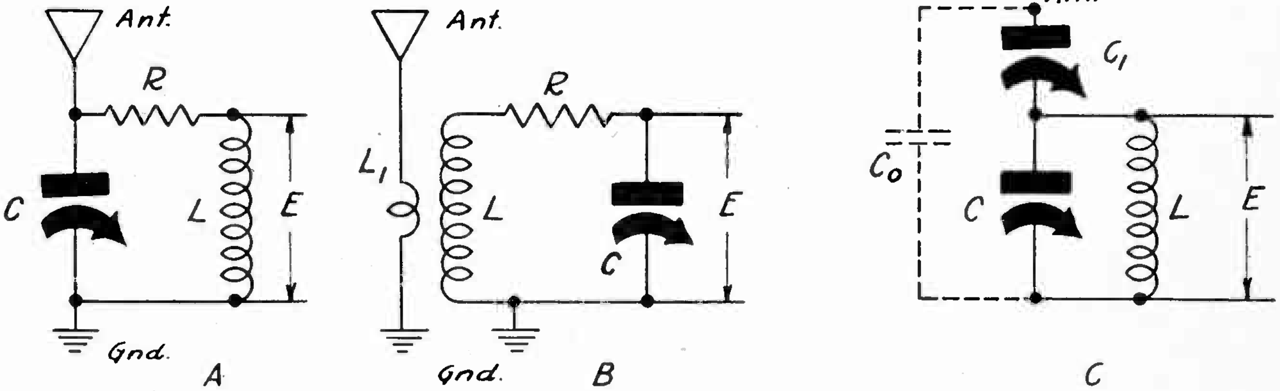
In A the antenna voltage fluctuates across the tuning condenser, across the coil which is substantially in parallel with that condenser, and of course across antenna and ground, which too are in parallel with the tuning condenser. R represents the resistance of the coil. E is the voltage across the coil.

If there is a transformer, with L1 the primary and L the secondary, as in B, again the coil has resistance represented by R, the condenser C also has resistance, and the voltage across the tuning condenser C. The antenna capacity again is in parallel with the tuning condenser, although this time the quantity of the effective capacity is not so large, because only the reflected capacity is present, that is, direct inclusion does not prevail.

Reduction of Resistance

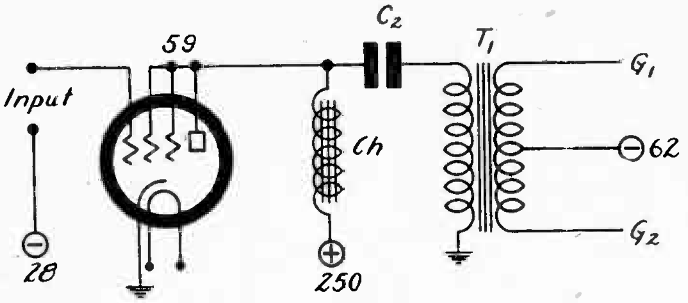
In C we find Co, the antenna capacity,

(*Continued on next page*)



The antenna circuit has inductance, resistance and capacity. In A the tuning capacity is principally the condenser, C, but the antenna capacity is in parallel with it, and the coil resistance is represented by R, which also has some effect on frequency. In B a transformer is used, otherwise the same conditions prevail as in A. In C the antenna capacity is Co while C1 is the "shortening" condenser, that electrically shortens the aerial by reducing the capacity.

45 Push-Pull Output O. K. for Latest Receivers



The 59 used as a triode has the extra grids tied to the plate. The 56 would do just as well as a driver for a pair of 45's in push-pull.

How many watts can you get out of the 45 push-pull power stage? Can you get out enough to permit use of these output tubes in up-to-date receivers?

The output may be 12 to 19 watts, percentage of total harmonic distortion not exceeding the allowable 5. The plate voltage is 275 volts. The bias values will differ, depending on uses and conditions, but anyway the total B voltage is obtained by adding the cathode-to-plate and cathode-to-control grid voltages.

The ordinary uses permit an output of around 12 or 13 watts from 45 push-pull. The higher values of output result from Class B and Class AB, or overbiased Class A. The Class B condition exists when the plate current is reduced to a few milliamperes at no signal input, due to heightened negative bias. The Class AB condition is where the bias is about half way between Class B and Class A. The Class A condition is the one shown on all tube characteristics charts, with overbiased Class A mentioned also in those lists.

56 Serves Good Purpose

In any instance where large output is to be obtained from 45's there should be a driver stage. This usually consists of a 56, or, if the tubes prior to the 45's have 6.3-volt heaters, a 76, which is the automotive series equal to the 2.5-volt 56. It is possible also to use a pentode as a triode, but there is no special advantage, unless one has the pentode and not the triode, and wants to avoid buying another tube. The 59 would be used. Both the 56 and the 59 have heater-cathodes, and therefore hum is kept low. Also, the plate impedances of these tubes are low, hence good quality reproduction may be obtained with transformers of reasonable primary inductance.

If for any reason the operating inductance of the primary is desired to be upheld, or relatively increased, parallel feed may be used. This consists of keeping the d.c. out of the primary, either by using a choke and stopping condenser, or a resistor and stopping condenser. The choke must be of the audio type and besides should be as good as the transformer itself in its characteristics. That is, if you have a high-grade transformer, and a poor-grade choke, the total result will be no better than that allowable by the choke. The diagram represents the use of a choke, with the 59 as triode driver of push-pull 45's, the negative bias on the 45's being 62 volts, and on the 59 tube minus 28 volts. Therefore the B voltage between B minus and the plate return is 28 + 250 or 278 volts. When the 45 tubes are considered, if 275 volts or so are mentioned for B voltage, the bias must be considered additional or extra, so for 275 and 62 the total B from minus to plus would be 337 volts.

Fixed Bias Preferable

It is better to used fixed bias on the output stage, although self-bias on the driver stage does not change the distortion result in any serious manner. Fixed bias would be such as arises from the use of batteries, or a separate C supply. The next best thing would be a combination, resulting in semi-fixed bias, where all the plate current in the set, plus some bleeder B current of the supply, are used for bias due to potential difference across a resistor, hence the signal does not produce so much of a B current change, and particularly if the signal increases the negative bias, as when the choke is in the negative leg and the semi-fixed bias is derived from a tap on the choke, usually the speaker field.

The input transformation ratio should not exceed 3.5 to 1, primary to one-half secondary, and may be as low as 1.3 to 1. The negative bias values affect the plate-to-plate resistance requirements of the speaker's output transformer. Where the bias is higher than usual, the ohms load should be higher, plate to plate, and self-bias always requires a higher plate-to-plate ohms load than fixed bias. Fixed bias may require as low as 4,000 ohms where self-bias for the same tubes and voltages might require 7,300 ohms. The higher load is required for self-bias so that the plate-current swings will be limited, distortion reduced, and the plate current saved from total stoppage during negative sweeps of the signal, which is merely a detailed example of the previous statement of curtailment of distortion. Tube manufacturers can supply plate-to-plate load requirements.

Since the output is well handled when the load conditions are best, and assuming that one has a speaker, perhaps the ohms load of which he does not know, there is a way of approximately matching the receiver to the tubes and circuit, especially in view of the already-discussed large difference in load requirements.

Grid Current

If 60 cycles as taken from the line, or 120 cycles as taken from a full-wave rectifier, are used as signal to the driver, and speaker connected to the output circuit, a few volts being put into the driver grid as from a potentiometer across the line, the negative bias may be adjusted until the 60 or 120 cycles are heard loudest in the speaker, consistent with a negative bias large enough to limit the plate current to the safe value, say, not more than 40 ma. This also makes the filtration requirements more severe, because the tonal response is improved in the low-note region, where the hum frequencies are.

When the 45 tube is used at more than 4 watts or so, there is grid current, practically under all operating conditions, and it is desirable to limit this grid current to 2 milliamperes or less. At 5 per cent. total harmonics in the output, the grid current is usually around 1.25 ma per tube.

Series Condenser Reduces Resistance, Aids the Antenna

(*Continued from preceding page*)

measured between antenna and ground. C1 is a series antenna condenser. Looking at the tuned circuit, CL, across which is the voltage E, the effect of the antenna capacity upon the tuned circuit is reduced, the smaller the capacity of C1, the series condenser. Since the frequencies of present-day receivers are various, from broadcast to high short-wave frequencies, naturally an adjustment of equivalent antenna capacity is desirable. For high frequencies small capacities are required.

Particularly in regenerative receivers the antenna series condenser should be included, for it has the effect of reducing the antenna resistance, as well as antenna capacity. In general, the condenser would have small effect on the broadcast band, because too small in capacity. About 50 mmfd. would be amply large for any short-wave use.

By using such a condenser it is easy to get rid of dead spots, or avoid them totally, and this is true whether the condenser be continuously variable, as the diagram suggests, or whether for each band there is the proper value of fixed condenser, or if a scheme is used, as the one shown in last week's issue, where a switch-type receiver has the stops represent fixed capacities derived from a variable condenser the shaft of which is united with the shaft of the coil switch.

Foot Police Using One-Tube Portable

Individual portable radio equipment recently was put into use by the police of Los Angeles, Calif.

These tiny one-tube sets are strapped on to a specially-designed Sam Browne belt which carries an aerial sewed into the shoulder strap. An earphone is attached to the policeman's hat and he is in constant contact with the central station by a short wave. The set uses a National Union type 30 tube.

NEW MICROPHONE FINISH

A silvered crackle finish will be used on the base of all floor microphone stands from the Universal Microphone Co., Inglewood, Cal., taking the place of the former chrome smooth finish. The new finish has been created on the demand of stations and microphone users who found that rough usage (the scraping and shuffling of feet) soon showed on the chrome. The crackle will be used for the standard floor stand, the banquet model and the manufacturers' combination floor stand.

Mobile Radio Expands

London, Eng., is having trouble with motor car thieves, and as Scotland Yard does not intend to tolerate any such offenses, police automobiles equipped with radio receivers, to get messages from headquarters dispatching them to particular destinations, are being installed. This is the police-radio system as exists in numerous American cities. Radio-equipped motorcycles are being tried in New York City. The receivers are on the handlebars of the police cycles.

