SHORT-WAVE DEAD SPOT ELIMINATION!

(See Page 7)

RADIO WORLD

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625th Consecutive Issue —Twelfth Year

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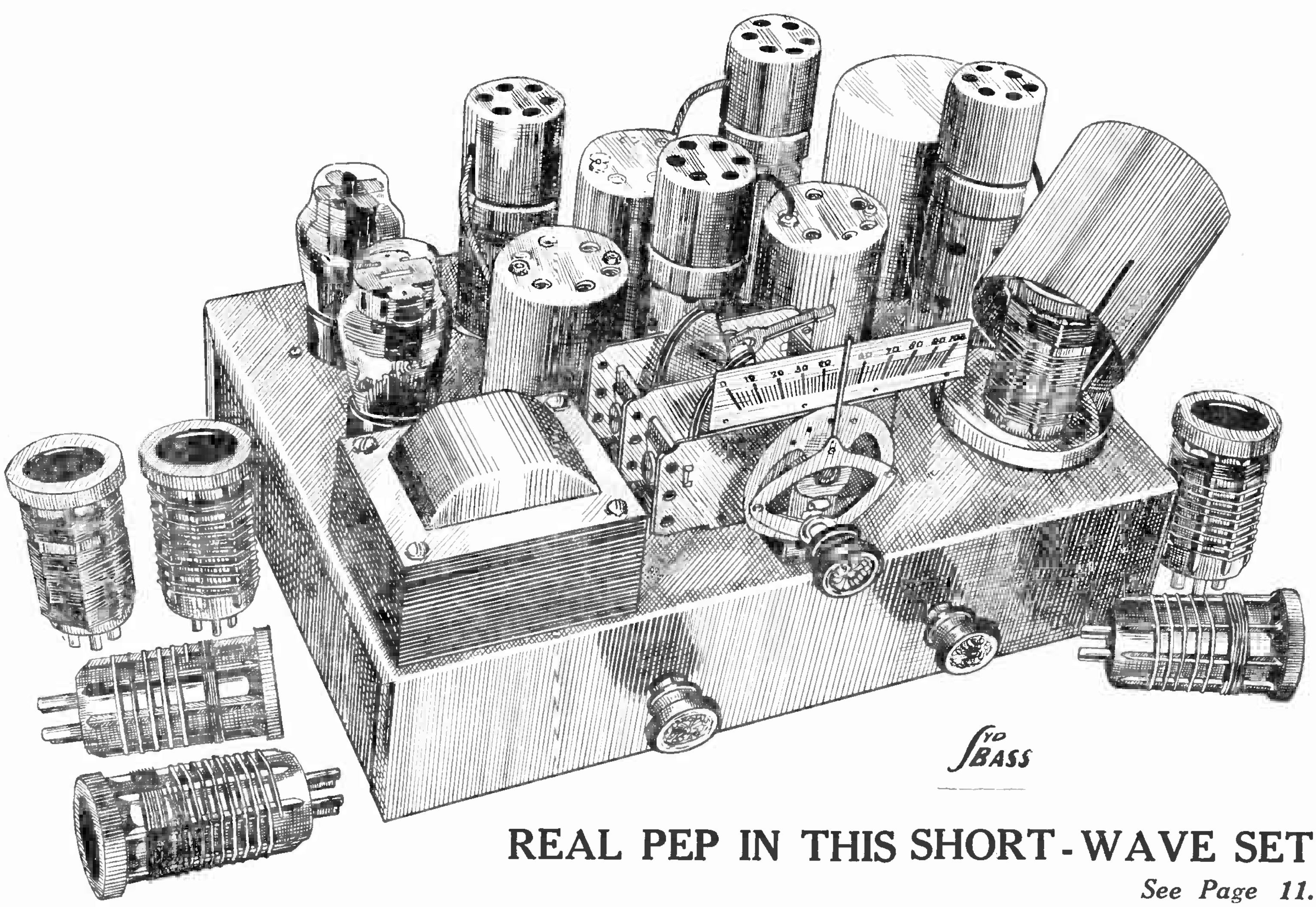
DYNATRON OSCILLATORS

Edward M. Shiepe's *Current - Resistance Volt Meter*

MARCH 17th, 1934

(TWELFTH ANNIVERSARY NUMBER)

A SUPER FOR SHORT WAVES



REAL PEP IN THIS SHORT-WAVE SET

See Page 11.

A FREQUENCY—STABILIZED BERNARD TEST OSCILLATOR

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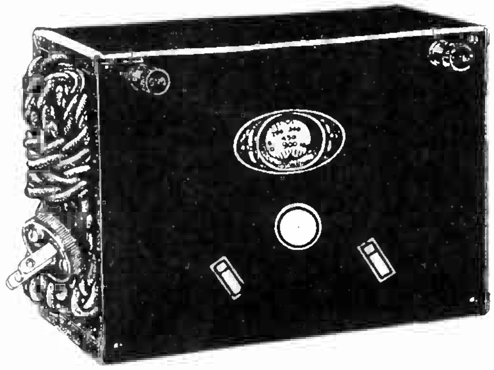

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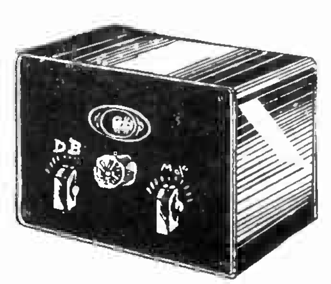

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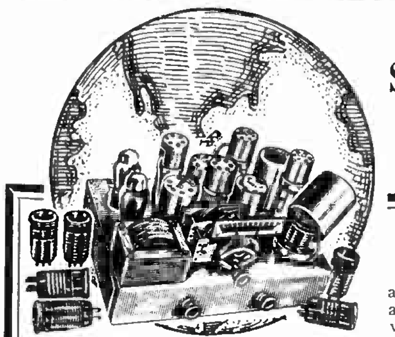

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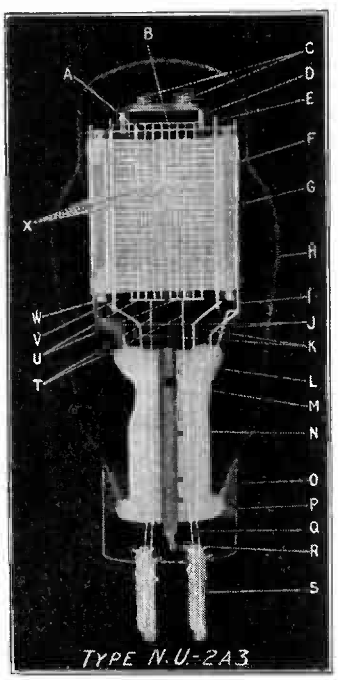

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TWELFTH YEAR

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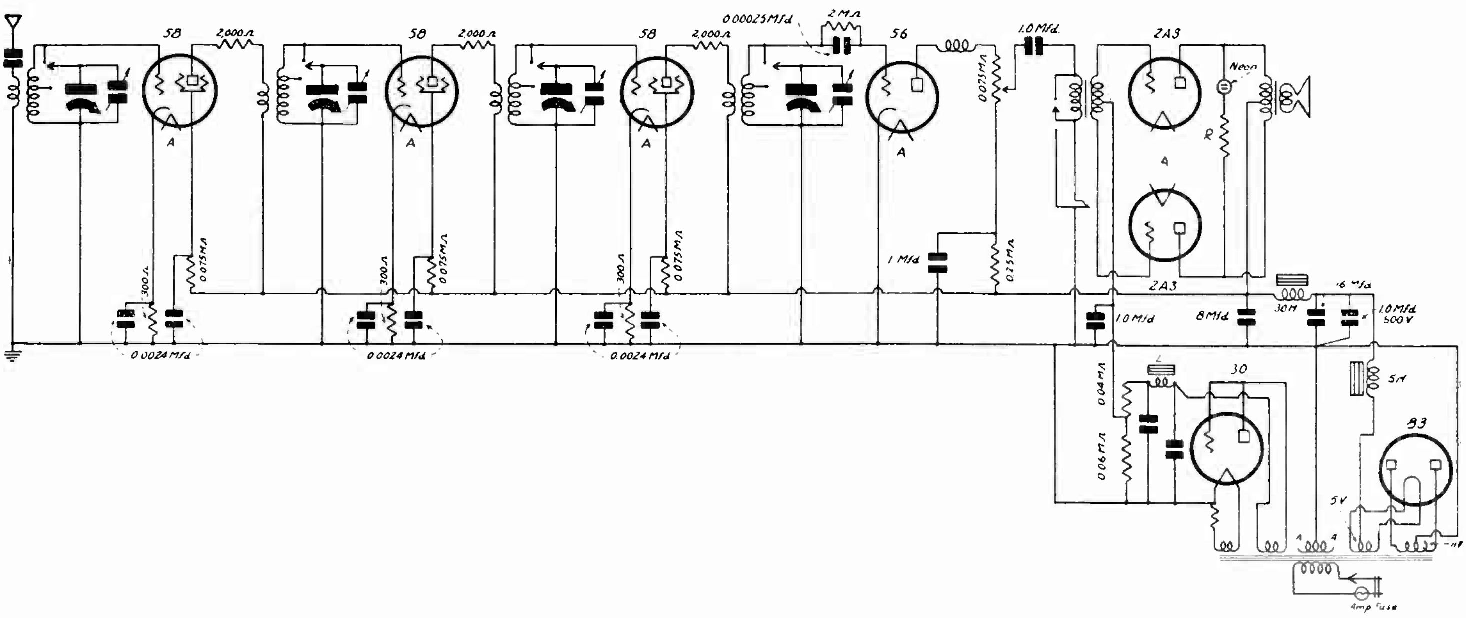
A CALIBRATION SET

T-R-F RECEIVER FOR IDENTIFYING FREQUENCIES ON TEST OSCILLATORS, AND FOR DUAL-BAND RECEPTION

By Warren L. Worcester



A tuned-radio-frequency receiver particularly suitable for determination of frequencies of test oscillators, no matter what those frequencies may be, including those above and below the range of the set proper. The receiver covers the broadcast and police-amateur-airplane bands. Amplification is levelled at radio frequencies by the series plate resistors.

SINCE many experimenters desire to calibrate oscillators, using broadcasting stations as standards, a tuned-radio-frequency receiver is necessary. Superheterodynes produce too many responses, due to sensitivity at different frequency levels, and the harmonics of multiple circuits, so that one can not know for a certainty what the external oscillator frequency is for such calibration.

So a set may be built of the type shown in the diagram. Then test oscillators may be calibrated practically without limit. As an example, a multi-range test oscillator was calibrated with just such a receiver, the fundamentals of the oscillator being 50 to 20,000 kc. And yet just a broadcast-band t-r-f set was used.

The receiver is shown as having dual range, that is, will tune in the broadcast band and also from about 1,600 to 4,500 kc, or so, but the higher-frequency range would not be necessary for calibration of such frequencies, though handy. Since the receiver, of course, is to be used for bringing in programs for entertainment, the dual range was included to give the added zest of police, airplane and amateur calls, as well as some short-wave re-transmissions.

Practically the only special provision in the receiver in consideration of the calibration objective is the earphone jack.

A series condenser is in the antenna circuit to reduce the effective capacity of the antenna so that tracking will be better than otherwise, and to improve the selectivity, since with present-day experience with superheterodynes one is likely to forget that a t-r-f set never has the selectivity of a well-designed superheterodyne.

The plate circuit series resistors are included in three instances so that the gain of the receiver will be practically uniform over the broadcast band of frequencies, and incidentally when the switch is turned for the higher frequencies there will be no oscillation in the r-f amplifier. With fairly large primaries, for the principal use of receiving broadcasts, there would be this oscillation trouble if precautions were not taken.

The Equalization Is Extensive

The series plate resistors require that selectivity be reconsidered, since at the higher frequencies they would work against selectivity. However, if the r-f channel squeals on the higher frequencies, as this one did with 20-turn primaries wound over secondaries, the introduction of the limiting resistor is not only a leveling effect in regard to r-f amplification but a stabilizing agency as well, and since there is good reception now in a region where previously there was nothing that could pass as such, there has been a gain. The selectivity has not been improved by the resistors at all, but the selectivity at the high-frequency end of the broadcast band is as good as it is at the low-frequency end, and in general equalized amplification, if carefully done, results in approximately equalized selectivity.

When we come to the detector we find a grid leak and condenser. This is more sensitive than the other method. Also we can be certain of recognizable harmonics, which we shall need for calibration purposes. The plate voltage applied must be low, around 45 volts, or a reading of around 40 volts between the upper part of the 0.075-meg. resistor in the plate leg and ground, taken on a meter of 1,000 ohms per volt sensitivity, 100-volt range.

Also "Silent Tuning"

The earphone jack has associated with it a single-pole, double-throw switch. Thus the audio transformer primary may be shorted out of circuit or the earphones shorted out. In this way you have the effective choice of switching from phone response to speaker response when the phones are in. Also, when the phones are out, the switch may be used for shutting off the feed to speaker, for so-called "silent tuning between stations."

The primary of the output transformer, looking toward the speaker, has a neon lamp across it that may be used for modulation indication. Relative values of modulation are judged by the intensity of the illumination. Also, on a strong enough signal, the lamp serves as a tuning meter. It should be the type of lamp with no series resistor in it. the smallest lamp you can get. Then insert the resistor R so that the lamp glows on average-volume reception. This resistance would have to be of the order of tens of thousands of ohms in the ordinary case.