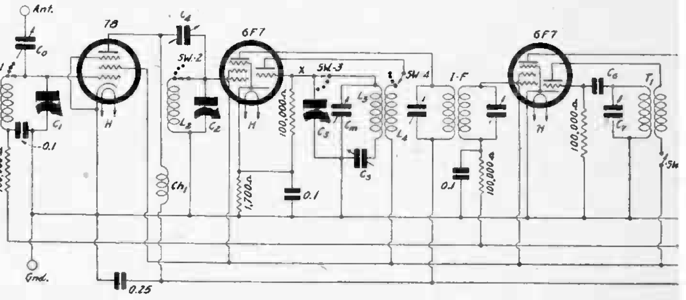
Editor Disputes Board

An editorial in the New York "Herald-Tribune" set forth that radio broadcasting was largely restricted to government propaganda. Ogden Reid, editor of the paper, called to account by the Federal Radio Commission (before the Federal Communications Commission was instituted), refused to "render you an account" on the ground that authority to compel an explanation was lacking.

Six Tubes

In This All-Wave Super of Multi-Pu

By Einar



FI

The circuit diagram of a superheterodyne of six tubes b of dual pu

WE have now a large number of multi-element tubes, yet many are not used extensively except in trick circuits. Is it not possible to use the more complex tubes in straight-forward receivers where the tuners and couplers do not differ essentially from those used when simple tubes are employed? Yes, it is possible, for it has already been done.

We are showing a circuit diagram in Fig. 1 in which two 6F7, one 6B7, one 78, and one 42 are used. The 6F7's and the 6B7 are multi-element tubes in the sense that we have used the term in this case, for each of the 6F7's contains a triode and a pentode and the 6B7 contains a pentode and a duplex diode.

Dual Use of 6F7

In a superheterodyne we always need at least one oscillator, and the best type of tube for this purpose is a triode. Therefore, since the 6F7 has a triode, we can use this; and since it has a pentode also, we can use this either for amplification or detection. In the present instance the first 6F7 is used for grid bias detector and oscillator. If the superheterodyne is to receive continuous-wave code signals as well as broadcast signals, another oscillator is needed, to be operated at the intermediate frequency. Therefore if we use another 6F7 tube, we have available the necessary triode for the beat note oscillator and at the same time we have a pentode for the intermediate amplifier. Thus two 6F7 tubes serve the same functions as four tubes. Indeed, they are four tubes in all respects except appearance.

When we come to the 6B7 we note a different arrangement of elements. This tube has a pentode amplifier and a duplex diode. These units can be employed in two ways. The pentode can be used as an intermediate-frequency amplifier and then the diode can be used as a detector, or the diode may first be used as a detector and the pentode can be used as audio-frequency amplifier. In this instance the first arrangement has been selected. This seems to be the preferable way. Either way the tube is used, it serves two distinct purposes. The tube plays a third, but incidental, role, namely, grid bias supply for the automatic volume control.

The Other Tubes Employed

The first tube in the circuit is a 78, a super-control radio-frequency amplifier; and the last tube is a 42, which is a power amplifier of the pentode type. In the power supply circuit an 80 is used, for this is large enough to supply all the rectified current needed and it is slightly more economical than the 5Z3.

It may be that additional audio amplifier will be desired as a means for increasing the sensitivity of the circuit. A tube like the 37 or the 76 may be used in a resistance-capacity setting to give about a seven-fold voltage gain. Of course, it is not necessary to add the extra tube; the output of the diode rectifier will be more than necessary to load the 42 to its limit, and that without overloading anything ahead of the detector.

The Radio-Frequency Tuner

The radio-frequency selector consists of three tuners, two alike and tuned to the signal and the third padded and adjusted to a frequency higher than the signal. It will be noticed that there is a small variable condenser Co between the first tuner and the antenna. To make the second tuner as nearly equal to the first as is possible, a condenser C4 is placed between the plate of the first tube and the high potential side of the second tuned circuit. If the coils L1 and L2 are equal and if they are equally placed with respect to shielding, it is possible to adjust Co and C4 so that the tuners will track if the two condensers C1 and C2 track well. They usually do well enough.

The condenser C3 in the oscillator is supposed to be equal to each of the radio-frequency tuning condensers and the three should be ganged together. Cm is a small trimmer condenser associated with the coil L3 and Cs is the series padding condenser, also associated with the coil. By association with the coil is meant that when another coil is switched in or changed, Cm and Cs go with the coil and do not remain with the condenser C3. This is necessary because different padding values are needed for each wave band.

The Intermediate

There are two intermediate amplifiers and three doubly tuned transformers, exclusive of the transformer in the beat note oscillator. The third of the i-f transformers has a centertapped secondary so that full-wave detection may be used.

While there is no one frequency that is best for the intermediate, those frequencies between 400 and 500 kc are the most practical, especially for an all-wave receiver. It is customary now to use 456 kc for broadcast superheterodynes and 465 kc for short-wave receivers. Either one is satisfactory for an all-wave circuit; and, as a rule, a transformer of either rating may be tuned to the other frequency. Let us assume that the frequency is 465 kc.

A doubly tuned transformer of this rating can be obtained in which both windings are tuned with air condensers. Such a transformer should be used unless its slightly higher cost, as compared with a transformer that is equipped with a compression type condenser, is a factor that must be taken into consideration. Of course, all intermediate-frequency transformers are now thoroughly shielded for without shielding it is impossible to stabilize the circuits at any gainful level. Not only must the transformers be shielded but there must be careful planning of the circuit and placement of leads so that back coupling will be as low as possible.

Bias and A. V. C.

The grids of the three high-frequency amplifiers should have a minimum bias of 3 volts, and they should also be put on the automatic volume control in order completely to control the volume level when the signal intensity varies. It is also desirable that all the cathodes be grounded. This has been accomplishd by connecting the cathodes of the three tubes directly to ground and then using a common bias resistor R1. It is in this resistor that the voltage drop is to be three volts. The normal direct current that flows through this resistor is 47.8 milliamperes. For simplicity let us say that it is 50. Then the value of R1 should be 60 ohms. Since this resistor is a common coupler for all the tubes to the left of it, it is essential that a large condenser should be put across it for filtering. The condenser is marked 0.25 mfd., but this should be regarded as the minimum. It may have any larger value, provided that it is not an electrolytic condenser.

The mixer portion of the first 6F7 is functioning as a grid-biased detector, and as such it should have a bias of 10 volts, a value which will result from a 1,700-ohm resistor in the cathode lead.

The oscillator portion of the tube should be self-biased by means of a 100,000-ohm resistor between the grid and the

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LIST OF

Coils

L1, L2—One set of short-wave coils as described (8 coils).
L3, L4—One set of oscillator coils as described (four coils).
Two doubly tuned 465 kc transformers.
One doubly tuned 465 kc transformer, secondary centertapped.
T1—One beat note oscillator transformer, 465 kc (like i-f transformers).
Ch1—One 10 millihenry choke.
Ch2—One 30-henry filter choke.
One field coil or 30-henry choke.
T2—One power transformer with one 700-volt, centertapped winding, one 6.3-volt centertapped winding, and one 5-volt winding.

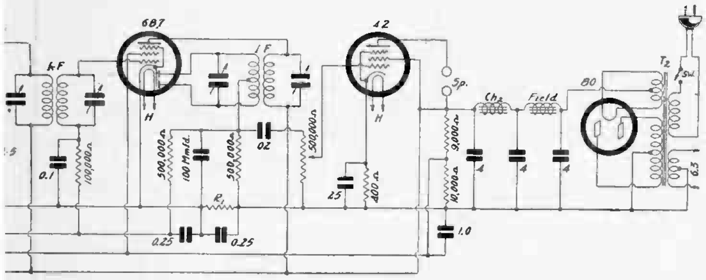
Condensers

Co, C4—Two midget variable condensers, about 50 mmd. each.
C1, C2, C3—Three 140 mmfd. tuning condensers, ganged.
Cm—Trimmers as explained.
Cs—Padding condensers as explained.

Equal Nine

heterodyne, Due to Use pose Valves

Andrews



G. 1

ut the equivalent of a nine-tube circuit due to the use pose tubes.

cathode. Note that the series padding condenser is used as the stopper in the grid circuit. For certain bands the series condenser will be very large, and may possibly be omitted. If this is the case a condenser of 0.00025 mfd. should be placed in the grid lead outside the grid circuit, that is, in the lead marked X.

The Beat Note Oscillator

The beat note oscillator is treated about like the first. The grid stopping condenser C6 should have a value of about 0.0005 mfd. and the grid leak 100,000 ohms. If blocking should occur because the grid leak resistance is excessive, it may be reduced to 50,000 ohms, or even less if necessary. This also applies to the preceding oscillator. Only one tuning condenser, C7, is shown on the beat note oscillator. One may also be placed on the tickler winding. In other words, the transformer used for the beat note oscillator may be exactly like the intermediate frequency transformers, but the frequency adjustment should be different. It should be made so that a tone of about 500 cycles per second is heard when an unmodulated carrier is tuned in accurately. The beat tone will then be loudest as well as clearest.

The adjustment of the intermediate tuner is easily made with the aid of a signal generator. The unmodulated signal, 465 kc, is impressed on the grid of the first 6F7. Each intermediate tuner, six in all, is adjusted until the output is maximum, which can be measured with a high resistance voltmeter, about 500,000 ohms, across the diode load resistor, which itself is 500,000 ohms. The voltage reading should be greatest when the tuning is exact. During this adjustment the switch Sw₅ should be open so that the oscillation form the beat note oscillator will not interfere. After the adjustment has been made, however, the oscillator should be turned on and its frequency adjusted until the desired beat note is obtained.

The Power Tube

A satisfactory output tube for a circuit of this type is the 42, which takes 6.3 volts on the heater and 0.7 amperes heater current. Its output power when suitably loaded is three watts, and that is more than is usually employed.