Modulation Lights the Lamp

If the lamp is intended for 100-volt use, R is 100,000 ohms (a standard commercial case). The lamp will strike at around 70 volts and be well protected up to around 150 volts. The actual voltage is only a.c.. because there is no d-c through the total primary, due to the push-pull effect. An unmodulated carrier will not light the lamp. But all signals intended to be received are modulated, that is, no provision is made on the higher-frequency setting of the switch for c-w reception.

Due to the plate resistors the frequency stability is good also, and is adversely affected by nothing of a very serious nature except the compression type trimmers on the four-gang tuning condenser. These will change their capacity a bit due to changes in meteorological conditions, of no consequence except when one is tuning on the higher frequencies of either band, that is, using a small part of the tuning condenser capacity. Very particular persons may remove these compression type mica-dielectric trimmers and put air-dielectric trimmers in some other physical location, although electrically in the same position.

The volume control is after the detector for the reason that whatever would be done ahead would have some effect on the tuning, and we desire for calibration purposes a receiver that we may calibrate ourselves, to make it direct-reading in frequencies, for the broadcast band and the other band, and that will not have the calibration upset by a volume control or other inconstant.

Overload Indication

It is satisfactory even from a rather finicky viewpoint to locate the volume control where it is, because for 45 volts applied to the plate, measured from top of the 0.75-meg plate leg resistor to ground, the plate current does not cut off until the signal reaches 4 volts, so that an input up to 3.5 volts is permissible. With a working mu of 10 for the stage, 35 volts could be put into the primary of the audio transformer, so that with only a 2 to 1 transformation ratio, the power tubes would overload before the detector. The neon lamp could be made to denote the overload, by selecting a high enough resistance for R. Then the lamp would not light until overload occurred. By using a smaller R the lamp may be put in the grid circuit, grid to grid.

Tuning Inductances

The shielded tuning coils should be well made, and so that the inductances will be satisfactorily alike it is preferable to use commercially-wound coils, as home-made coils, wound by hand, result in unequal inductances due to differences in tension while winding, hence slightly different effective coil diameters. The full secondary inductance is 230 microhenries, while the inductance between tap and ground is 25 microhenries. The primary is wound over the secondary, with 0.02-inch insulation between, and consists of 20 turns of any fine wire.

The tuning condenser may be of 350 mmfd. maximum or even up to 500 mmfd., the only difference being that with larger capacities lower frequencies will be reached, and there will be more overlap between the two bands. Actually the coils are intended for a tuning condenser rated at 406 mmfd.

The negative bias for the push-pull tubes is obtained from a separate C supply, and if any have a 2.5-volt transformer with 110-volt secondary (three windings, including 110-volt primary) that may be used for the purpose. If the separate C-bias method is not used, and it is not imperative, then a self-biasing resistor may be connected between center of a separate 2.5-volt winding feeding the push-pull circuit only, and grounded B minus, around 700 ohms, no bypass condenser across it.

Class B May Be Tried

If the C bias separate supply is used, then Class B may be tried by using around 100 volts negative bias, no other change. One advantage of the separate C bias supply in that if the choke input is used in the rectifier, which choke reduces the resultant direct B voltage, the C supply helps out, as the biasing voltage is not taken from the B supply. For instance, suppose the applied plate voltage to the power tubes is to 350 volts, and the negative bias 62 volts. The plate voltage is measured from cathode (filament) to the lower end of the primary of the output transformer, and the bias voltage is measured between cathode and grid return. Between cathode and grid return would be the self-biasing resistor of 700 ohms, so if the drop there is 62 volts, the applied voltage 350 volts, the plate voltage is the difference, or 288 volts. This point must be watched carefully, for to maintain 350 plate volts, and 63 grid volts bias, the total voltage between grid, or grid return, and the plate feed should be the sum of the two, 392 volts.

The C bias supply is therefore a way of getting around a difficulty arising from a power transformer or system that of itself yields too low a voltage. The capacities used for C supply filtration need not be high, nor need the choke L be high, even the secondary of an old audio transformer serving the purpose.

For calibration of the receiver itself a separate oscillator should be used, covering the broadcast band. If desired, this may be built into the set, but with separate control. The reason is that the exact resonance spot can be determined, even from strong locals, by zero beating the separate oscillator and the station carrier. Also by beating with low broadcasting frequencies the set dial may be turned to frequencies twice as great (external oscillator's second harmonic) for determination calibrations at the higher end, while also harmonics of the test oscillator may be used entirely, by beating with broadcasting stations, for calibrating the police-airplane-amateur receiving range. Also later on when test oscillators at low frequencies aret obe calibrated, or even at higher frequencies than those to which the receiver responds directly, the external oscillator yields the definitive beats, always better than mere reception of the station alone on, where some signals would be strong, and otherwise occupy more dial space than one could desire, especially in a receiver that does not have the utmost of selectivity.

The Separate Oscillator

The separate oscillator may consist simply of a regular r-f coil used with inductive feedback from plate to grid, any suitable tube used, voltages as for detection, and a grid leak and condenser in the oscillator, grid return to cathode (or negative filament). The condenser may be 0.00025 mfd. and the resistor 50,000 ohms. Again, 2,000 ohms in series with the plate leg may help.

A tuning meter may be used in the detector plate circuit, 0-5 milliamperes being sufficient, and will read lower current the higher the input signal, therefore ascertain resonance by the minimum needle swing. The beat with a station, however, is enough audio to swing the neon lamp and thus enable use of the lamp as tuning meter.

B Supply Chokes

The choke L in the C supply has been mentioned as possibly the secondary of an old audio transformer, but the two other chokes, 15 and 30 henries, should be of the heavy-duty type, capable of maintaining their inductance at the specified values when 100 milliamperes are flowing. In general the 15-henry choke would be independent, but the 30-henry choke may be the speaker field, if of low enough resistance, not more than several hundred ohms, as the regulation of the B supply which it is intended to maintain excellent so that voltage changes will not affect radio frequencies, would depend on the resistance of the chokes. So, too, the 15-henry choke must be of low resistance.

The 1.0 mfd. condenser after the 15-henry choke, and in parallel with the 16 mfd., is paper dielectric, 600 volts rating, the cast of the 1.0 mfd. condensers 300-volt rating. The reason for the 600-volt condenser is that the 16 mfd. might consist of electrolytic capacity, say, two eights in parallel, and the hum will be less if the 1.0 mfd. paper condenser is included. In fact, the hum is kept extraordinarily low.

It should be pointed out in connection with the 15-henry choke that standard recommendations by tube makers is that this inductance should not be less than 20 henries.

Cure for Gurgling

If there is a strange noise, sounding like gurgling, it is due to oscillation in the rectifier, and then two r-f choke coils, of not less than 1-millihenry inductance each, should be put in series with the rectifier plates. One choke would go, for instance, from one plate of the 83 to one side of the high-voltage winding, and the other choke from other plate to other side of the HV winding. A very quiet circuit results from the use of a stabilized mercury-vapor rectifier, the 83 being selected simply because it takes 5.0 volts on the filament, though if you have a 2.5-volt winding you could use the smaller mercury-vapor rectifier, the 82.

Now as to the calibration.

First we calibrate the receiver at both

(*Continued on next page*)

(*Continued from preceding page*)

ranges. This is done for the broadcast band as follows:

Line up the receiver by trimmer adjustment at around 1,500 kc.

Starting with nearly maximum capacity, bring in the lowest-frequency broadcast station you can receive. Write down on a sheet of paper the dial setting and the frequency. Then progress to higher frequencies, tuning in stations on the set for standards of frequencies. When you have obtained as many points as possible, with as good distribution as you can, get some cross-section paper of large size, and on the bottom write the dial settings, zero at left, maximum (100) at right, and on a perpendicular write the frequencies, so arranged that multiples of 10 are readable. Thus for 0-100 dial the bottom may consist of ten squares of ten. As the broadcast band now has 1,060 kc difference, maximum to minimum (540 to 1,600 kc), have at least 106 lines up and down, or, for excess, eleven squares of ten, so that the whole plotting will be approximately square.

Curve Plotted

Register the points tentatively in pencil on the plotting paper and draw the curve. Unexplored poins in the high-frequency region of the broadcast band now may be established if one has a test oscillator, by multiplying the lower frequency of a broadcast range-test oscillator by two to yield the second harmonic for the higher broadcast frequencies. Thus the receiver may be checked as to where frequencies come in, 1,080 to 1,600 kc, on the basis of test oscillator fundamentals of 540 to 800 kc, that is, the set uses the second harmonics 2 (540 to 800). The extent of this service will be measured largely by the number of low frequencies, 540 to 800 kc, that can be tuned in on the set itself for registration of exact zero beats in the interest of test oscillator accuracy and callibration accuracy in general.

By directly using station frequencies in the second band, 1,600 to 4,500 kc, the same procedure obtains as for the broadcast band, but the frequencies are not as readily obtainable, and some of them are not so steady, so a test oscillator that covers the broadcast band may be used for its second and even third harmonics.

Use of Protractor

When the curve is prepared and checked for the higher band, the dial result is changed to degrees of a circle, and for a condenser that rotates in a semi-circle (180 degrees), as most condensers do, the dial-reading factor is multiplied by 1.8.

Now it is practical to use a protractor, which may be purchased in a stationary store for a quarter or 35 cents, and from the curve you read the positions for every 100 kc in the broadcast band and at least every 30 kc in the higher frequency band. Prepare a scale in this way to fit on your dial mechanism, so that you will have a frequency-calibrated dial. Now the frequencies may be read directly and dependably.

It is clear, of course, that any frequencies of a test oscillator or any other transmitter that fall in the two ranges of the receiver may be checked directly by reception. There are two remaining considerations: (1) frequencies lower than the lowest to which the set will respond and (2) frequencies higher than the highest to which the set will respond. In respect to the lower frequencies we have no methodical choice, but in respect to the higher ones we may use either band.

Differences Averaged

The low-frequency determination is easily made. Suppose a modulated test oscillator is generating an unknown frequency. This is put into the receiver so that a harmonic of the test oscillator comes in at a given frequency F_2 on the receiver, which frequency we read from the set's dial. Now we turn the receiver dial in the direction of a lower frequency until we pick up another harmonic of the test oscillator and note the frequency, F_1. The frequency of the test oscillator is then the difference, or $F_2—F_1$. Now go back to the original point, F_2, and move toward a higher frequency, stopping at the next response point, F_3. Now subtract F_2 from F_3, add this difference to the previous difference, and divide by two. The adding and dividing are done simply to average the readings and are in the interest of accuracy.

In this manner any low-frequency oscillator may be calibrated, down to 20 kc safely, and once the experimenter has has bearings he may use broadcasting stations as accurate standards, by beating their fundamentals with test oscillator harmonics, and actually identify the harmonics.

Now Turn Oscillator Dial

When one harmonic is identified, particularly at a low-frequency setting of a test oscillator, then the receiver may be left intact at one station or frequency, and the oscillator dial turned. Say the frequency of the test oscillator was 50 kc heard at 600 kc in the receiver (12th harmonic of t.o.). As the oscillator dial is turned the frequencies generated will be higher, hence the harmonics of the test oscillator beating with 600 kc will be lower, and the order of progression of t.o. frequencies is 600/12, 600/11, 600/10, etc., or 50, 54.545, 60, etc., kc.

Now for determining frequencies higher than those of the broadcast band, assuming that band is used for the test, because of easier and more dependable reference to frequencies of stations on the air.

Tune in a station or tune in a broadcast test oscillator on the receiver. Insert earphones. Suppose the frequency is 800 kc. Now the device is to be calibrated, say, another oscillator, is set going, and tuned until a beat is heard in the phones plugged into the receiver jack. A beat is present because there are harmonics in the set's detector grid circuit and the beat is registered and communicated as an audio frequency. Make the beat as low as possible in frequency. Reduce it to zero if you can. Remember that frequencies higher than the set's resonant frequency by some harmonic order (2, 3, 4, etc.), are present, and you are to use this fact in calibrating.

Now if you leave the measured oscillator circuit intact and turn the receiver dial another beat will be heard, related to the first by the frequency difference of the two settings of the receiver dial. As the general region is known, the frequency is easily identified as to its harmonic of the difference registered in the broadcast set.

Elimination of Line Noises

A PRACTICAL LINE FILTER FOR SHORT-WAVE RECEIVERS

By A. D. Lodge

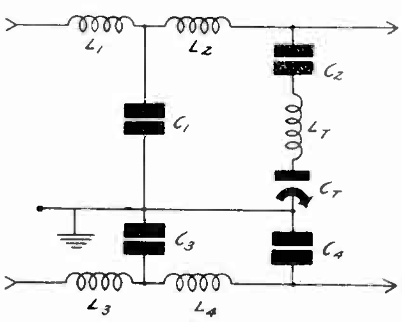


FIG. 1

The circuit diagram of a line filter for the elimination from a short-wave receiver of the noises that exist in a power line. The filter is tuned to predominant noise frequency.

List of Parts

C1, C2, C3, C4—.0055 mfd. fixed mica condenser.
CT—.0001 mfd. trimmer condenser.
L1, L2, L3, L4, LT—Five 100-turn honeycomb coils (Harrison).
Shield can.
Bakelite sub-panel.
A-C cord and plug.
A-C outlet.
Miscellaneous hardware.

WE have modern, selective receivers and we erect carefully designed antenna systems, yet all these precautions are in a measure spoiled if we overlook the greatest remaining collector of noise—the house wiring that offers a conductive path from the many sources of man-made disturbance directly into the heart of our receiver. Through this unguarded portal may enter the roars, crackles, and sputters that mar the otherwise perfect reception of distant stations. True, there have been many line filters, but being in general designed primarily for the broadcast receiver, they are practicaly inoperative on the higher frequencies.

The writer's assistance was requested in clearing up a particularly troublesome case of noisy reception. Every known noise reducer—doublet antenna—transposed leadin—ordinary line filters, etc., had been tried but there still remained an annoyingly high noise background. It was then decided to tackle the problem through the back door, so to speak, by designing a line filter that would really be effective on the higher frequencies.

The result of many weeks' experiments in several different locations is shown in Fig. 1. Literally hundreds of different combinations of inductances, condensers, and resistances were tried in an effort to produce a filter that would absolutely eliminate every trace of line noise in the short wave receiver between 11 and 200 meters.

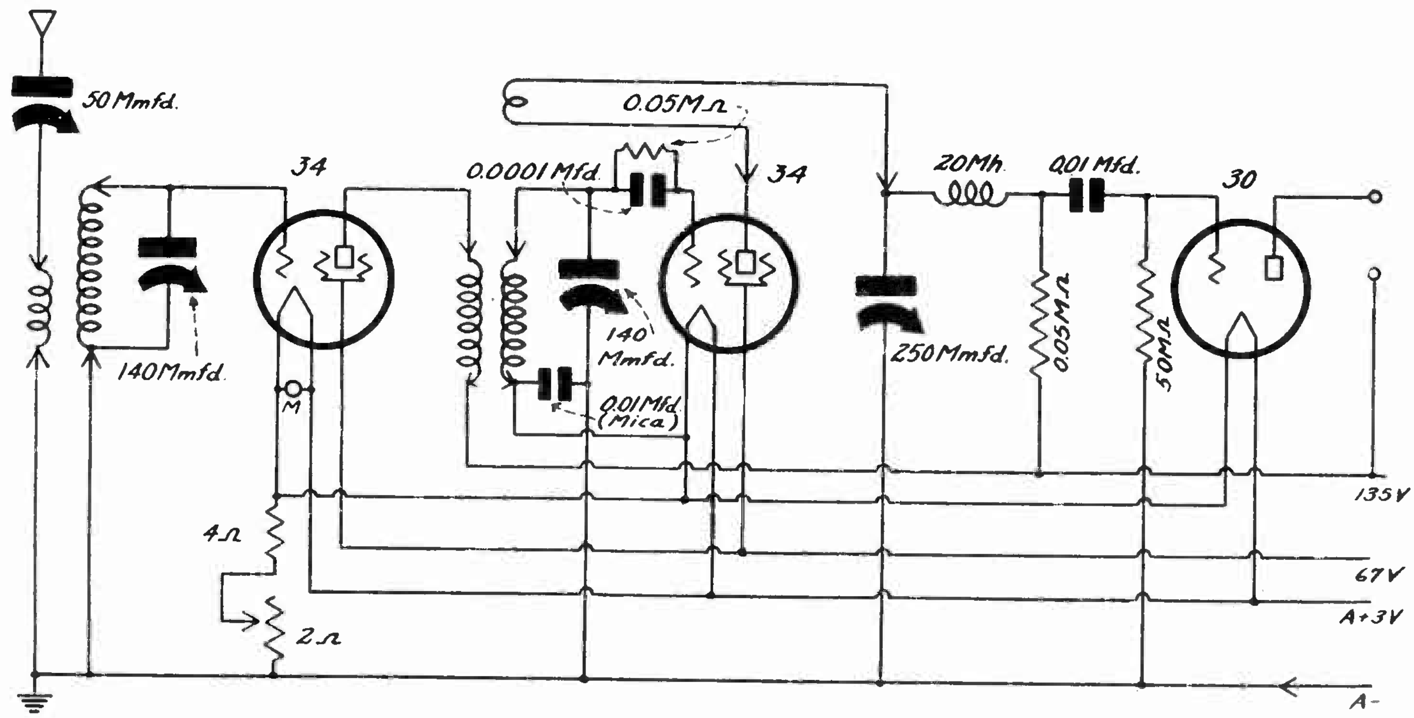
Needless to say, the values given in the diagram are those which were found to be superior to all others in producing the desired results, and any deviation, except where noted, is not recommended. All types of inductors, from the old "spiderweb" to bank-wound solenoids were tried, but the duo-lateral or "honey-comb" coil with its low distributed capacity was found to be most effective. Incidentally, as the inductances must be able to carry the entire current drawn by the receiver, the heavy wire used in the "Harrison" duo-lateral coils

(*Continued on page* 17)

AVOIDING DEAD SPOTS

in a Regenerative Short-Wave Earphone Receiver

By Jack Tully



A very inexpensive short-wave circuit that produces excellent results, especially when precautions against dead spots are taken according to the suggestions made in the accompanying text. It is advisable to hold the filament voltage at just 2 volts, so a meter to read that voltage is suggested.

THERE can be no doubt as to what is the most popular short-wave circuit. Naturally it has to be one that does not cost much to build, yet it can not be one that fails to yield excellent results. Despite the close tuning adjustment necessary, occasioning a critical aspect that may as well be admitted, the regenerative detector is a certainty as to its inclusion in the most popular short-wave circuit. Why? Because so much can be obtained for so little. But regeneration alone is not quite sufficient for those enthusiasts who listen with joy to foreign reception, because all interference must be eliminated, and an extra tuned circuit will do it. Therefore the circuit consists primarily of a stage of tuned-radio-frequency amplification and a regenerative detector, familiar indeed, and yet blessed with those advantages which the real short-wave enthusiast who can not afford a big superheterodyne really craves.

Audio Stage Included

One might stop there, except that it is a known fact that the general intensity of signals from abroad is not as great as that of broadcasting stations not unreasonably distant from the listening post. Sometimes, to be sure, London or Paris or Madrid or Rome comes in with such steadiness and such volume that a fellow feels he must be listening to a local, although secretly triumphing in the known fact that he is crossing the ocean for his radio entertainment. The rule is adamant, nevertheless, despite the comforts of the exceptions. More volume would be welcome often, and so an audio amplifier is included to meet this real need.

The circuit is then not the most popular one, since the two-tube device is the one that gains the greatest favor for earphone reception, as the four-tube hookup the leading one for speaker operation. Yet when the advantages are fully realized by the earphone listener, especially after he has gone through the experiences of the author, he will want that stage of audio, not that it makes a single station audible that could not be heard before, but because it raises the audibility of the weak station beyond that exasperatingly low level that requires utmost quiet all over the house, if not in the entire neighborhood, before the program becomes intelligible to the listener. And a strong point on the score of intelligibility is recognition of the announcement that gives call letters and wavelength (or frequency), sometimes missed because the amplification isn't great enough.

And so the standard circuit, with its t-r-f stage and its throttle type regeneration control, is shown, followed by a step of audio amplification, for so many are now entering the short-wave ranks, and indeed building radios for the first time so they can hear short waves, and what is familiar to the old-timers is brand-new to the newcomers.

May Help Old-Timers

But even the old-timer well may learn a little something about the circuit. It can not be said that even the regenerative detector has been fully conquered. Frequency stabilization still is to be introduced in such a circuit. It is not included in the present one beyond the stabilization effect of the leak-condenser action in the detector, which prevails over most of the tuning for any band, for practically three-quarters of the capacity of the condenser in the higher capacity direction. Stabilization of frequency is important but not vital in such a set just at the moment. When its solution is found for simple duplication in such a circuit the detuning effect of the throttle condenser will be almost eliminated. This effect is slight but undeniably present.

Now there are two important factors concerning this receiver or any other receiver like it. One is the necessity of elimination of dead spots and the other is ability to select the desired frequency for reception to the exclusion of all other frequencies, that is, selectivity.

Dead spots arise as a general proposition from a trap circuit. If the antenna is tuned to the frequency to be received, or to an harmonic thereof, such tuning being accidental and due to the constants of resistance, inductance and capacity as they exist, the signal is shorted out. What we want to put into the set is instead put into the trap circuit. Like it or not, we have a wave trap.

So a series antenna condenser is a great help, for the aerial may be detuned from the trap frequency or harmonic, and the detuning may be so closely made with ease that the signal we desire is boosted enormously, and we gain practically the advantage of a transmission line input. Moreover it is the type of antenna coupling that does not result in losses due to bypass capacity between leads to ground. Acceptance is held high with losses at a minimum to input. Thus do we take the first step to avoiding dead spots.

Increasing the Leak

The second step may be taken under the following conditions: Should the circuit be quiet in operation, and not develop a howl at the higher frequencies of tuning particularly on the smallest coil, the grid leak value in the detector may be raised. The value is shown as 0.05 meg. (50,000 ohms), but there will be greater sensitivity and a further and practically complete safeguard against dead spots if the leak is raised, say to 1.0 meg. or even higher, provided the detector does not become then an audio howler. This is the limitation and within

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Second Harmonic Determination by Graphic Method from Curves

By J. E. Anderson

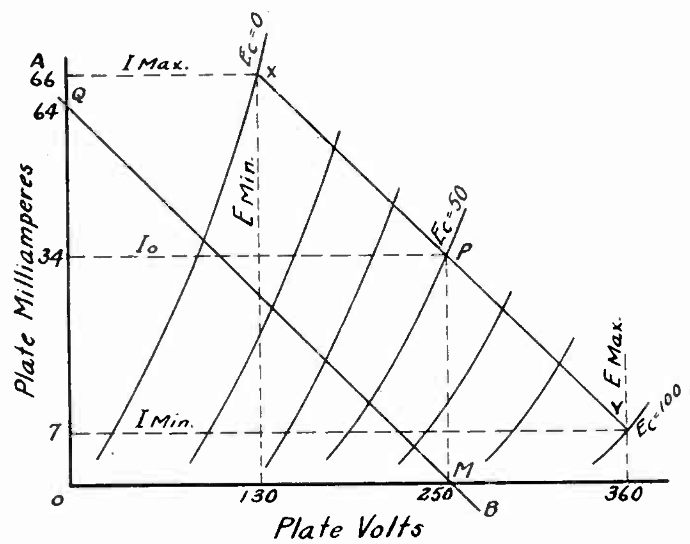

FIG. 1

A family of plate voltage, plate current curves for a power triode illustrating how, by means of load lines, the output power and the percentage second harmonic can be determined graphically.

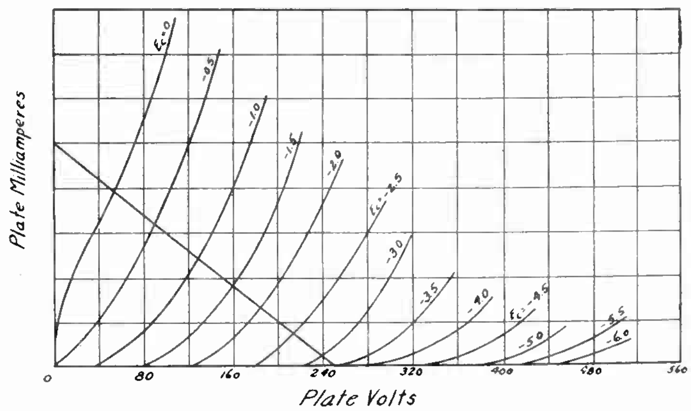

FIG. 2

A family of plate voltage, plate current curves for a 75 high mu triode, showing how the voltage amplification can be obtained under specified operating conditions.

THE total undistorted power output of an amplifier under stated conditions can be obtained from a family of plate current, plate voltage curves, and it is also possible to estimate the amount of second order distortion, that is, distortion due to the second harmonic.

In Fig. 1 we have a typical family of plate voltage, plate current curves for a triode power tube. The first thing to do is to establish a load line corresponding to the resistance of the load that is put on the tube. This line is drawn across the family of curves with a slope equal to the reciprocal of the load resistance. The first step in drawing this line is to find the slope. Suppose the voltage in the plate circuit is 250 volts. When no current flows this voltage exists on the plate of the tube. Therefore, we find our first point on the line on the voltage axis at 250 volts, which is indicated by M in the figure.

Now, suppose that the load resistance is 3,900 ohms. When this is put in series with 3,900 ohms, the current will be nearly 64 milliamperes. When this current flows the total drop is in the resistance and the voltage on the plate is zero. Hence, we find the second point on the line at Q, where the voltage is zero and the plate current is 64 milliamperes. Draw the straight line AB through these points, M and Q. This might be called the auxiliary load line.

Actual Load Line

If the d-c resistance in the plate circuit is negligible, the auxiliary load line does not represent the facts. Suppose we are operating the tube with a negative bias of 50 volts and that at that bias the plate current is 34 milliamperes. The d-c voltage on the plate is 250 volts. Therefore the operating point is at P, where the 50-volt bias line crosses the 250-volt plate voltage ordinate. A line XY through P and parallel to the line AB is the true load line. Since it is parallel to the first line, it represents the same load resistance, but being higher up, takes into account the plate current and the d-c plate voltage at the operating point.