The power tube is biased by means of a 400-ohm resistor in the cathode lead, and this resistor should normally give a bias of 16.5 volts. Since the 42 is a high-gain pentode, it is of first importance to minimize reverse feedback; and a 25 mfd. electrolytic condenser should be sufficient to prevent degeneration on all essential audio frequencies.

The manual volume control is placed in the grid circuit of the power tube and it takes the form of a 500,000-ohm potentiometer grid leak, to the slider of which the grid is connected.

The load resistance, which has a value of 500,000 ohms, is coupled to the potentiometer by a 0.02 mfd. condenser. The load resistance is returned to the negative end of R1, and it is in that manner that R1 provides a limiting negative bias of three volts. A filter condenser of 100 mmfd. is put across the load resistance. The other 500,000-ohm resistor associated with the detector is a part of the automatic volume control, for it serves to prevent the signal from shorting through the necessary filters in the a.v.c.

In each of the three grid return leads of the controlled tubes there is a 100,000-ohm resistor, and for each resistor a 0.1 mfd. by-pass condenser.

Design of Coils

If the receiver is to cover the broadcast band only, each of the three tuning condensers should have a capacity of 350 mmfd. and the inductance of each of the radio frequency coils should be 245 microhenries. The main reason for this choice is that the parts are most easily obtainable. When the r-f inductance is 245 microhenries and the intermediate frequency is 465 kc, as we assumed it to be, the inductance of the oscillator coils should be 137 microhenries, the series padding capacity, Cs, should be 340 mmfd., and the parallel capacity, Cm, should be 9 mmfd. Of course Cm will be provided by the trimmer that is on C3 and Cs will be provided by an adjustable condenser which can be given the required capacity. The oscillator inductance is obtained by winding 80 turns of No. 32 enameled wire on a one-inch form.

In case the circuit is to be used primarily for short-wave reception, each of the three tuning condensers should have a capacity of 140 mmfd. Preferably they should be ganged. If the tuning is to begin at 200 meters, or 1,500 kc, the largest r-f inductance should be 80.5 microhenries and the corresponding oscillator inductance 61.8 microhenries. The next pair should be 16.6 and 14.7 microhenries, and the third pair 3.44 and 3.25 microhenries. The smallest r-f coils should be 0.71 microhenry and the oscillator coil 0.691 microhenries.

The Series Condensers

The values of the three series padding condensers should be 436, 920, 1,900, and 4,000 mmfd., the smallest being for the lowest frequency band. Two of these condensers are so large compared with the tuning condenser that they are not needed. But it should be remembered that a stopping condenser is needed in any case.

The following windings give very nearly the required inductances:

Inductance	*Turns*	*Wire*
81	80.5	No. 24 enam.
61.8	69.2	No. 24 enam.
16.6	26.0	No. 24 enam.
14.7	23.8	No. 24 enam.
3.44	11.4	No. 18 enam.
3.25	11.0	No. 18 enam.
0.71	4.1	No. 18 enam.
0.691	4.05	No. 18 enam.

The tickler winding should contain about 2/3 as many turns as the tuned winding for the larger coils and about the same number as the secondaries for the smaller, the tickler wire diameter being immaterial. In any event there should be enough turns to cause oscillation.

Coupling

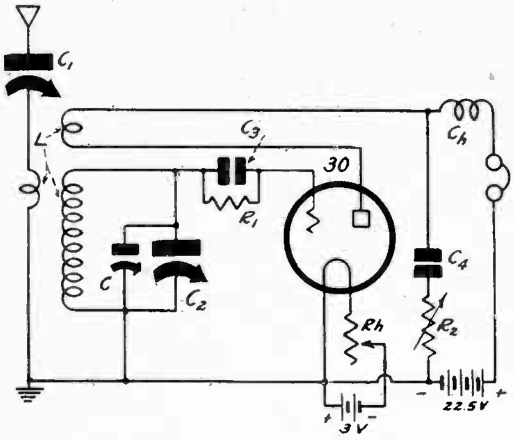
There is no definite coupling between the oscillator and the mixer. There is enough stray coupling to yield satisfactory operation. For any desired additional coupling a wire can be run from the grid of the oscillator and wrapped around the grid lead of the mixer tube, both wires being insulated. In the same way coupling may be established, if necessary, between the beat note oscillator and the i-f amplifier tube, but in this case a tiny condenser might be used, since the frequency here is much lower.

PARTS

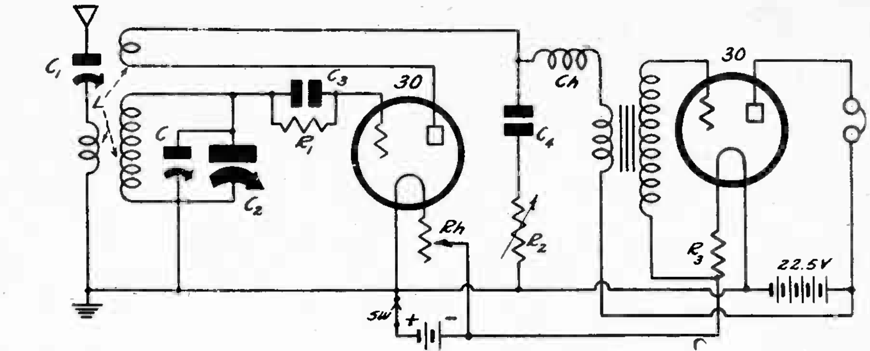
C6—One grid stopping condenser, about 250 mmfd.
C7—One adjustable condenser, preferably built into coil.
Four 0.1 mfd. by-pass condensers.
One 100 mmfd. by-pass condenser for detector.
One 0.02 mfd. condenser, mica type.
The 0.25 mfd. by-pass condenser.
One 1.0 mfd. by-pass.
Four 4 mfd. or larger condensers, which may be electrolytics.
One 25 or larger electrolytic condenser, rated at over 17 volts.

Other Requirements

R1—One 60-ohm resistor.
One 400-ohm resistor.
One 1,700-ohm bias resistor.
One 9,000-ohm, 3-watt resistor.
One 10,000-ohm, 3-watt resistor.
Two 500,000-ohm resistors.
One 500,000-ohm potentiometer.
One medium 6-pin socket.
One small 6-pin socket.
Three small 7-pin sockets.
One 4-pin socket.
Four grid clips.
Four tube shields.
One four-stop, four-deck switch.
Two on-off switches.



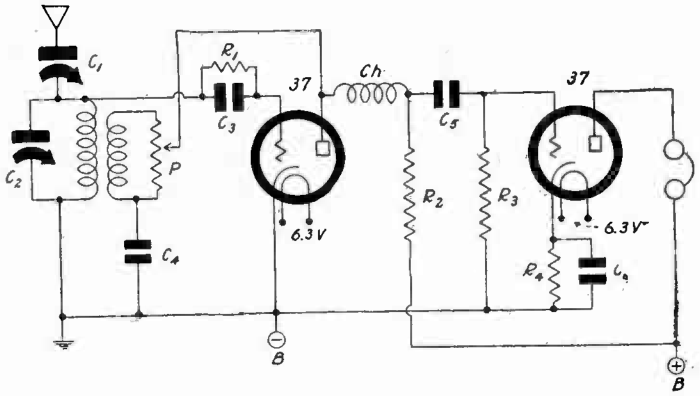
Series resistance control of regeneration.



The same circuit, with a stage of audio added. As the control of regeneration is really from a high-resistance rheostat, the moving arm may be grounded.

Resistance Methods of Controlling Regeneration

Parallel resistance for control of regeneration. By this method the direction of connecting the tickler is of as much consequence as if any other regeneration-control method were used.



Two methods of resistance control of regeneration in short-wave receivers are shown. In one instance, the paired one-tube and two-tube sets, the resistor is of high value and is in series with a condenser. In the other instance, a low value of resistance may be used for P, say, 20,000 ohms or so, though P is in parallel. In one sense it is well to say that the higher the resistance of P the better, but from a practical viewpoint, since P will be used considerably, the lower values permit of a wire-wound type, which is the more durable by far, whatever else may be said. In general, wire-wound controls are obtainable up to 100,000 ohms, so perhaps one could compromise on 100,000 for both.

No doubt every one has heard one or another side of the arguments about which is best—resistance, capacity or inductance control of regeneration. Whoever gets paid by a variable-resistor manufacturer to discuss the topic seems to think there's nothing like resistance to accomplish the objective. Others, obtaining imbursement from strictly coil manufacturers, may point out the desirability of the inductive adjustment, merely the tickler to manipulate. The capacity cohorts have the easier arguments, because of the popularity of the throttle control of regeneration, consisting of a variable bypass condenser across the line (P to ground).

Two Regeneration Controls

Perhaps the best answer to give is that all methods work well, and that when anybody wants a very close adjustment he always has two controls of regeneration, a major one and a minor one.

The series-potentiometer diagrams are of circuits having those two controls. The rough control, or one used for a first approximation, is the filament rheostat. If just a trifle too much regeneration is present, so that the signal is not clear enough, and a bit of reduction of feedback is requisite, then the plate-current rheostat, of high value, may be adjusted to take up the difference, that is, used as a sort of vernier.

It can be seen from the foregoing observation that the inductive, capacitive or resistive control is not the deciding factor, all methods are good, but that for extremely close adjustment two controls are needed, and one of them may be just the same type as the other, or any two different ones may be used.

Perhaps a way out is to use a close vernier on the feedback control, for then only one control actually would be necessary, although since a good deal of jumping about is done in tuning, one would have to be content with turning the shaft slowly back and forth again and again in the process of adjusting the feedback to the frequency. Or, indeed, dual ratio control could be used—a refinement yet far removed from regeneration control, for it has only just been introduced in the main tuning.

Parallel Resistance

The antenna series tuning condenser is faithfully present as C1 in the paired diagrams. C2 is the main tuning condenser, but C may be one of about equal capacity, for bandspread. C2 is the grid condenser, 50 to 100 mmfd., while R1 should be relatively low, to preserve the selectivity at the high-frequency settings of any band, and also to avoid grid blocking, so from 50,000 ohms to 25,000 ohms would be all right. C4 and R1 are inter-related, values of 0.00025 mfd. and 100,000 ohms being suggested. The filament rheostat may be 20 ohms. The series antenna condenser may be anything from 50 to 20 mmfd. maximum.