Now, when the instantaneous bias on the grid varies, the current will vary along the actual load line. If we allow the grid potential to just reach zero bias at the peak of the signal wave, the maximum plate current is determined by the point X. At this point the plate current is 66 milliamperes and the plate voltage is 130 volts. Now, when the signal reaches the other extreme, the grid voltage is—100 volts, for the signal varies 50 volts each side about the 50 volt bias. The minimum current is determined by Y. The maximum plate potential is also determined by this point. Therefore, the minimum current is 7 milliamperes and maximum plate potential is 360 volts.

We now have sufficient data for determining not only the power output on the fundamental but also the percentage of second order harmonic. The power is one-eighth of the product of the current and voltage changes. For example, the maximum current is 66 and the minimum is 7 milliamperes. The difference is 59 milliamperes. The maximum voltage is 360 and the minimum voltage is 130 volts. The difference is 230 volts. Therefore, the output power is (0.059) (230)/8, or 1700 milliwatts.

Explanation of Formula

When direct current and voltage are concerned, the power is given by the product of the current and the voltage. When alternating current and voltage are concerned, and if they are pure sine waves, the power is given by one-half the product of the amplitude of the current by the amplitude of the voltage. The changes in the current and voltage above were twice the amplitude. Hence, to get the amplitudes we have to divide each by 2, and then the resulting product by 2. Thus, the factor 8 centers.

The question may arise as to the source of the extra plate voltage. The d-c voltage applied is only 250 volts, yet the maximum voltage on the plate is 360 volts. This comes from the energy stored in the output transformer when the steady current MP flows, in this case 34 milliamperes. Work had been done on the transformer to start the current of 34 miliamperes through it and the transformer can return this work in such a way that the voltage generated is added to the steady polarizing voltage. It should be remembered that potential is work done.

Harmonic Distortion

It may be shown that the percentage of second harmonic is given by the ratio of the mean value of minimum and maximum currents diminished by the mean current to the difference between the maximum and minimum currents, all multiplied by 100. In symbols it becomes

$\%D = [(I_{max}+I_{min})/2 - I_o]\ 100/(I_{max} - I_{min})$.

If we apply this formula to the above case we have $(I_{max} + I_{min})/2 = 36.5$ $I_o = 34$, $(I_{max} - I_{min}) = 59$. Hence, the percentage distortion on the second harmonic is 4.24 per cent. The conventional limit for this distortion is 5 per cent. Hence, this particular tube is not overworked when it is operated with 50 volts bias and a signal amplitude equal to the bias.

Application to Resistance Coupling

When this method of determining the output power and the harmonic distortion is applied to a resistance coupled tube, that is, a tube in which the load is a pure resistance, the actual load line coincides with the line we called the auxiliary line. In this case it is necessary to apply the maximum voltage.

If we apply to the case when the load is a pure resistance of 3,900 ohms with a plate voltage of 250 volts we do not get nearly as much power, because the maximum current is not more than about 40 milliamperes and the maximum voltage not more than about 225 volts.

The same method may be used for deter-

(Continued on next page)

DYNATRONS WOBBLE

OSCILLATORS DIFFICULT TO STABILIZE BY SIMPLE MEANS, COMPARED TO AN ASTONISHING RESULT USING THE 30 TUBE

By Herman Bernard

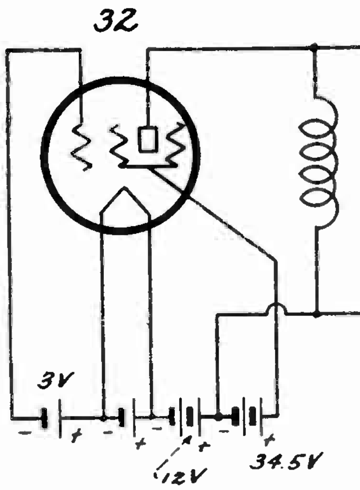

FIG. 1

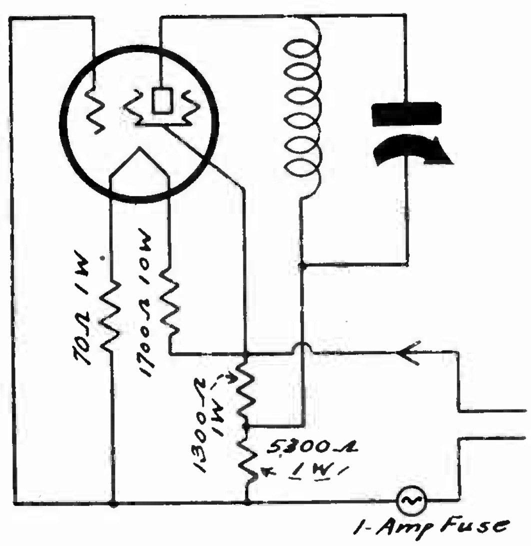

FIG. 2

BECAUSE of its simplicity the dynatron oscillator has been under serious discussion for years, and since frequency-stabilization has engaged the attention of experts, the valuable contribution has been applied to the dynatron as well. However, the most successful application concerns the use of a separate rectifier tube, so that the intensity of the oscillation governs the negative bias on the oscillator tube directly, and thus the operating level is held constant. This particular circuit requires two tubes and is usually battery-operated. In fact, the scientists who have been writing about frequency stabilization in the learned periodicals have been concentrating on battery-operated devices exclusively.

The dynatron principle is one of utilizing the reverse direction of current flow through one of the elements. For instance, suppose you have a screen grid tube of the type that lacks a suppressor, say, the 24, 22 or 32. Under certain applied voltage conditions, for instance, while the current is flowing in the usual direction from cathode to screen, the plate current is flowing in the opposite direction, from screen to plate, hence in the direction of the cathode. Then the reverse action in the plate circuit may be described as a negative resistance. The sign must be negative in any oscillator.

Screen Higher Than Plate

The voltages are critical, but may be found by putting a high-resistance potentiometer across the voltage supply. The plate always will have a lower voltage than the screen. Hence, maximum voltage normally is applied to screen, less than maximum must be applied to plate. It is conceivable the plate voltage could be zero. For the 32 tube, for instance, for 67 volts on the screen the plate voltage may be 30 volts. The absolute values of voltage are not important, but the relationship of the voltages is vital and this accounts for the critical aspect.

If a meter is put in series with the plate circuit, say a 0-1 milliammeter, usual direction, negative to plate, positive to voltage supply, during certain voltage conditions, where the plate voltage is either too high or too low, there will be no oscillation. In fact, oscillation will be absent at any time that the meter shows a reading in the positive direction, for it is only when the needle tends to go off scale (minus direction from zero) that oscillation can be produced. This is the negative resistance condition. The meter should be reversed.

Sharp Beats Desired

Now, the needle will move in the right direction, and as the voltage is changed a bit the current will go "wrong" again and then right itself. The point where oscillation is best may be obtained experimentally, and does not concern the gas in the tube, as has been stated by some in the past, but the proper apportionment of voltages.

While there may be oscillation, it is likely to be absent nevertheless over part of the span of tuning, and this simply discloses wrong voltage apportionment. The screen voltage always may be left as it is found and the plate voltage varied to a value less than the screen voltage so there is not only good oscillation at the highest frequency of tuning, but also a decisive zero beat is obtainable with some station, using either the fundamental of the oscillator if in the broadcast range or an harmonic of an oscillator that works at lower frequencies.

There will then be oscillation all over the dial, but it will not be stable. In fact,

(Continued on next page)

High Amplification from Single Triode

(Continued from preceding page)

mining the voltage amplification in a resistance coupled amplifier. The load line is drawn from the point of zero current and applied plate circuit voltage, with a slope equal to the reciprocal of the load resistance used. The second point is determined by dividing the applied voltage by the resistance and the current thus obtained gives the second point on the current axis. But let us illustrate the procedure by a drawing.

In Fig. 2 we have a family of plate current, plate voltage curves for the 75 high mu tube. The applied voltage is 250 volts and the plate load resistance is 250,000 ohms. The load line passes through the voltage axis at 250 volts and through the current axis at one milliampere. We assume that the grid bias is 1.5 volts and that the signal peak voltage is equal to this. Therefore, the grid swing is between zero bias and 3 volts bias. The load line cuts the zero bias curve at 52.5 volts and the 3 volt bias line at 235 volts. A change in the grid voltage of three volts, therefore, produces a change of 182.5 volts, making the amplification 182.5/3, or 60.8 times. This is a high amplification for a single triode. And it can be increased considerably by increasing the load resistance. If the frequency to be amplified does not exceed 10,000 cycles per second, it is allowable to make the load resistance on this tube as high as one megohm. This would boost the voltage amplification, on the low frequencies, to about 77.

The percentage distortion in this case can be obtained by the same formula as that used for the power tube, except that voltages are substituted for currents. Emax would be the plate voltage when the current is minimum, Imin, and Emin would be the voltage when the current is maximum, Imax. E_o would be the plate voltage when the current is that determined by the grid bias.

MODEL 30-AB TEST OSCILLATOR

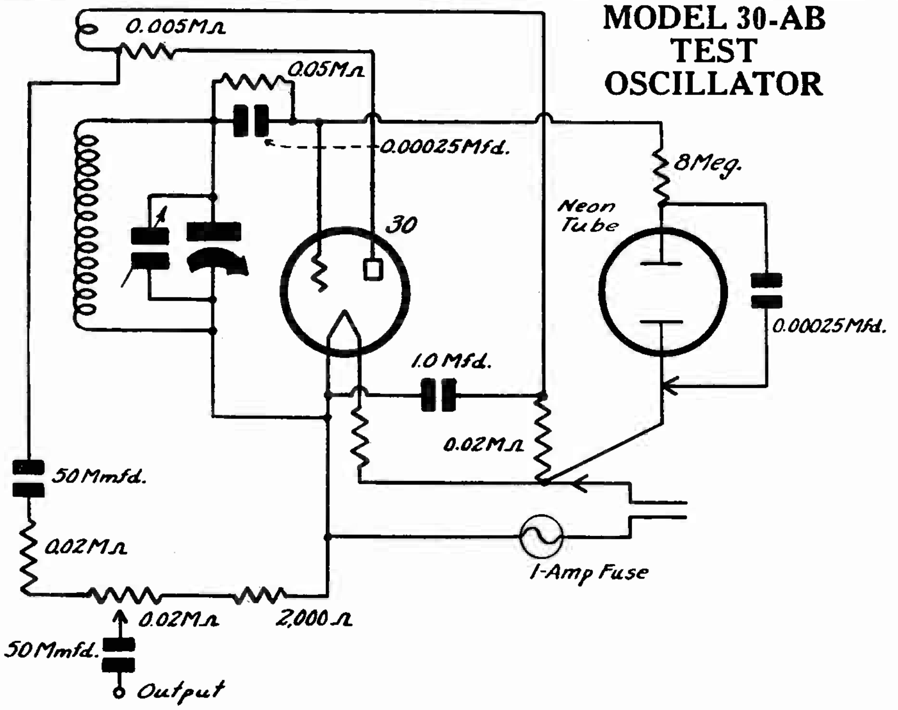

FIG. 3

A stabilized circuit, using the 30 tube as r-f oscillator. On a.c. the line frequency (hum) is the modulation. On d.c. and batteries this universal test oscillator remains stable and selective because of a separate audio oscillator, the neon tube. The r-f frequency stability is 50 times as great as that of either of the dynatrons in Figs. 1 and 2.

(*Continued from preceding page*)
no system has been presented that treats conclusively of the stabilization of the dynatron without the aid of some extra tube or tubes, or without introducing numerous coils and condensers, sometimes including two-gang tuning condensers.

It has been found by the author, however, that one of the requisites for stabilization of the dynatron is that no grid current shall flow under any condition of operation. For a single tube this would require practically that there be only battery operation. There is in general always danger of grid current, and especially if a.c. is used as the voltage source, as in a universal oscillator at least sometimes. The resultant bias is not always of a sufficient magnitude over the alternation of conduction to prevent grid current, or, if more bias is used, the tube may stop oscillating.

It is characteristic of over-biased oscillators that they are not self-starting, and that means one does not know in advance for a certainty just when the oscillator will oscillate. One over-biased dynatron was turned on, didn't oscillate, and was left in that condition. Ten minutes later it decided to oscillate. That is the acme of undependability.

Agree on Its Instability

The dynatron is itself very unstable. The scientists investigating the field have reported to that effect almost without exception, and the exceptions simply were investigators who did not render any report on that aspect. Although the dynatron was popularized with amateurs a few years ago, that was done without reference to instability, and how an unstable oscillator could be of much use to an amateur for monitoring or the like is hard to understand.

The battery-operated oscillator in Fig. 1 was constructed and followed the expected course of behavior, except that the addition of the negative bias improved the stability because substantially getting rid of grid current. Yet the stability was not of an acceptable order, being simply not as bad a case of instability as was met in the circuit without bias.

A test for the presence of oscillation may be made by turning the oscillator dial, and if the plate current changes much there is oscillation. Also, if the tuning condenser is shorted the plate current will change considerably if there was oscillation, for the oscillation is stopped by the shorting.

A series resistor was placed between the joint of tuning condenser stator and upper part of coil as one terminal and plate as the other, and this reduced the amount of current change through the tuning cycle, thus showing that frequency stability was increased, but still there was too much change. When a beat was struck with a broadcasting station, and set at around 8,000 cycles, the wavering note clearly proved that the desired high degree of stability was absent.