In one diagram there is no audio stage, in the other there is.

The foregoing were for battery operation. The two-tube set with parallel resistance control is for 6-volt storage battery and B batteries, or for a-c on the heaters and rectified B supply on the plates. The tuning condenser across the secondary is 140 mmfd. for standard plug-in coils, as is true of the preceding examples; C4 and P could be the same as before, but note that the moving arm can not be grounded this time. The previous method, and the throttle condenser method, both permit grounding of the moving element, and therefore minimize the body-capacity effects.

The r-f chokes should be of appreciable inductance, 2 mlh. or more, the higher the inductance, as a rule, the better, because universal-wound coils are used, or lattice-wound, and both of these are honeycombs, the universal with turns closer together (narrower pitch of winding), the lattice type with much extension of the distance between adjacent turns of the same layer of wire. All these coils have the smaller distributed capacity, the higher the inductance, because the capacities of turns are in series.

R2 may be 50,000 ohms, C5 be 0.01 mfd., R3 be 2 meg.; R4, 1,000 ohms; C6, 1.0 mfd. or higher.

New Plant for WOR

A new transmitting plant for WOR will be set up at Carteret, N. J. Objections of residents have been silenced, and necessary permissions granted by the Federal authorities. The station, owned and operated by the Bamberger Broadcasting Corporation, has a 50 kw license it hopes to cash in on when the plant permits that power.

TIME SWITCH ON SET

Atwater Kent has a time-clock set, for automatically switching the receiver on to bring in stations at particular times, switching it off, and on again.

A THOUGHT FOR THE WEEK

AGAIN radio and the liquor question figure jointly in the news. If you run a tavern where beer is sold in Connecticut you can't turn on a radio for dancing, or, for that matter, for any other purpose calling for music. Mind you, your radio may tell your customers all about the weather, the baseball scores, and the latest news of a strike, but the moment Rudy Vallee strikes up the band or Kate Smith tries to get that moon over the mountain you'd better turn it off or you'll get in trouble with the state authorities.

Of course, it all sounds incredible but we can't help that. If you're sore and resentful, just take it up with the Liquor Control Commission of Connecticut—and see how much good it will do you!

Severest Problem is Same Frequency Backing Up

In the typical receiver there are four frequencies: the incoming carrier frequency, the oscillator frequency, the intermediate frequency and the audio frequency. One would suppose that most elaborate precautions would be specially taken to avoid particular frequencies mixing with other frequencies, but the main problem is to stop the same frequency from mixing with itself. This self-mixing is also known as feedback, oscillation, squealing, motorboating, etc.

It is true, of course, that some precautions are taken against frequencies outrunning their intended channels. The first example of this would be in the modulator or first detector of a superheterodyne. The carrier frequency has been put into this tube at the control grid, the oscillator frequency at some other place in the same tube, the mixture results in the intermediate frequency, which is lower than either of the two others.

Plate Condenser

The best way to avoid the high frequencies from getting into the intermediate amplifier is to tune the plate circuit of the first detector to the intermediate frequency, which is practically always done, the capacity required being more than 50 mmfd., which it always is. In fact, it is generally around a couple of hundred micro-microfarads, for 465 kc i.f.

Thus the plate condenser serves as a bypass capacity, and the intermediate level is protected sufficiently against entry of the high-frequency signal, but as each stage of i.f. is tuned, the stray higher frequencies would find it increasingly difficult to get anywhere.

With intermediate channels being of high gain, it is common to run into squealing trouble, or oscillation at the i-f level. This is an example of a single frequency being concerned. There are possibilities of inductive, resistive and capacitive feedback in the i-f amplifier, and if any such feedback is present, it is dangerous in that it may rise to oscillation values hence render the receiver practically squeal-laden for all operation.

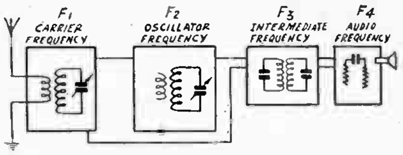
The usual method to get rid of this trouble is to put a choke and condenser in the B plus and screen leads, and while this helps, it is also worth nothing, for the fact is seldom brought out, that plate and screen current combine in phase in the cathode leg, the resistance for biasing is low in this branch, and to get rid of feedback in a low-resistance a high capacity is necessary, depending somewhat on the extent of the feedback. Therefore the chokes in screen and plate legs usually may be omitted if one is willing to endure the high capacity, which may be a 2 mfd. paper condenser. This is usually cheaper than the two chokes and two smaller capacity bypass condensers. Anyway, it is very effective.

Different with Audio

Any system or method that tends to reduce the gain also reduces the feedback. This fact leads to the occasional use of methods that stop feedback at too great an expense. If the feedback or oscillation is at radio frequencies, which includes intermediate frequencies, methods that stop oscillation often do so at ruinous expense to the amplification, or give the selectivity a terrific setback. Dampers of various types, like series and parallel resistors, are included in this group. But at audio frequencies this does not hold, for the method that stops the oscillation, which trouble in that instance is called motorboating or steady squealing, depending on frequency, is satisfactory if not pressed beyond the point where the trouble disappears. Reduction of the value of an audio grid leak, for instance, is one safe way, or insertion of a parallel resistance across a transformer primary or secondary, or across a choke.

Efficiency at Audio

Everyone is familiar with the bypass condenser after the detector or, in superheterodynes, the second detector. The second detector requires detouring of intermediate frequencies, to keep them out of the audio channel, which, often partly resistance-coupled, offers a suitable path for i. f. Therefore the stabilization of the intermediate channel likely depends on keeping intermediate frequencies out of the audio channel so that the unexpected and undesired height of amplification causes the disastrous feedback.



The four frequency levels in a modern receiver.

The audio frequencies are in general the ones most efficiently handled, the high radio frequencies those least efficiently handled. This is brought out well enough in experiments with oscillators. A tube may be used as audio oscillator with no B voltage, even a 30 tube, with a suitable transformer, one winding in the grid circuit, other, in the plate circuit, simply returned to positive filament. This does not present itself as a possibility at radio frequencies, even at low ones, say, 50 kc. And when the frequencies become high, say above 10 mgc, the worries about the transconductance, the plate voltage etc. begin, for the oscillation amplitude declines.

Station Sparks

By Alice Remsen

A broadcast from "The Roof of Europe," on the peak of the famous Jungfrau in the Swiss Alps, will be heard in this country over an NBC-WEAF network on August 12th. The Jungfrau, towering 13,669 feet in the Bernese range, affords a view of unsurpassed beauty, which, lighted by the setting sun, will be described for the NBC audience during the program. Time is 3:30 p.m., EDSTA. . . . A group, including many of the most famous conductors in the world, will direct the Chicago Symphony Orchestra in its daily broadcasts over NBC networks during the coming two months. Under the batons of such notable musicians as William Van Hoogstraten, Sir Hamilton Harty, Frederick Stock, Henry Weber and Carl Bricken, nine concerts weekly will be broadcast from the Century of Progress Exposition up to and including September 8th. . . . NBC now has more than thirty ace dance bands to which listeners may trip the light fantastic during the summer months. . . .

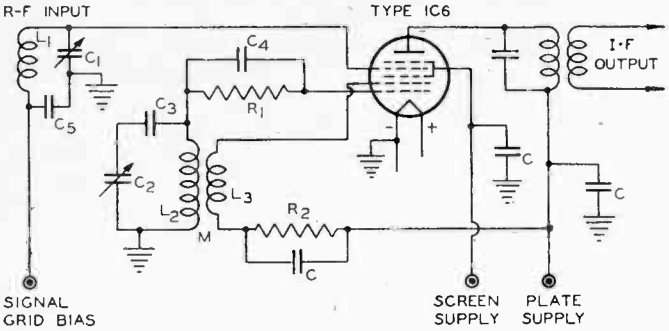
Arrangements are now being made by NBC to bring the words of President Franklin D. Roosevelt to the entire nation during his trip across the country in August. Watch your local papers for exact date and time. . . . John S. Young, NBC announcer, has been invited to lecture at Oxford University; he has already sailed for England. . . . Eddie Peabody is spending his vacation out on the Pacific Coast; he will return to New York and his radio schedule on August 16th. . . . Here's something for short wave enthusiasts: A very interesting and ancient ceremony will be broadcast over an NBC-WJZ network at 9:00 a.m. on August 9th, direct from the annual Gorsedd, or Assembly, of the Royal Eisteddfod at Neath, Wales, David Lloyd George will be the presiding officer. The ceremony, which originated many centuries before the Christian era, is called "The Chairing of the Bard" and consists of the award of a prize to the bard who has produced the best Welsh poem, song or piece of literature while a student in one of the "chairs" or schools of the Eisteddfod. . . .

Over at CBS the "Forty-five Minutes in Hollywood" program has changed its schedule; it is now heard each Thursday at 10:00 p.m., under a renewal of contract. . . . "Roxy" (S. L. Rothafel), radio pioneer and one of its foremost showmen, will make his debut over the Coast-to-Coast WABC-Columbia network starting September 15th, in his first sponsored series of programs. He will be heard from 8:00 to 8:45 p.m. each Saturday, sponsored by Fletcher's Castoria. . . . "Bar X Days and Nights," featuring Carson Robison and His Buckaroos, has returned to the Columbia network. They are heard each Thursday at 9:00 p.m.; sponsored by the Health Products Corporation in the interests of Feen-a-Mint. . . . There is a new group of hill-billy singers on CBS; they are heard every Tuesday and Thursday at 5:45 p.m. and on Fridays at 6:30 p.m. They call themselves the Blue Ridge Mountaineers, but they aren't mountaineers; in fact, the six of them hail from Bridgeport, Conn. . . . Kate Smith is back on the air from WABC, N. Y. She is heard on Mondays, Thursdays and Fridays at 8:00 p.m. She is accompanied by Jack Miller's orchestra. Jack, you will remember, used to be her pianist, then he sang over the air-waves himself, and now he has developed into a regular orchestra leader. More power to him! . . . Once a trouper always a trouper, describes Madame "Momma" Ilona Thury, who, at the age of sixty-eight, is captivating audiences after fifty years of show business. Her voice is still a rich vibrant contralto. She sings with Fisher's Orchestra from a restaurant in Yorkville, and is heard over radio station WMCA each Sunday at 10:30 p.m. and each Thursday, Friday and Saturday at 9:45 p.m. She sings until four in the morning and never seems to get tired.

Beat Frequencies as Sedatives

Beats between oscillators, yielding a high audio frequency, on the fringe of the inaudible, seem to have a somnolent effect and should be tried medically on persons who find it hard to fall asleep. If one hears a program and beats an oscillator against the carrier for production of 9,000 cycles, say, pretty soon the 9,000-cycle note seems to disappear. This may not be due exactly to getting tired of the frequency but rather to decline in attentiveness or ear perception, due to a drowsy condition. Experiments performed on two persons, who were unaware of the intentions, resulted in their falling asleep on two sofas, where they had been tempted to lie. Also, canaries chirped responsively to frequencies above human audibility.

New 1C6 Tube Doubles 1A6's Transconductance



Typical circuit for use of the new 1C6 pentagrid converter tube.

C = 0.1 mfd.
C_1 = } Ganged Variable Condensers
C_2 = }
C_3 = Padding Condenser
C_4 = Grid Condenser—0.00025 mfd.
C_5 = Blocking Condenser—0.05 mfd.
L_2 = Oscillator Grid Inductance
L_3 = Oscillator plate Inductance
M = Mutual inductance of L_2 and L_3
R_1 = Oscillator Grid Resistor—50,000 ohms.
R_2 = Voltage Dropping Resistor—20,000 ohms

Note: Voltage applied to anode-grid (grid No. 2) should be higher than that on screen (grids Nos. 3 and 5).

THE 1C6 is a pentagrid converter of the two-volt filament type. It is particularly designed for use in 2-volt, battery-operated, superheterodyne receivers in which it performs the functions of mixer and oscillator.

This tube is similar to the 1A6, although not directly interchangeable with it, requiring twice the filament current of the 1A6, but offers the feature of an extended operating range at the shorter wavelengths. This feature is of particular value in the design of multi-range receivers, since the oscillator section of the 1C6 has sufficient mutual conductance to function at frequencies as high as 25 megacycles. In order to cover this same range of operation, the 1A6 requires for frequencies above 10 megacycles the use of a triode connected in parallel with the oscillator section. The 1C6 is, therefore, to be preferred for multi-range receivers, since these may be designed to cover frequencies from about 20 megacycles to 150 kilocycles or lower, says RCA Radiotron Company.

The oscillator section of the 1C6 has a mutual conductance of 1,000 micromhos (when not oscillating) and an anode-grid current of 4.9 milliamperes, whereas the 1A6 has corresponding values of 425 micromhos and 2.3 milliamperes, repectively. This comparison is made under the voltage conditions of 180 plate volts, 67.5 screen volts, 135 anode volts (no dropping resistor), and zero oscillator-grid volts.

The maximum conversion transconductance is obtained with an oscillator-grid current of slightly less than 0.2 milliampere. This value should be borne in mind when the oscillator-grid and plate coils are wound. Their coupling should be adjusted to make the grid current approximately 0.2 milliampere when a grid condenser of 0.00025 mfd. and a grid leak of 50,000 ohms are used.

Remote Cutoff

The control grid is of the remote cut-off type. This characteristic may be employed to supplement the control on the amplifier stages. These r-f and i-f stages should use the 34, a tube also of the remote cut-off type, which can be connected to receive a-v-c voltage for volume control. For the 34, cut-off occurs at —22.5 volts with 67.5 volts on the screen, and for the 1C6, at —14 volts with 67.5 on grids 3 and 5.

Fig. 1 shows a typical circuit for the 1C6 as a pentagrid converted. Typical operating voltages and currents for converter service follow:

Plate Voltage	180 max. volts
Screen (Grids No. 3 and No. 5) Voltage	67.5 max. volts
Anode-Grid (Grid No. 2) Voltage	135 max. volts
Anode-Grid Supply*	180 max. volts
Control-Grid (Grid No. 4) Voltage	—3 min. volts
Total Cathode Current	9 max. milliamperes

Typical Operation:

Filament Voltage (D.C.)	2.0	2.0	volts
Filament Current	0.12	0.12	amperes
Plate Voltage	135	180	volts
Screen (Grids No. 3 and No. 5) Voltage	67.5	67.5	volts
Anode-Grid (Grid No. 2) Supply	135*	180*	volts
Control-Grid (Grid No. 4) Voltage	—3	—3	volts
Oscillator-Grid (Grid No. 1) Resistor	50000	50000	ohms
Plate Resistance	0.55	0.75	megohm
Conversion Conductance	300	325	micromhos
Conversion Conductance at —14 Volts Bias on Grid No. 4	4	4	micromhos
Plate Current	1.3	1.5	milliamperes
Screen Current (approximate)	2	2	milliamperes
Anode-Grid Current	2.6	3.3	milliamperes
Oscillator-Grid Current	0.2	0.2	milliamperes
Total Cathode Current (Approximate)	6.5	7	milliamperes

*Applied through 20,000-ohm dropping resistor.

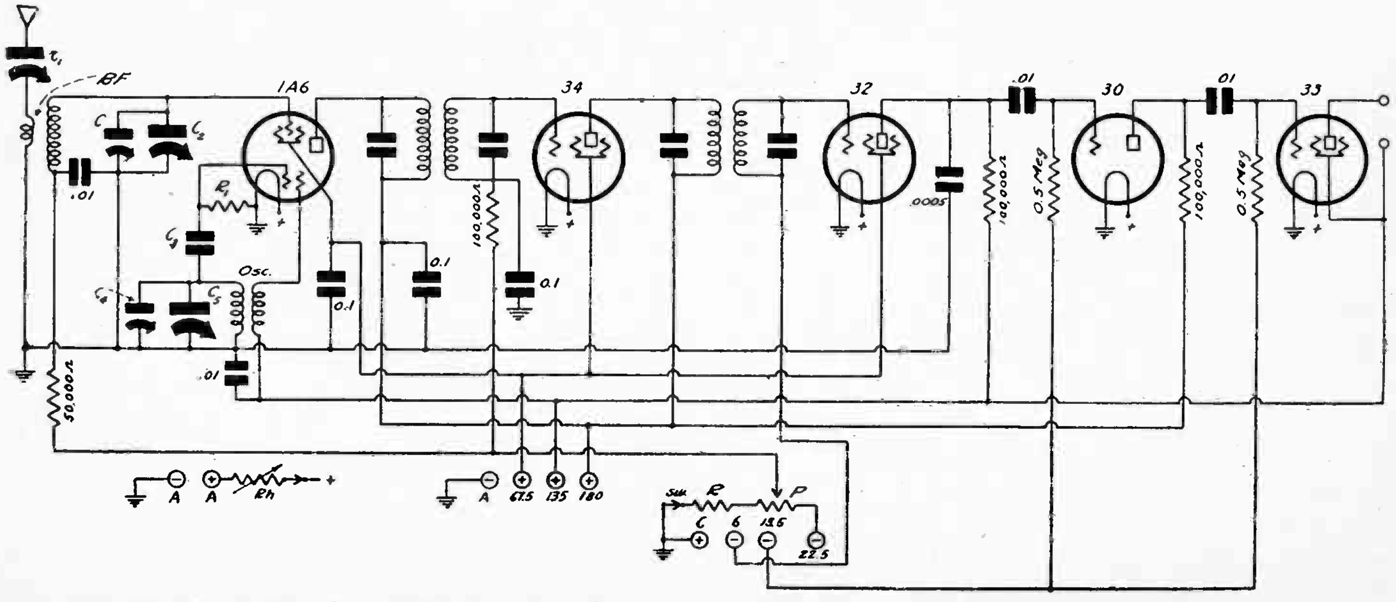
Direct Interelectrode Capacitances (Approx.):

Grid No. 4 to Plate (With shield-can)	0.3 mmfd.
Grid No. 4 to Grid No. 2 (With shield-can)	0.3 mmfd.
Grid No. 4 to Grid No. 1 (With shield-can)	0.15 mmfd.
Grid No. 1 to Grid No. 2	1.5 mmfd.
Grid No. 4 to all other Electrodes (R-F input)	10 mmfd.
Grid No. 2 to all other Electrodes (Osc. output)	6 mmfd.
Grid No. 1 to all other Electrodes (Osc. input)	6 mmfd.
Plate to all other Electrodes (Mixer output)	10 mmfd.