Universal Model

For a universal model the circuit may be built as in Fig. 2, but with stability still far from what it should be. The 70-ohm resistor develops bias, not on account of the B current through that leg, which is equal to the screen current less the plate current (since the plate current is negative), for that bias would be less than one volt, but because of the a.c. During only half of the a-c cycle (one alternation) the tube is conducting, for that is when the plate and screen are positive in respect to negative filament. If a resistor of 70 ohms is inserted, the voltage drop will be about 5 volts rms, due to the a-c filament current. The bias will be greater (1.41x5 or 7.05 volt) as a peak, but the voltage being a.c. it falls to zero, so the bias during actual functioning is sometimes close to zero, and during that part of the alternation there may be grid current, especially as bias and oscillation proper are not in phase.

200 Microamperes Plate Current

The a-c model should have the resistors marked 13,000 and 5,300 ohms equal to just those values for duplication of results, as it was found that when 15,000 ohms replaced the 13,000 ohms, and when 5,000 ohms replaced the 5,300 ohms, while there was oscillation throughout the tuning range, the modulation on a.c. (hum frequency) did not permit distinct zero beats. This is simply a sign of misallocation of voltages.

The plate milliammeter read 200 microamperes when conditions for best oscillation obtained in Fig. 2.

In both circuits an inductance equal to the one used in the tuned circuit was inserted, between the joint of coil and stator, on the one hand, and plate on the other, the stabilizing coil not inductively related to the other. Oscillation was stronger, but the expected stabilization did not prevail, although it is known that the series coil system works as a stabilization agency, if given free rein, because the voltages are equal but opposite in phase, hence the net effect looking into the plate circuit is that of no phase shift, which is another way of expressing frequency stability.

As a stunt, an inductance of 20 millihenries was tried in the position occupied previously by the intended stabilization coil, and oscillation remained, but when a series resistance of 15,000 ohms was used in this circuit, oscillation disappeared, and no readjustment of voltage would restore it.

Frequencies Lowered

It is clear from the above that the capacity contributed by the tube is large. A so-called output capacity of 12 mmfd. may be expected, but more serious contributing factors are stabilization devices, which lower, never raise, the frequency, hence have the behavior characteristics of parallel fixed or slightly variable capacities or of combined parallel capacities and series inductances.

The resistance in the circuit must not be neglected. The tuned circuit has a negative resistance, but the screen circuit has a very high resistance, and the tuned circuit is related to the cathode by this high screen resistance, or the resistance of the mutual space-stream circuit. Since the plate acts as a sort of auxiliary cathode to the screen, by reason of the secondary emission, or cathode-originating electrons that bounce off the plate back to the screen, the plate-to-cathode and screen-to-cathode capacities add up, hence we have such a large output capacity effect that with a 500 mmfd. condenser, no trimmer, from which with any coil a ratio of 3 to 1 in frequency is expected, the ratio drops to 2.59. If we take this ratio as 2.6 we have a capacity ratio of 6.76, so the minimum capacity may be computed from the ratio $6.76X = \frac{500+X}{X}$ or 89 mmfd., a very seriously high minimum.

Very Interesting!

It is easy to understand therefore that the intended series stabilizing coil was upset in its effect by the large capacity attributable mostly to the tube itself, and acting as a coupling condenser. To make the coil effective would require neutralization of the plate capacity, which means another tube.

While the dynatron is interesting, and is perhaps even the most interesting oscillator, being the basis of the strictly familiar dynatron as well as the much-discussed short-wave and ultra-wave oscillators of the Barkhausen-Kurz and Gill-Morell types, it does not offer the ready stability and frequency-range results of other circuits, and is critical enough as to voltages to be beyond consideration for the present in commercial test oscillators.

A Better Result

A much better result indeed was achieved with the 30 tube, where frequency stability of the order of one part in 100,000 was achieved, plus a linear modulating characteristic, and where, also, because no critical voltage aspects were present, it was practical to block the line against conductance of the oscillation voltage, so attenuation could be introduced. This oscillator was discussed in detail as to theory of performance in last week's issue (March 10th), and the diagram is reprinted herewith, as Fig. 3. The circuit is that of the Model 30-AB Universal Test Oscillator, which covers fundamentals from 135 to 380 kc, and takes care of above-fundamental i-f frequencies, as well as the entire broadcast band, by harmonics, the positions of which, as well as for all fundamentals, are imprinted on the direct-reading frequency-scale dial.

When this test oscillator is switched from

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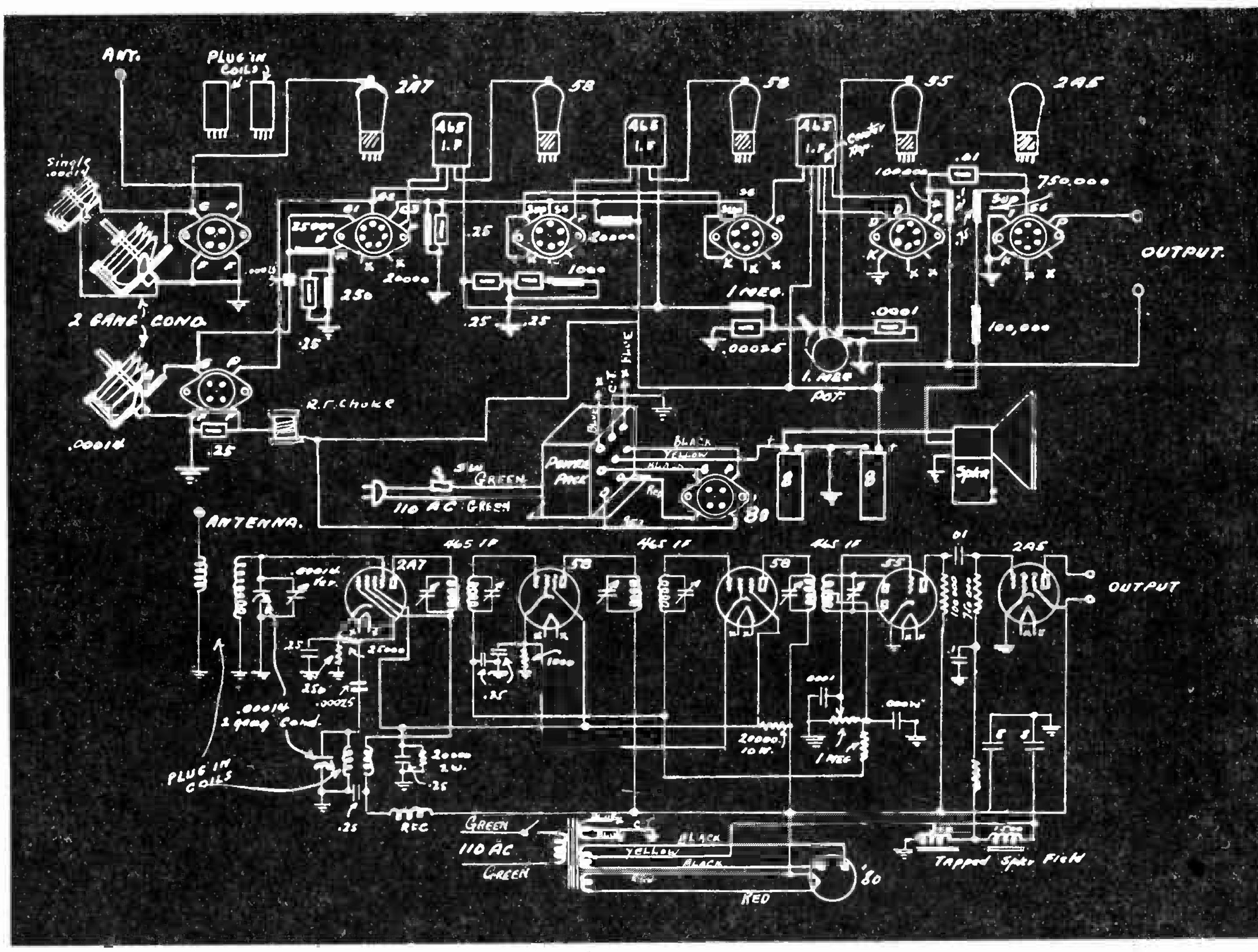
PICTURE DIAGRAM

of a Powerful Short-Wave Receiver

By Emanuel Mittleman

Try-Mo Radio Corporation



A GREAT deal can be done in short-wave reception with simple receivers, but for consistent reception a superheterodyne is the best by far. Yet even in respect to a superheterodyne the rule of simplicity holds. To receive distant stations it is not necessary to have a very complicated superheterodyne, one containing an imposing array of tubes, coils, condensers, and other devices. No, a six-tube superheterodyne such as that diagramed will do admirably well.

There are a few salient features that every short-wave super should have. Since it is hardly practical to have a large number of radio frequency tuners, due to difficulty of lining up the tuners and of stabilizing the amplifier, the most logical thing is to obtain most of the gain in the intermediate frequency amplifier. It is for that reason that well designed short-wave receivers employ two intermediate frequency amplifiers and three doubly tuned transformers in the intermediate level. As to the intermediate frequency, there is no one that is outstanding above all others in any super, including a short-wave one, but the frequency of 465 kc has been accepted as a suitable one for several reasons, and coupling transformers have been designed for this frequency. In choosing this frequency, therefore, we have the result of much experimenting and much selection of the best and rejection of the not so good. From a practical point of view, as applied to the home set builder, we might say that the 465 kc frequency is the best. That is why this frequency has been selected for this circuit, that is, the circuit shown diagramatically.

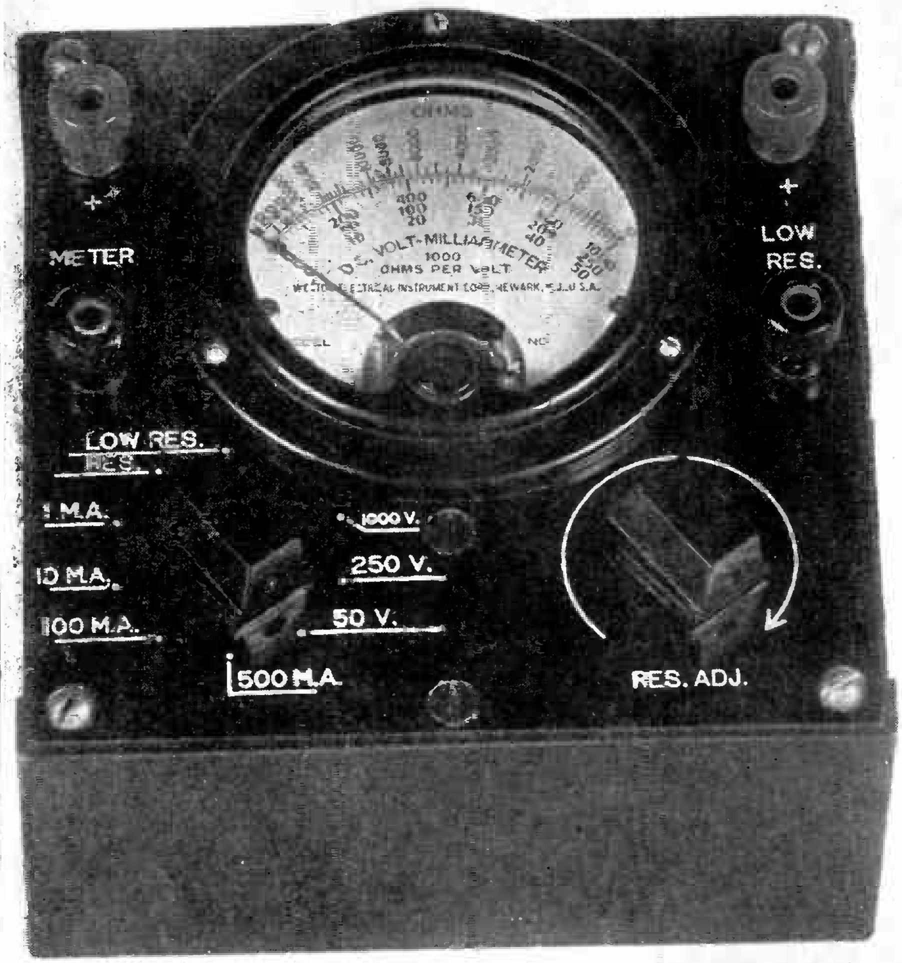
While there are only six tubes in this receiver if we count glass bulbs, there are many more in the circuit if we count functions, and that is the only right way of rating a modern receiver. Consider, for example, the first tube. It performs three functions. It acts as an oscillator, generating the frequency that is to beat with the incoming frequency; it acts as an amplifier of the beat frequency, and it acts as a mixer, or detector, producing the beat frequency between the two different frequencies involved. Thus we might say without exaggeration that functionally the first tube is really three in one. Objection might be raised against the claim that this tube amplifies, but it is a well-known fact that there is a high "conversion gain." If the circuit were an ordinary detector and oscillator there would be a "conversion loss" which would require at least one intermediate amplifier to recoup.