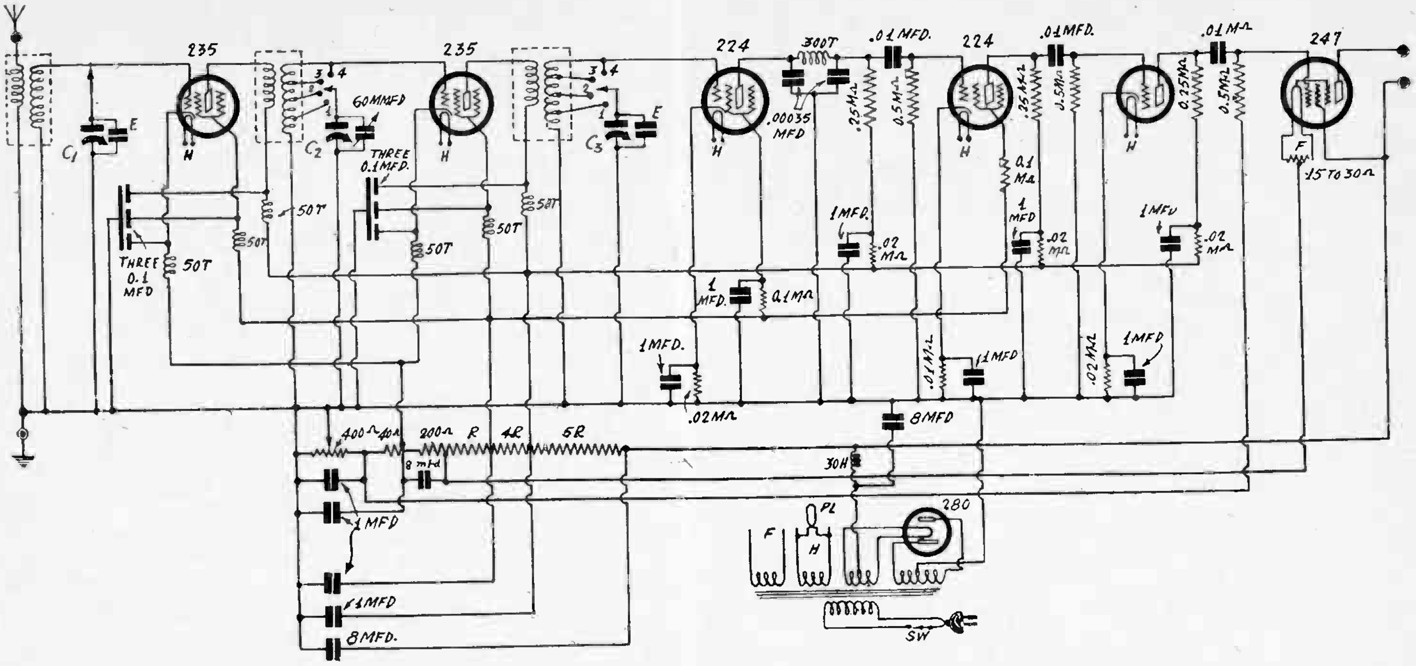
Sustitution

The instances where the 1C6 would be substituted for the 1A6 would be where each tube has a separate filament resistor, when a resistor of half the previous value would be substituted, or one of the same value as before put in parallel with the existing one; and where a chain of tubes is served by the same resistance, usually a rheostat. Series-connected filaments, which would offer something of a problem, need not be considered, because the 2-volt tubes are not recommended for series connection, will not well stand the plate current accumulation, nor even the variations in filament voltage.

In the example illustrated, the common resistor, Rh, lower left, in series with A plus, would be reduced a bit in value, because the current goes up when the 1C6 is used. If the set is for broadcast use only, as is the case, there would be no necessity for any change or substitution, yet whenever a new tube comes out, if it is anything half appropriate, any demand for the previous model is met with a supply of the new one.



Small super, using the 1A6. The 1C6 may be substituted. Readjust Rh (lower left)



Bad practice in attempting to "simplify" short-wave construction. There is nothing that can be presented to the antenna circuit that even faintly approximates the advantage of a tuned circuit, so all untuned antenna stages may as well be ruled out at once. The succeeding tapped-coil method of covering wide frequencies is no comparison with the separate-coil method. And all the audio to atone for r-f insensitivity shows that regeneration should have been included in the detector, whereupon two audio stages would have sufficed, with less hum.

Some Silly Experiments Tempt the Short-Wavers

A good deal of short-wave experimenting is being undertaken that is rather futile. By this is meant the bold work being done by those who have a scant konwledge of short-wave technique, but are induced to try certain things in the hope that great results will be economically attained. One of the first efforts is to determine whether it is possible to go from 540 kc to 25 mgc, using a system of tapped coils—one winding, suitably tapped. Ah, what an invitation that is! What bait for the experimenter! How much simpler the whole construction becomes when the coil system is reduced to that absurdly simple status. Yes, absurdity characterizes it, all right.

There is no known method of tapping coils for any such wide frequency coverage, and as a general proposition tapping a coil even for shifting from one band to a second one is not the better practice, since a separate coil would be preferable even then. Always there exists the danger of two frequencies—particularly due to the larger distributed capacity of the greater inductance resulting in a resonant frequency that may interfere with a higher frequency intentionally tuned—and always there is lessened efficiency.

Single Coil for All Bands?

Another fallacy is that one coil can be worked well for all bands, although in a sense this is the same fallacy as previously stated, that is, the reasons why a tapped coil will not do very well are about the same reasons that a single choke or primary will not do for a wide range of frequencies.

See what is attempted in the diagram herewith. For some band or bands, say for 3 and 4, perhaps 540 to 1,000 and 1,000 to 1,900 kc, C1 is in circuit being a large capacity, say 350 mmfd. and covering a ratio of 3.2 to 1, or so, to keep pace with two steps of the 60 mmfd. condensers C2 and C3. Then when the broadcast band is completed, C1 is out of circuit and we have an unutuned coupler. The word "untuned" has to be explained. It is used when there is no intentional tuning condenser across a transformer primary or secondary, or across any winding for radio frequencies. But "untuned" does not mean that the circuit is aperiodic, that is, equally responsive to all frequencies. The impedance factor is present in the "untuned" coupler, which soon becomes a serious producer of losses, as the frequencies become higher and higher, until the coil practically kills off the signals. The reduction of signal intensity at 15 mgc may be 90 per cent. due to a coupler that, for tuning purposes, had its characteristics selected for the broadcast band.

Therefore it is well to avoid all untuned methods, except perhaps where one insists on an antenna circuit that is free from detuning effects due to aerial, when a resistive input would be tolerable, but selectivity suffers, at least comparative selectivity, as there is amplification without selection. Nor is the stage strictly untuned even then, for a resistance has a frequency characteristic because of its own capacity and the capacity associated with it, here the antenna capacity. The higher the resistance, the larger the effect of a small capacity, the result being something like that of a tuning curve, so sooner or later even the resistor, at high frequencies, becomes a loser.

Can't Beat Tuned Circuit

The conclusion finally is reached that there is nothing like a tuned circuit to yield the kind of results a fellow insists on, and the coil to use is one that is particularly selected for the band to be covered, which may be a plug-in coil, or a separate coil associated with a switch system. There is no sense in damning the switch systems. Manufacturers of plug-in coils may take that attitude, but the host of switch type all-wave receivers that have no dead spots constitutes quite an answer to that type of propaganda. Why isn't there an all-wave coil-switch arrangement on the market for the home experimenter and service man?

The circuit shows an attempt to execute the following nearly hopeless movements: (1) "simplify" the coil system, to enable switching, with only one winding used for each stage; (2) atone for lack or r-f sensitivity by an overdose of audio amplification.

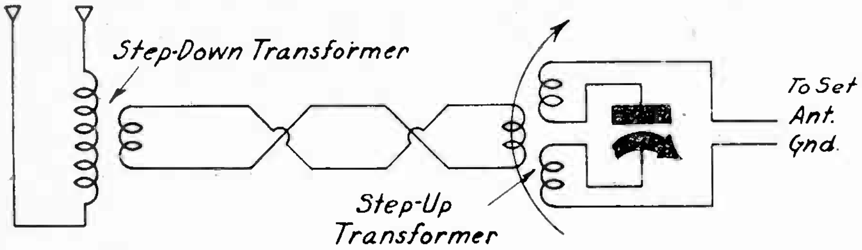
One factor that tends to destroy the hopes of the aspiring experimenter who tinkers with single-tapped-coil methods is that the distributed capacity is large across the total winding. In the past the distributed capacity of a coil has been taken to be, in micro-microfarads, equivalent to the diameter of the form in centimeters. That was for non-spaced winding. For spaced winding the radius was used as the factor, that is, the distributed capacity was supposedly halved. But nothing was said about the length of the winding. The distributed capacity methods, or makeshifts, including the above and the intercept method, proved out well enough for short coils, where the diameter and axial length of the winding were approximately the same, but not for long coils, for then the distributed capacity would turn out to be considerably more than expected. And every coil for broadcast and short-wave coverage, using the tapped system, would be a long coil as to its lowest-frequency use. Would it not be long also for the other use? Yes, it would.

Dead Spots

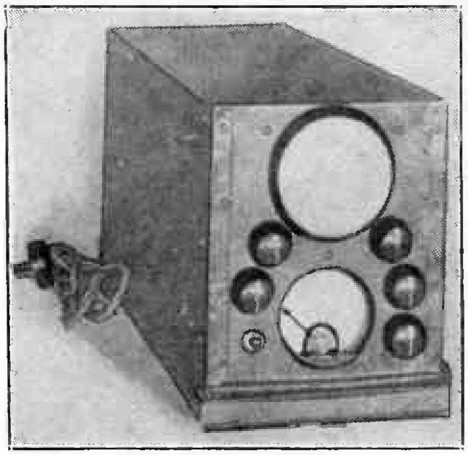
The whole winding, with all its distributed capacity, plus the input capacity of the tube, plus the socket capacity, would be in the total grid circuit, so much of the winding would be intentionally tuned as the tuning condenser would be across, but the aforesaid other capacities would tune the total winding to perhaps some other frequency than intended, and cause trouble, either interference or dead spots.

It was the common experience of the early all-wave sets of the commercial set manufacturers that they were "shot full of dead spots," due to coil conditions somewhat akin to those under discussion. It was mortifying what silly things some great names attempted. Honeycomb coils for very high frequencies, for instance. Yet honeycombs develop high resistance for unit inductance. Solemoids could have been wound efficiently on the same ⅜-inch diameter used for the honeycombs, and now are!

Radio University



The transformation system for a current-fed transmission line. The transformer next to antenna is of the step-down type, then comes the transmission line with transposed leads, connecting to the input transformer, which is of step-up ratio. Some suggestions for winding these coils are contained in the answer to a question from I.K.C.



View of a cathode-ray oscillograph assembly, with the viewing screen at top, meter below it, control knobs and switch.

PLEASE SHOW the transformation method and give transmission line details for the current-fed line.—I.K.C.