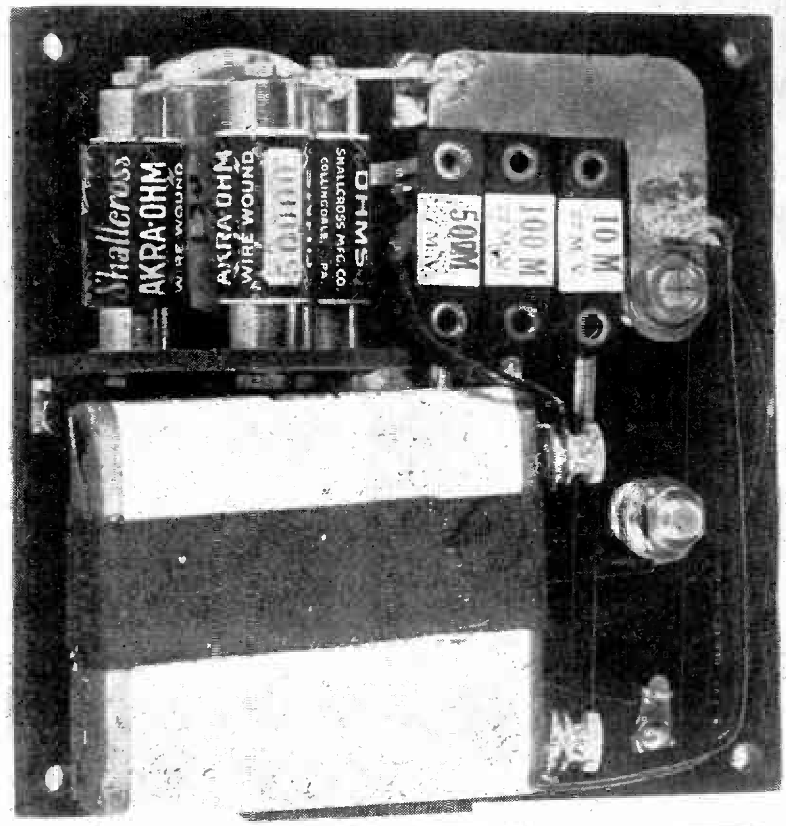
In regards to the two intermediate frequency amplifiers, we cannot say that either acts in more than one capacity, but a given function can be performed in an infinite number of degrees. An amplifier, for example, can increase the signal in the ratio of 1.05 to one. That would hardly be enough to justify the use of the tube. Then, again, it might increase the signal in the ratio of 100 to one. That is something to consider. But that is not an ideal figure to be aimed at, for it is approximately the gain in each intermediate stage in this circuit, counting the gain introduced by the 58 pentodes and that produced by resonance in the doubly tuned transformers. Such a gain, of course, applies only to the resonant frequency of the transformer, or to a narrow band of frequencies in the immediate vicinity of the resonance of each of the tuned circuits. We might add that it is a narrow band, something of the order of 10 kc. That is a highly desirable state of adjustment, a very high gain at the frequency desired and practically none on frequencies separated from it by from 5 to 10 kc in either direction. Of course, whether this highly desirable condition obtains in any given case depends on how well the tuners have been adjusted after they have been installed in the circuit.

A COMPA

Special Feature

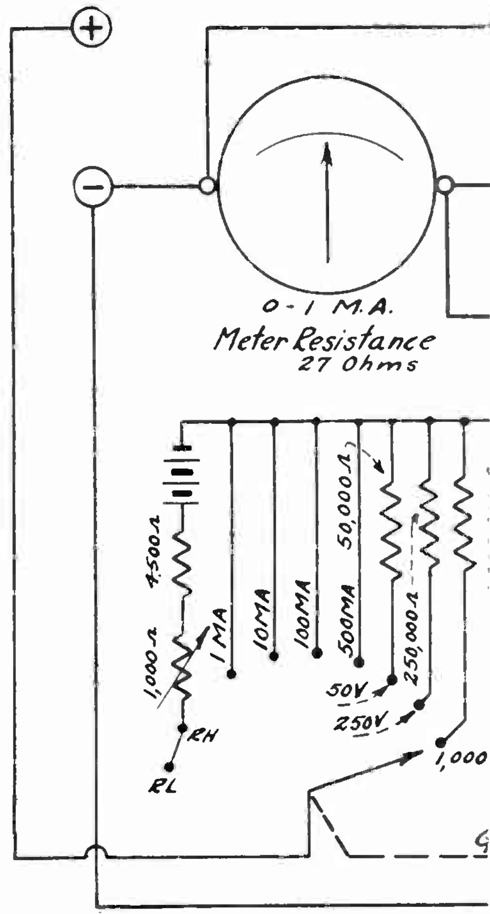
Maxima a





Front view of the meter designed by the author. The panel is 4⅞ x 4⅞ and the black crinkle-finish box is 5 x 5 x 2⅝ outside.

The neat arrangement of the parts inside. The fittings contrived by the author made possible this attractive assembly.



THE ohmmeter is an essential testing device in any general work in radio, and the usual way of establishing it is to have a small battery and a limiting resistor in series, and introduce the unknown as a closing device in the series circuit, that is, as a further series branch. In that way, if the battery voltage is small, only medium low, medium and fairly high resistance values may be read, say, from 100 ohms to 100,000 ohms, if the battery is 4.5 volts and the meter a 0-1 milliammeter. In the 100-ohm region it is not satisfactory to estimate relatively small differences in resistance in either direction.

To get around the difficulty of reading low resistance values with a circuit comprising a sensitive instrument and a low-voltage battery, where the current is necessarily small, the unknown may be shunted across the meter itself, when the ordinarily high-resistance terminals are shorted. Thus the needle is swung at once to full-scale deflection, and as the unknown resistance becomes lower and lower, the needle moves to the left, or the same direction in which it moves when *higher* resistances are tested in the orthodox method.

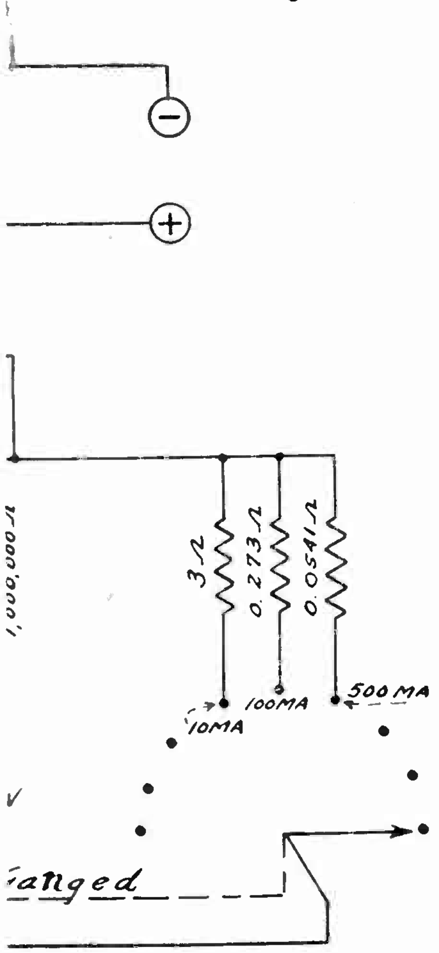
Curves for Low Resistance

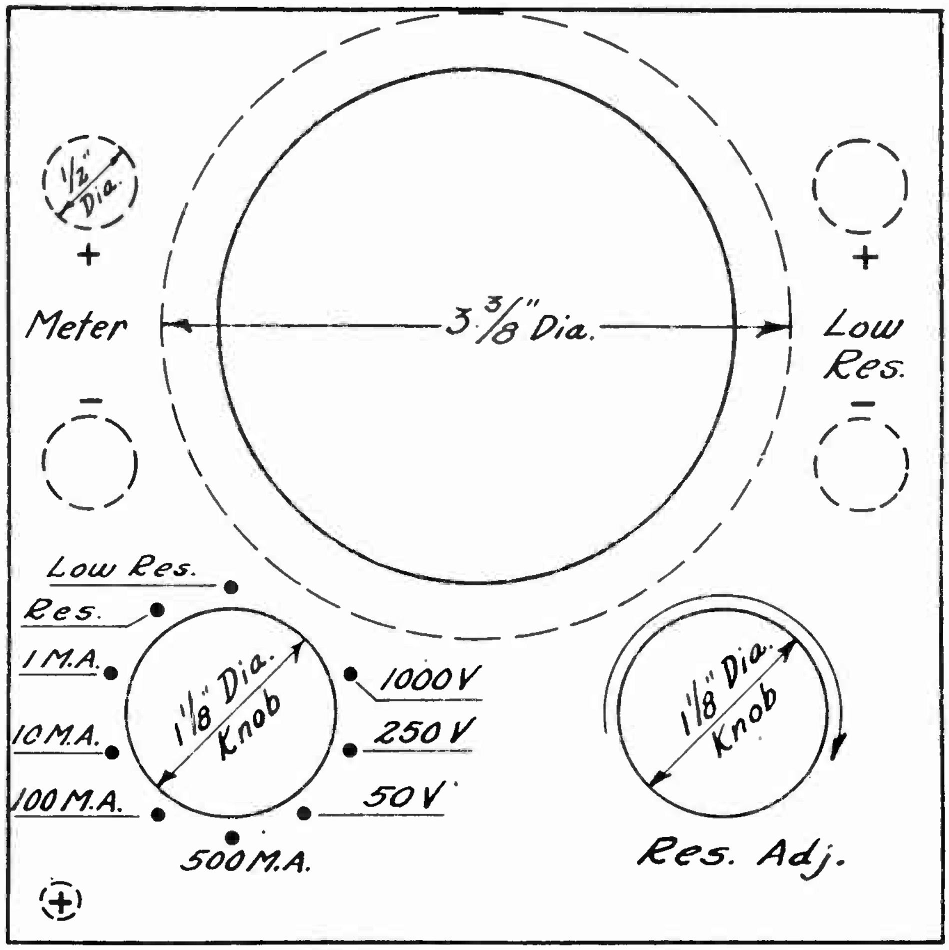
By reason of the known resistance of the meter itself, which for the Weston model 301 milliammeter used is 27 ohms, the value

ACT IRE METER FOR D. C.

are Low-Resistance Measurements at Low Current
re 100,000 ohms, 500 ma and 1,000 volts

By Edward M. Shiepe





Template for the panel of the IRE meter.

of the shunt may be determined. The easiest way to picture the situation is to imagine the meter with a series circuit connected to it consisting of 4.5 volts and 4,500 ohms, the end of the chain from one side of the meter closed on the other side of the meter. That is, the needle is swung to full scale because 1 milliampere flows (4.5 divided by 4,500 equals 0.001). Now across the meter terminals (not elsewhere) is put a resistance of 27 ohms. This is exactly equal to the resistance of the meter. Therefore the current, always a total of 1 milliampere, is divided equally between the meter and the "unknown" shunt, hence the meter reads 500 microamperes. That is, at half scale the unknown is 27 ohms. For various other unknown values the current bears a proportion to X that may be expressed in a curve, or a series of curves, so that these may be consulted whenever a small resistance is measured and the intermediate answer is obtained in terms of current. And the close measurement of small resistance values, hardly possible on the general 100,000-ohm scale, becomes more important each year in radio.

The curves for the unknown under the shunting condition are reproduced herewith from a drawing I made on the basis of calculations, and the accuracy was tested and found exceptionally high. To facilitate measurements in the most useful and desired region at best accuracy and closeness the curve for 1 to 10 ohms was made extensive, the curve for 10 to 100 ohms somewhat less so, and the curve for 100 to 1,000 ohms compacted, as the range from 100 to 1,000 may be read in steps of 100 ohms very well on the high resistance scale, and by most persons may be estimated to 50-ohm values where a high degree of accuracy is not required. From 100 to 500 ohms or so the shunt curve may be consulted whenever the accuracy in this region has to be high. For the 500 to 1,000-ohm readings the high-resistance scale will serve nicely.

The Auxiliary Rheostat

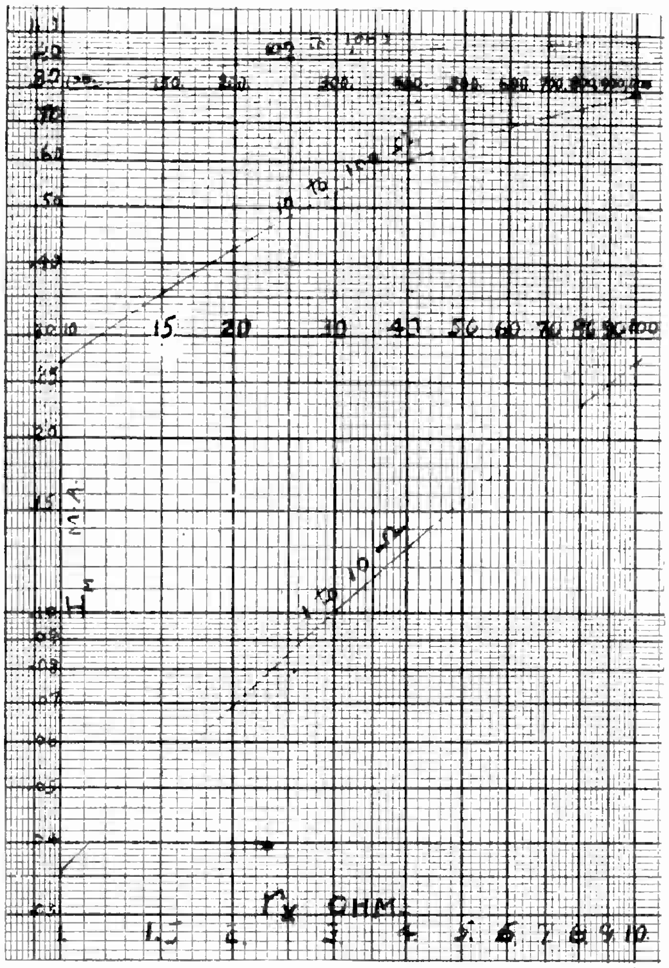
The circuit is a standard one, except for the introduction of the meter-shunting method for measurement of small resistances at low current, and also for the use of a dual-deck switch only for halving the contact resistance, without requiring anything else of one of the decks, save to introduce a short of the unknown resistance terminals for high-resistance measurements to enable meter adjustment to exactly full scale. As all radio experimenters and workers know, the battery resistance is not a constant, but increases with age and use, and therefore an adjustment is required, and is usually made once each time the meter is to be used for resistance measurements, in this example, either high or low resistance measurements, for the battery is in circuit both times.

Instead of only a limiting resistor of 4,500 ohms, therefore, an auxiliary series resistor of some hundreds of ohms may be introduced, but as some prefer considerable leeway in this direction (evidently because of hesitancy to renew batteries that develop a high resistance and consequent apparent voltage reduction) the rheostat that is auxiliary to the fixed limiting resistor may be 1,000 ohms, in which instance it is well that the limiting resistor be 4,000 rather than 4,500 ohms, although shown as 4,500 ohms on the diagram for the purpose of exact relationship of the fixed limiting resistor to the battery voltage and meter sensitivity.

The general uses of the meter in addition to the measurement of low resistances from, say, 1 ohm to 1,000 ohms, are those represented on a stock scale obtainable from Weston outlets. The total accomplishments therefore are direct-current measurements,

(*Continued on next page*)

For Low Resistances



Curves for determining the unknown low resistances. The current values are in upright column at left, the unknown values (Rx) in the three horizontal tiers. The lower curve is for 1 to 10 ohms, the middle one for 10 to 100 ohms and the upper one for 100 to 1,000 ohms. The upper scale duplicates the lower end of the high-resistance direct-reading scale on the meter itself.

(Continued from preceding page)

direct-voltage measurements and resistance measurements as follows:

Resistance: 1 ohm to 1,000 ohms; 100 to 100,000 ohms.

Voltages: 0-50, 0-250 and 0-1,000 volts.

Currents: 0-1, 0-10, 0-100 and 0-500 milliamperes.

These ranges and types will be found suitable for practically all d-c purposes.

All in Compact Box

The meter is built on a Bakelite panel, and the panel is suitably engraved. The resistance adjustment, so-called, represents the rheostat. The nine points of the switch are used for the purposes declared above, and also for shorting the high resistance X terminals. This avoids the necessity of picking up the ends of the test leads and touching one conductor to another to get deflection for rheostat adjustment, for the switch has a position that accomplishes the desired end, and moreover this is the condition repeated for low-resistance measurements by the shunting method.

Thus the switch knob and the rheostat knob balance each other nicely on the panel.

The connections are shown on the wiring diagram, the panel and views, top and bottom, are reproduced from photographs, and the drilling information for the panel is contained on what may be called a template, although the actual sizes of some holes are omitted, as it is not known what make or type of switch will be used, or rheostat, either, and holes for such devices are not uniform.

The built-up instrument, complete on the panel, remember, was put into a crinkle-finish black box as used for making small models of a Bernard Universal Oscillator, the dimensions being 5x5x2¾ inches outside. This makes an exceedingly compact instrument, and to enable the fit to be just right there had to be a close reckoning of meter, switch and rheostat positions.

The Binding Posts

However, everything turned out excellently, aided by some special fittings contrived by the author, which any industrious worker can duplicate with his own head and hands, so that a neat and arresting internal appearance will prevail.

It isn't that what the inside looks like makes much difference, but rather that the job is much more likely to be done in a workmanlike manner if some regard for the nice balance and snug placement of the parts is had from the very beginning. Besides, as stated, there is not much room to spare, therefore close quarters are to be expected in any duplication of this device on such a reduced scale.

The meter terminals themselves must be brought out to binding posts, naturally, since only in that way is access to the meter alone made possible for shunting, when the switch is used for an additional though auxiliary purpose, that of causing 1 milliampere to flow when there is no unknown shunt. Besides, the two general-purpose posts must be provided, these being the ones for all other measurements, that is, for high resistance, for all currents and for all voltages.

Some persons use test leads that have tip jacks at one end and spades at the other, some use spades at both ends, others tip jacks and needle points, clips, etc., and therefore it was deemed expedient to provide binding posts that also serve as jacks. That is, if you have the equivalent of phone tips on the test leads, the cap of the post may be unscrewed and the tip inserted in the hole of the post's upright conductor. Or the tips may be inserted perpendicularly from the top, as these posts, as said, are jacks, too. And that double provision assures a good contact no matter what terminal method you have or prefer for the test leads, because, for instance, phone tips are rather loose in banana jacks, where the tips are intended to be of the compression type (bulging).

Watch Your Step!

The usual precautions must be taken when working this instrument. There is scarcely much protection to be offered to the foolhardy. The meter is sturdy and will stand more of an overload than the manufacturer likes to advertise. Nevertheless, since 1,000 volts represents the extreme of one setting, and 1 milliampere the extreme of another, it is to be hoped that all who build this device, or have or work any other similar meter system, will have some respect for the 0-1 milliammeter when exposed to the raw risks of having 1,000 volts put across it with nothing between the voltage source and the meter except the user's carelessness!

LIFE BEGINS — AFTER *TWELVE*

Sarnoff Cites Service Rendered to Industry

Mr. Roland Burke Hennessy, Editor,
Radio World,
145 West 45th Street,
New York, N. Y.

Dear Mr. Hennessy:

It is a pleasure to congratulate you on the Twelfth Anniversary Number of the Radio World, not only because of the years in radio which that number indicates, but also because of the character of the service you and your staff have performed for the industry. I hope you will have many other anniversaries to celebrate as radio grows and as its services are still further improved and extended.

Very truly yours,
DAVID SARNOFF.

* * *

Dr. Zworykin Sends Wishes for Success

RCA Victor Company, Inc.
Camden, N. J., U. S. A.
March 2, 1934.

Mr. Roland B. Hennessy
Editor, Radio World
145 West 45th Street
New York City

Dear Mr. Hennessy:

My best wishes for the continued success of your valuable periodical. It is my sincere hope that you will participate fully in any improvement in the radio industry, which I believe to be one of the important factors in general progress.

Very truly yours,
V. K. Zworykin.

The Review

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

Questions

1. State which is the preferred method of tube testing.

2. What is the new method of synchronized transmission by broadcasting stations.

3. In a vacuum tube oscillator, what is meant by the "curvature of the characteristic," and does this curvature limit the oscillation? If so, why? If not, why not?

4. What are zero beats?

5. Is there any known method of independently attenuating the audio oscillation in a single tube used as self-modulated radio-frequency oscillator?

6. State a simple test for determination of the frequency stability of an oscillator and also a test for determining whether a universal oscillator's frequency shifts when change is made from a-c to d-c use.

7. If a small audio transformer is used as audio oscillator, how may the connections depart from usual practice for clearing the note, and why?

8. What is the effect of a very large tickler in an oscillator?

9. What are the two main types of B supply filters? If harmonics and side frequencies are not bypassed in one of them, what is the remedy?

10. How high a frequency may be generated by a neon-tube oscillator, on what does the frequency depend, and what conditions are necessary to insure oscillation?

1. The preferred method of tube testing is to determine the mutual conductance of the tube dynamically, that is, with a-c voltage input and a-c current measurement in the plate circuit. This gives a truer picture of the actual performance under conditions of tube use. The input voltage should be very small indeed.

2. The new method of synchronization consists of transmitting a reference frequency of 4,000 cycles to control the synchronized stations' frequency, and this external control applies even if the stations have their own crystals.

3. The curvature of the characteristic means that when grid voltage is plotted against plate current, or plate voltage against plate current, at suitable bias values, the resultant curve is not a straight line, that is, an amplifier is not linear. In an oscillator this curvature does not limit the amplitude of the oscillation because if the curve were a straight line there would be no limit to the amplitude of oscillation, which would mean that more could be taken out than could be put in, a condition commonly accepted as geing against the laws of nature.

4. Zero beats are zero differences in frequency between two oscillators, that is, they are both oscillating at exactly the same frequency. When the difference is more than zero and less than 20,000 cycles, the result can be heard in an acoustic device attached to a detector into which both frequencies are put. The frequency would be equal to the difference.

5. No such method is known, because the coupling is accomplished in the tube, and there is no suitable access to the elements for practical attenuation.

6. A test for determining the frequency stability of an oscillator is to cause a clearly audible beat to be registered with some standard carrier, e.g., of a broadcasting station, then change the B voltage applied to the test oscillator by 20 per cent or so in both directions, and note the resultant change in beat frequency. If the change is equal to 1,000 cycles and the station carrier is 1,000,000 cycles, the frequency stability is 1 one part in 100,000, or 0.001 per cent. In a universal test oscillator (one that works on a.c., d.c., or batteries) a test for frequency shift is made the same way, by noting whether the beat note changes when the oscillator is shifted from a-c to d-c power supply.

7. If a small audio transformer is used as a-f oscillator, to supply modulation, for instance, to an r-f oscillator, the usual secondary may be put in the plate circuit and the so-called primary in the grid circuit, so that the note will be clearer, because the frequency is higher, due to smaller self-capacity across the grid winding than across the other.

8. The effect of an extremely large tickler, say, one five times the inductance of the tuned secondary, is to stop oscillation, because then the socalled tickler becomes a choke coil and does not conduct the radio-frequency current back to the grid.

9. The two main B filters are the tuned type and the brute force type. Where harmonics and side frequencies are not filtered and where resistance changes become large, a combination tuned and brute-force filter is used.

10. To a first approximation, the frequency is determined by 1-RC, where R is the resistance through which the condenser C is charged. However, the frequency also depends on the voltage in series with this resistance, the voltage at which the neon tube begins to glow, the voltage at which it ceases to glow and one the resistance of the neon tube while it is discharging. The complete expression for the frequency is very complex and is not accurately known, mainly because the resistance of the discharge tube during discharge is not known. The maximum frequency obtainable depends on the value of the charging resistance, the voltages, and on the value of the capacity. Frequencies as high as 100,000 cycles per second have been obtained.

The following are based on articles published in the March 3d issue.

Questions

1. State a method of determining the distributed capacity of a coil. State how this finding is related to the pure inductance.

2. What is the equivalent capacity effect, in general, of the flow of grid current in a tube circuit, and is this effect greater or less when there is a grid leak?

3. Define the decibel and distinguish between decibel ratings as applied to power and current.

4. When a low-frequency standard is available, how are accurate high frequencies obtained?

5. What is a wavemeter? What is one valuable purpose it serves in particular?

6. State whether the 868 phototube becomes less sensitive after early use.

7. Compare the penetration of short waves and broadcast waves.

8. Assuming 22.5 volts on the plate, 1.5 volts negative grid bias, about how low a voltage may be read with a 30 vacuum-tube voltmeter?

9. How does the frequency of an oscillator vary with temperature?

10. When are the transmissions of a standard frequency made by the Bureau of Standards, on what frequency, and how accurately?

Answers

1. One method of measuring the distributed capacity of a coil is by the intercept method. The coil is put into a circuit tuned by a variable condenser, the frequencies are obtained, and converted to wavelengths. Then a curve is drawn relating and squared against capacity, hence a calibrated condenser is needed. Enough room is left to permit the extension of the curve beyond the minimum capacity of the condenser. Then the curve that is stopped by the minimum of the circuit is carried beyond the original plotting region to the point where it intercepts the base line. If the capacity was represented by micro-microfarads for the base scale code (abscissa) the intercept gives the distributed capacity. When the distributed capacity of a coil is known its pure inductance may be measured.

2. The flow of grid current increases the capacity, and the increase is greater the lower the input impedance, hence use of grid leak decreases the capacity effect.

3. The decibel is a rating applied for the comparison of two powers related to sound on such a basis that a change of one decibel is approximately the smallest difference the ear can distinguish. The DB as the unit of comparison of two powers is $(10 \log_{10} \frac{P1}{P2})$, but the method may be ap- applied to currents and voltages (for current $20 \log_{10} \frac{I_1}{I_2}$ for voltage E replacing I).

4. A high frequency approximately as accurate as a highly-accurate low frequency standard is obtained by doubling. This consists of beating the fundamental of an external oscillator with an harmonic of the highly-accurate standard. It is called doubling, though it may be tripling, quadrupling, etc.

5. A wave meter is a device that responds to frequency and has an indicating instrument to denote resonance with some other circuit or harmonic of that other circuit. One particularly useful purpose it serves is in calibration of test oscillators, where low frequencies are covered, especially if a meter is used for indication, for then a fundamental may be distinguished from its second harmonic by the extent of the needle deflection, there being a marked difference. Actually this difference is somewhat masked, due to the fallibility of the ear.

6. The 868 phototube, on the contrary, becomes more sensitive with use, attaining good stability after an ageing process.