The transformation method is to have a step-down transformer at or near the aerial, attached to the inside terminals of the dipole or doublet. There should be a transmission line connecting the secondary of the step-down transformer to the primary of the step-up transformer. The secondary of the step-up transformer should be tuned. The extremes of this secondary should be connected to the set. Series tuning would be used as diagramed. The details of the transmission line can not be given, as they would depend on the coil constants, and these would be related to a particular antenna, and we do not know what antenna you are using, nor can we give special detailed data of this nature, anyway. The transformation is not commercial, as the commercial method is exclusively voltage-fed. Here the voltage has been reduced, the power remaining constant, the current naturally is up, therefore the line loss has to be reduced to a minimum by keeping the resistance very low. The current being high, only a small percentage of it will flow to ground through the capacity to ground in the transmission line and transformers, whereas in a voltage-fed line the loss to ground through even a small capacity, at the radio frequencies concerned, is large. The step-down transformer may be tried experimentally as 10 turns on 1 inch diameter, secondary 1 turn, transmission line a standard transposed method, and input transformer to the set, 1 turn primary, 20 turn secondary, center-tapped, with 75 mmfd. or thereabouts for the tuning. For results at particular frequencies use a signal generator and read the output meter in a set.

* * *

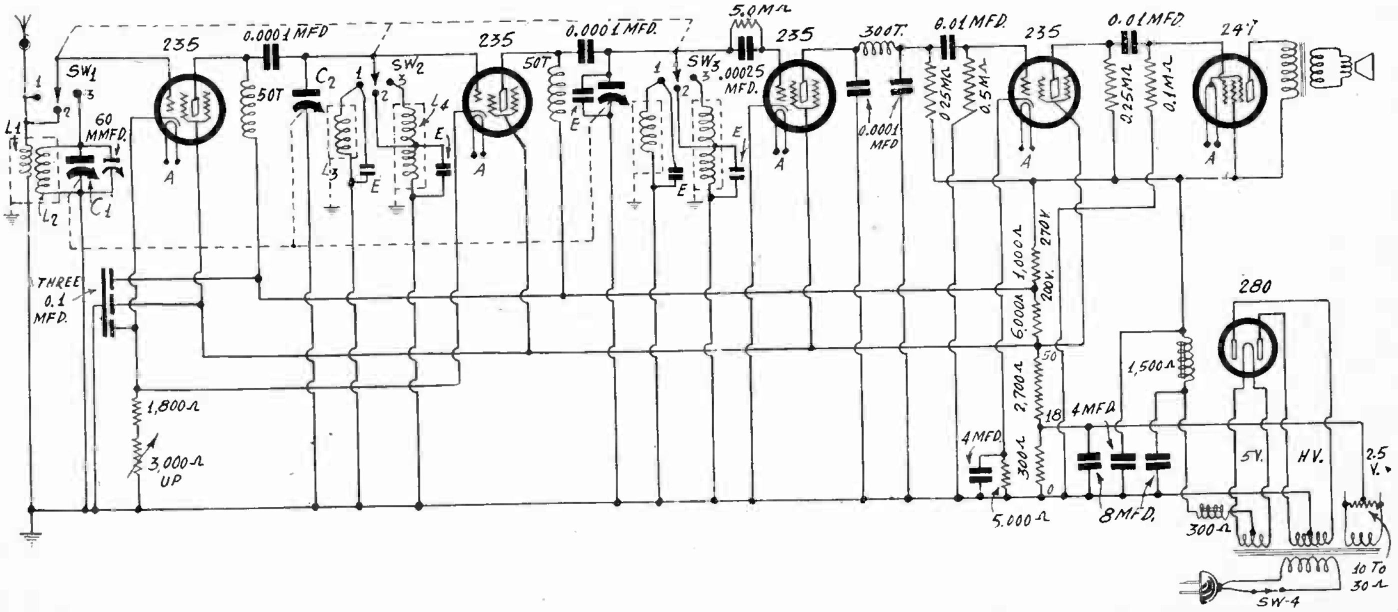
PLEASE TELL me what the oscillograph is and in general how it works.—H.S.D.

The oscillograph commonly used is the cathode-ray type tube. Electrons from the cathode are sprayed or shot onto a screen, as from a gun, and since the screen is fluorescent the introduction of a pattern would provide visibility thereof. So if frequencies are put itno the tube, to influence the cathode emission, the behavior of these frequencies may be studied by observation. A form of rectification enables the viewing of high-frequency currents and voltages due to a fixed ratio of reduction produced by other plates of the tube. The general appearance of a cathode-ray oscillograph, using the new 905 tube, is shown herewith. The viewing screen is at front top, while the meter below is for relative intensity measurements. The knobs control voltages, deflectors, timing, etc.

* * *

I AM DESIROUS of building a set with some parts that I have, and if you will excuse the request, I would like some assistance (a diagram), even though the methods may not be of the best. For the antenna stage I have a regular broadcast coil. For the second r-f and detector stages I have tapped broadcast coils, and an extra winding for higher frequencies. So I could tune in the broadcast band, police bands, etc., and one higher band, say, 4 to 12 mgc. Please give me the diagram, and some pointers.—U. H. H.

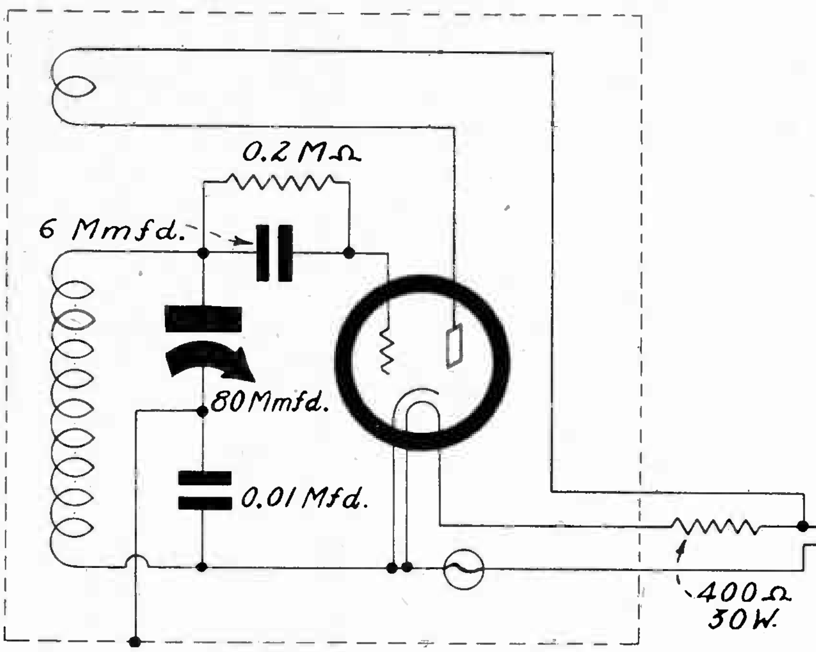
Here is the diagram. For switching, the primary of the broadcast bands is used for the two bands higher than broadcasts. Then for the third position (3) the secondary is picked up as usual. C1 is 0.00035 mfd. or a bit higher, and across it should be a good-sized manual trimmer. The 50-turn plate coil is a compromise in the first 35 circuit. The switching is carried out for the two tuned coils as you request. Small reception need be expected on the 4-12 mgc. band, next to nothing. The police-airplane-ship band will be good and of course broadcasts will be best. At least you will get something good for your pains, but this general method does not represent a satisfactory one for all-wave coverage, but rather typifies the group of inferior methods used in an attempt to simplify what is not simple.



Six-tube a-c receiver, giving good results on the broadcast band, and covering 1.6 to 4 mgc and 4 to 12 mgc. approximately, with none too much reception on any of the bands above the broadcast.

Newest Station-Finder Has Harmonic Counter

By Herman Bernard



One of the most interesting things about this station-finder is the fact that it contains an automatic electric harmonic counter. Where is it? What does it? How can it be? If it does work, is it accurate? How accurate? Where do you find it? Who puts it in there? Much interest attaches to this device. See accompanying text.

The circuit diagram of a station-finder, shown herewith, is like that of any other oscillator, the only unexpected values being the 0.01 mfd. series condenser and the 6 mmfd. grid condenser.

Since the circuit is for operation of the 76 tube, which is the 6.3-volt equal of the 56 tube, and since a shield cabinet is desirable, heavy insulation pieces are avoided by using the series condenser, and grounding the common point, which is frame or rotor for the tuning capacity. If the box is finished, using good paint or the wrinkle-black spray, even the slight voltage due to the drop in the 0.01 mfd. will not be felt when one touches the box and some other grounded chassis at the same time.

The fundamental frequencies of the station-finder are 500 to 1,000 kc. They are distributed practically over the entire dial span by the use of a tuning capacity of 80 mmfd., and it would be possible to encompass the same frequency distribution (with slightly higher inductance) if the tuning capacity were 75 mmfd.

Cabled Resistor

The limiting resistor for the heater is part of the a-c cable, so that three leads are present: (1) picking up one side of the line for one side of the heater, (2) picking up the other side of the line for the plate return, and (3) picking up the same plate-return side of the line, for interposition of the limiting resistor, to reduce the voltage for the other side of the heater. Insertion of a 30-watt limiting resistor inside the small metal box, almost hermetically sealed, causes the whole box to get too hot to touch. Everything is cool enough by the cable method.

Since the frequencies are 500 to 1,000 kc, it is easy to distribute them in frequencies 10 kc apart. Roughly, half of the broadcast band is taken care of in this way. Then for the second harmonic, about which there can be scarcely any confusion, the equivalent separation is 20 kc, except that one is able to estimate the half-way point between the bars, and thus retain the 10 kc situation that obtained at the lower frequencies.

A scale that is direct-reading in kilocycles may be made direct-reading also in wavelength, and though 1 per cent. accuracy obtains by the kilocycle method, it is not so easy to maintain this accuracy in application to wavelengths, but the accuracy is still good enough, and besides the wavelengths come in handy, not only for determining the wavelengths of stations in the fundamental band, which is unimportant, but stations on much lower waves, because the difference between adjoining fundamentals that cause harmonic responses at a particular frequency of a set equal the wavelength to which the receiver is tuned. That is, the unknown wavelength is the difference between the wavelengths of the adjoining fundamentals that produce harmonics. Therefore, to determine the wavelength of a station, pick up a response in the set due to any position of the station-finder dial, and turn the station-finder dial either way until another response is produced. The wavelengths of both positions are noted. The unknown wavelength in meters is the difference between the two, a method due to Edward M. Shiepe.

The Third Scale

Thus there are two scales accounted for, frequencies from 500 to 1,000 kc on one scale, wavelengths from 600 to 300 meters on the other scale. The third scale, or lowest one, represents highest frequencies, and enables the determination of unknown frequencies to which a receiver is tuned, practically without limit, although for the sake of ending the scale somewhere, the highest frequency is taken as 60 mgc. Whatever would anybody be wanting to measure 60 kc for? asks the poet from Ireland. But anyway the 60 kc are imprinted on the dial scale, and the next lower frequency is 30 mgc, the next 20 mgc, the next 15, 10, 9, 8, 7, 6, 5, 4, 3, 2 and 1 is last. There we have jumps of megacycles, from 1 to 10, jumps of 5 mgc and larger for the higher frequencies.

And yet this does not mean that the frequencies can not be read or determined for high-frequency values closer than, say, 30 to 60 mgc, or 15 or 20 mgc, for indeed the frequencies can be determined all along the line with the same 1 per cent. accuracy which applies to the fundamental, and besides the output will be steady, enabling output meter measurements without confusion due to needle wobbling.

The stability is attained by the use of the strange combination of 6 mmfd. and 0.2 meg. for condenser and leak. The capacity is six micro-microfarads, or 0.000006 mfd. It's the very small value, not the medium or the big one, in case you're confused.

When the constants are of the nature discussed, there is very small change in the amount of plate current, any one dial position compared to any other, and particularly is the very serious dip at the higher frequencies of tuning in this band quite absent. This wobbliness in this region is the serious drawback of most oscillators. Whenever you get interested in an oscillator or signal generator or station-finder, put a milliameter in the plate circuit, tune over the entire capacity range of the condenser, and note whether the plate current changes little, or not at all.

Interesting Aspect

If the needle stands practically still, the oscillator, signal generator or station-finder is stable. If the needle moves considerably, the oscillator, signal generator or station-finder is unstable.

One of the most interesting aspects of this station finder, which permits frequency determinations from 500 kc to 60 mgc, is the method of determining the 1, 2, 3, 4, 5, 6, 7, 8 and 9 mgc results, as well as the other multiple megacycles. This method is original. It is known now as the Automatic Electric Harmonic Counter. It uses no mechanical system, as is evident from the fact there is nothing associated with the accompanying diagram even suggesting any such thing. Therefore the origin must be mathematical. So it is. Yet you do not have to compute anything. It's all done for you by what amounts to the performance electrically of the functions of multiplication, subtraction and division, for the purpose of determining harmonic identity. The way this was worked out will be described in next week's issue.

WHAT SETS ARE SELLING

Radio set sales are marked by all-wave and auto sets almost exclusively.

TRADE WAR ON SHORT WAVES

While paid-advertising programs are not heard on short waves, except the rebroadcasting of long-wave programs on short waves without any extra expense to the sponsor, the commercial aspect is entering nevertheless, as foreign countries try to build up their trade with overseas prospects, by sending some entertainment by short waves, mixed with trade propaganda.

In the United States considerable propaganda from foreign countries is heard, but of a political nature. Most of this draws a big laugh, or roils the listener with disgust. The idea of winning over adherents or sympathizers with this type of propaganda goes great in the foreign chancellories, but it's sawdust under the foot over here.

European nations are getting keener about South American business, with the result that short-wave programs are sent in the native tongues of the intended recipients, and no such mistake is made as assuming that it's Spanish that's spoken in Brazil. The French and German short-wave senders have been particularly busy, and more intensive campaigns are under way.

How Locals Fare

The Germans have solicited the American press to print the programs intended for North American and South American listeners. Much of the intended South American material will be heard in North America. Some of the newspapers have been a bit keener about obliging than they would have been did they not see in short waves an opportunity to get the listeners away from the sponsored American program, which the newspapers believe simply extract advertising dollars that should go to the press. In fact, large newspapers carry daily short-wave programs, and even give space to German and English stations while completely omitting mention of some local stations, even not giving the call letters and frequency of some minor locals, much less the program. The newspaper enmity toward broadcasting is believed to be the reason.

The British will send special programs to the Argentine, as will the Italians. This is the big radio season in South America, where it is the equivalent of our Winter, but without the blizzards. The South Americans are mostly interested in hearing programs from abroad as a matter of entertainment. Static on broadcast frequencies at this time of the year is unbearable down there.

That Classical Music

The listeners are not without their interest in United States programs. South Americans that may hate Uncle Sam nevertheless like WGY. The calls of the short-wave transmitters of this broadcasting station are familiar and welcome to the South Americans. Perfect reception of W2XAF, Schenectady, N. Y., is constantly reported. Besides, there is showmanship in American broadcasts, and peppy events, like the Carnera-Baer fight. Germany and Britain do better with the classical music, but as one American station manager said: "Let them." A prize-fight for some reason not clear outweighs all the classical music ever composed.

American broadcasting interests say they have heard about this foreign propaganda for trade objectives and are retaliating with more and better programs for South America.

Lighting Line for Programs Tried Abroad

The lighting lines are being used as experiments for carrying radio frequencies and also audio frequencies. As for radio frequencies, the situation is familiar when one uses a signal generator or test oscillator that "feeds through the line," and of course the oscillation generated can be picked up by plugging into the lamp socket elsewhere in the building. Also, some sound engineers, desiring to avoid long-line special installations in night clubs and the like, mix an orchestra's music in an oscillator and send out the radio frequencies along the lighting line to some remote part of the club for pick-up by a set.

With audio frequencies used directly there are difficulties, due to the hum frequency of the line, usually 60 cycles. A common method is to have the audio amplifier dead from 100 cycles down, which is not considered so serious, and is approximately on a par with present broadcast receivers.

In Liverpool, Eng., the municipal corporation's electricity department recently co-operated with British Insulated Cables, Ltd., for "wired-wirelessing" some radio programs. Programs sent out to subscribers over wires use overhead wires at present, but large cities have banned the method, e. g., Manchester and Sheffield, as there are too numerous overhead wires already. Use of the lighting company's lines, which are buried, would enable the extension of wired-wireless programs, or relaying in that way regular air-broadcast programs. What the lighting company will get for the use of its lines, except thanks, is one of the problems. The test worked out satisfactorily.

"$200 Television Set Next Year"—DeForest

Television, like horseracing, fattens on differences of opinion. Some experts point to the enormous amounts of money that would have to be expended on transmitting stations if television were attempted on a commercial scale. Others do not bother so much about this detail, but mention that receivers of modest cost could be built, and nothing said about what stations are to send out something to be tuned in.

However, the television hopefuls are not without their status. There is Dr. Lee DeForest in this country and there is Marconi-E. M. I. Television Company, Ltd. in England.

Speaking in Montreal, Dr. DeForest, American inventor, prophesied that $200 television receivers will be on the market next year. He told of picking up outdoor scenes in bright sunlight, being able to identify the make of autos 100 feet away, and read the license numbers of cars 25 feet from the camera, when the results were viewed on a television screen 18 inches square.

The British venture is not without American aspects, as E. M. I. stands for Electrical and Musical Industries, Ltd., in which the Radio Corporation of America holds a large block of stock. The house of R.C.A. is divided on the television prospects, the business heads of manufacturing plants suffering from time-delay like an automatic-volume-control circuit, while enthusiasts about iconoscopes and kinetoscopes think that the present results being good—which all admit—the real impetus will be given when receivers are made and some transmitters put up to render the receivers of some value.

FEEDBACK CASE STILL GOES ON

In the championship court bout for the title of feedback inventor, the judges have rendered the final decision in favor of Dr. Lee De Forest, against Major Edwin H. Armstrong, but wait a second! It is well known that in this case even the most final judgment is only temporary and tentative. It is true that the Supreme Court of the United States has found that Dr. DeForest was the inventor, the recent decision having been written by Justice Cardozo. But a stay has been obtained, on the ground that certain technical aspects deemed to have led the court to its determination were haywire, and so there are to be more hearings.

The status of the case, aside from this new motion halting the execution of the judgment, is that the court has found in favor of Radio Corporation of America against Radio Engineering Laboratories, Inc., in a suit in which the defendant asserted that the invention was now public property, having been awarded by the Patent Office to Armstrong, who is precluded by a final judgment from asserting ownership, since the Circuit Court of Appeals awarded the patent to DeForest.

Financed by Armstrong

Armstrong financed the case for Radio Engineering Laboratories. His chief interest was to vindicate his reputation as the inventor and justify the many awards, medals, diplomas, decorations and miscellaneous other honors heaped upon him because of his important contribution to regeneration and oscillation technique.

In fact, Armstrong showed up at the recent convention of the Institute of Radio Engineers, in Philadelphia, and was ready to ask the Board of Directors to take back the medal given to him years ago, for his contribution to science by regeneration and oscillation, but the present board heard of this intention, passed a resolution affirming the action of the granting board, Armstrong received a great ovation, expressed his thanks with bashfulness and kept the award.

The Supreme Court held that DeForest and his assistant, Van Etten, on April 17th, 1913, received a "clear note, the true heterodyne beat note," due to mixing their local oscillation with the transmission of a carrier from San Francisco Beach.

It will be remembered that in 1906 De Forest invented the three-element tube, by introducing the grid as the third element to Fleming's diode, or two-element tube. This grid enabled the control of the current in the tube's functioning stream, increased the sensitivity of the valve or relay action, and, as later discovered, enabled the introduction of feedback or, to extend the feedback to beyond the spillover, to produce oscillations, or the generation of radio waves.

It was this use of the tube as an oscillator or sender of waves that made the tube so very important.

The court granted that Armstrong, then a young boy, had been working on the same basis at about the same time, nevertheless, though both made brilliant conceptions, DeForest came first, Armstrong's discovery having been made in January, 1913, and that of DeForest and Van Etten during the Summer of 1912. The beat from San Francisco was merely confirmatory of the 1912 finding, said the court, which said that DeForest's long delay in applying for a patent was explained, not fully convincingly, yet in a way that hardly justified saying that Armstrong's idea had antedated DeForest's invention.