7. Short waves travel farther on less power, compared to broadcast waves.

8. For a negative bias originally 1.5 volts, plate voltage 22.5 volts, input voltages to a 30 tube may be read to 0.1 volt.

9. In nearly all resonators the frequency decreases as the temperature increases. If we consider a mechanical resonator, the frequency decreases because the temperature decreases the stiffness and also because it increases the dimensions. If we consider a circuit composed of an inductance and a capacity the frequency decreases because the inductance increases and also the capacity. That inductance increases is obvious from the fact that the physical dimension of inductance, when expressed in henries, is a length. The linear dimensions of the coil increase as the temperature goes up. The capacity is also dependent on dimensions in the same way. If the capacity is measured in electrostatic units, the physical dimension is a length, and the same conclusions apply as for the coil. When the capacity is measured in farads, the dimensions are the same but multiplied by a constant.

10. The transmissions are made each Tuesday on 5,000 kc, and are accurate to one part in 5,000,000. The schedule is: noon to 2 p. m., and from 10 p. m. to midnight. Unkeyed continuous-wave carrier is used, except that some code announcements of frequency are made. The time is Eastern Standard.

Carter Claims Smallest Auto B Eliminator

The smallest rotary type B battery eliminator with full power output is made by the Carter Motor Company, 361 West Superior St., Chicago. It is 2⅞ inches wide by 4 inches high, and 5 inches long, and weighs 6½ pounds. It can be easily placed in either the radio set or speaker case.

A QUIET SET FOR S-W

A Battery-Operated Three-Tube Receiver

By Leo Sharon
Leotone Radio Company

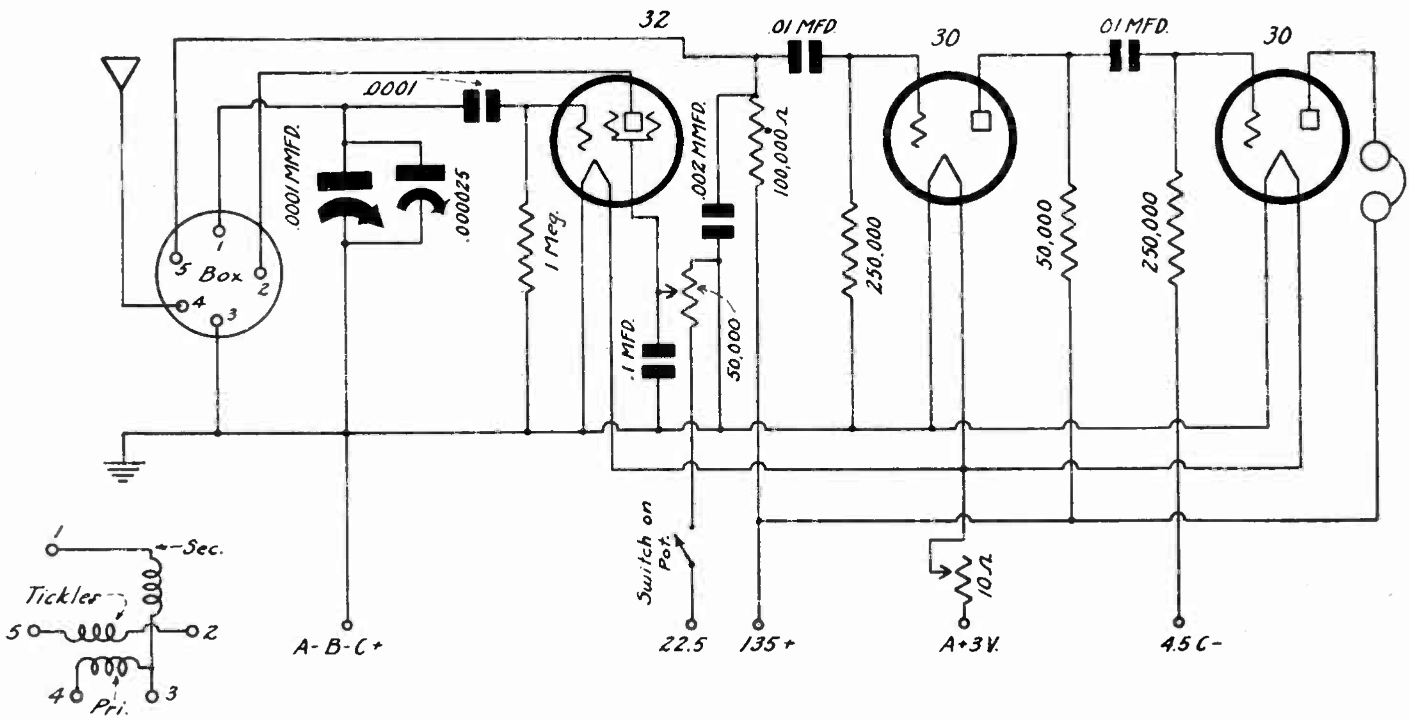


FIG. 1

A three-tube regenerative receiver for short waves. It employs a 32 screen grid tube for detector and two 30 tubes for audio amplification. Regeneration is controlled by means of screen voltage changes.

ONE of the greatest radio authorities, the late Prof. John H. Morecroft, said in one of his well-known books that the simpler the circuit, the more efficient it was. That statement may now be accepted as axiomatic, provided we do not confuse efficiency with sensitivity, where that sensitivity is obtained by well-nigh countless tubes. Of course, when it comes to the question of utmost sensitivity, with inevitable bringing in noise and hisses, the multitube receiver stands by itself and nothing can compete with it, and a suitable control may govern the sensitivity. We do not want noise, we want the clear signals, hence must not develop sensitivity beyond the noise level, without control. The simple regenerative set has never been displaced therefore as a dependable hookup for operation above noise level.

In going through radio literature and looking over circuits the experts used in their investigation, where the absence of disturbing noises is essential, we find absolute unanimity in the choice of battery-operated devices. Do they choose battery-operated amplifiers, oscillators and detectors because they are more convenient? No, to them either source of power is equally convenient, for often it is only a matter of moving a plug an inch or two to change from one to the other. Their choice is based on something more fundamental. Low noise level, steadiness of operation, reproducibility, are some of the factors that count.

Choice for Short-Wave Reception

It is just as valuable to choose a noiseless receiver for short-wave reception as it is for laboratory investigations. And when the choice naturally falls on a receiver of utmost simplicity and economy, we are double gainers.

The question of audio amplification always enters when a short wave receiver is to be selected. Shall the audio amplifier contain power tubes in push-pull with tremendous output, or shall it contain small tubes with volume just enough to enjoy with a head set? All radio fans will not select the same type of amplifier, for some have a mania for tremendous noise while others are sedate and are pleased with the quietness of a headset receiver. There is one big advantage in selecting a receiver with just enough power for a headset, and that is that it is easy to add more audio amplifier when it is desired. Of course, the big set has the advantage that the audio amplification and tremendous volume are already available and a headset can always be used. But suppose that after the big set has been procured it is decided that only headset volume is required. Then the costly audio amplifier stands idle, not idle in the sense that it does not cost anything to operate, but in the sense that it is not in use, yet drawing power and running up light bills.

We assume that the choice falls on a short-wave receiver of the type shown in Fig. 1. It consists of a regenerative detector utilizing a 32 screen grid tube, and two stages of resistance coupled audio amplification, two 30 type tubes being used. Above all, this set is economical, both to build and to operate. The three tubes draw only 0.18 ampere and that can easily be supplied by No. 6 dry cells. Only two of them are needed for the voltage of two such cells connected in series is 3 volts and the set requires only two. The extra volt

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LIST OF PARTS

Coils

One set of four plug-in coils, five-pin bases.
(Broadcast coils optional)

Condensers

One 0.0001 mfd. tuning condenser, with dial.
One 0.000025 mfd. band spread condenser, with dial.
One 0.0001 mfd. grid condenser.
One 0.002 mfd by-pass condenser
Two 0.01 mfd. stopping condensers.
One 0.1 mfd. by-pass condenser.

Resistors

One one-megohm grid leak.
One 100,000-ohm plate resistor.
One 50,000-ohm plate resistor.
Two 0.25-megohm grid leak.
One 10-ohm rheostat, with knob.
One 50,000-ohm potentiometer, with knob and filament switch.

Other Requirements

One five-contact coil socket.
Three four-contact sockets.
One grid clip.
Two output posts.
Six battery terminal posts.
One battery lead cable.
Two double clips for holding resistors.
One 4.5 volt grid battery.
One 135 volt plate battery, with tap at 22.5 volts.
One moulded subpanel chassis.
One metal panel.

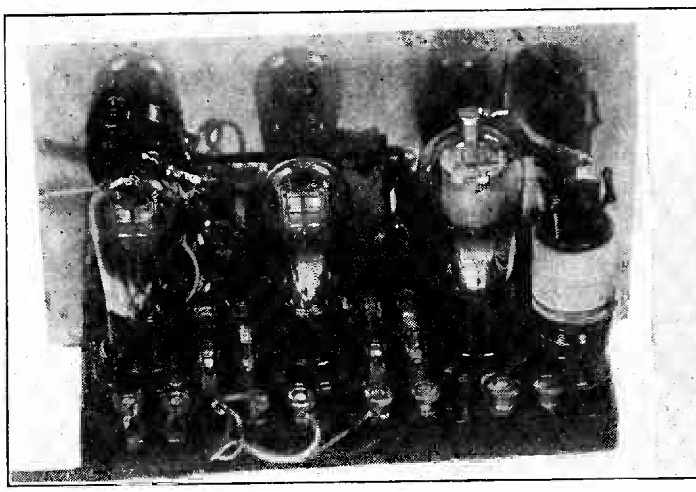


FIG. 2
A rear view of the completed short-wave receiver as diagrammed in Fig. 1. The three tubes are lined up on a moulded bakelite subpanel.

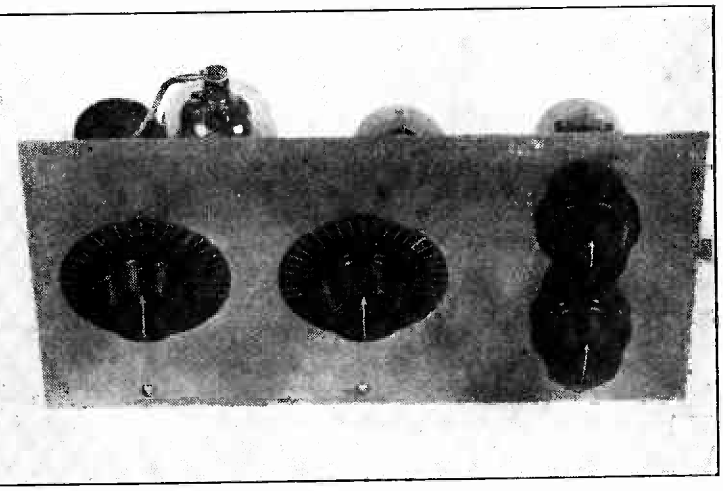


FIG. 3
Panel view of the three-tube short-wave receiver, showing the arrangement of the tuners and the volume controls. The middle dial controls the band spread feature.

is needed to allow for wear. The circuit is also economical in respect to B current. While the voltage is high, 135 volts maximum, the current drawn is so small that the batteries will run down about equally fast whether they are operating the set or standing idle. The first two tubes together take less than one milliampere and the last tube does not require more than 2 or 3.

Circuit Is Regenerative

High sensitivity is obtained by regeneration. It is well-known that regeneration is more effective the weaker the signal. A gain ratio of 10,000 or more is not difficult to get on a weak signal, that is, the gain solely due to regeneration. That is equivalent to several stages of straight amplification. This gain is controlled by means of a potentiometer in the screen circuit. The resistance of this potentiometer is 50,000 ohms and the voltage across it is 22.5 volts. Therefore the screen voltage can be varied between zero and 22.5 volts. This is sufficient in view of the fact that there is a high resistance in the plate circuit. There is a 0.1 mfd. condenser across the used portion of the resistance to insure that for radio frequencies the screen shall be grounded.

Since the 50,000 ohm resistance should admit considerable current, it is necessary to put a switch in series with the lead to the battery so that when the set is not in use the battery circuit may be opened. The switch is attached to the potentiometer. Thus no extra knob is required for this control.

Plug-in Coils Employed

There is a single tuner in the circuit, for in a regenerative receiver it is difficult to control more than one on account of the high gain due to regeneration. These coils fit a five-contact socket. One of the springs connects with the antenna. The other side of this, of course, is grounded. One of the springs is connected to the plate of the tube, one to the top of the tuned circuit, and one to the input to the audio amplifier.

A set of four coils covers the entire short wave band from about 200 to 15 meters. For broadcast waves a larger coil is required than any of the four. In fact, to cover the entire broadcast band, two coils are required.

A small trimmer condenser of 0.000025 mfd. is connected across the main tuning condenser. The purpose of this is to enable the operator to tune precisely to the station desired. In other words, it is a band spread condenser. Since the capacity of the condenser is one-fourth of the capacity of the other condenser, it is four times as effective in spreading out the stations on the dial. It is a valuable and indispensable feature in any short wave receiver. Without it, it is practically impossible to tune exactly to any desired station because of mechanical limitations, and the band spread condenser may make the difference between receiving a foreign station clearly or not at all.

Layout of Receiver

The physical layout of the receiver is clearly shown by the two photographs in Figs. 2 and 3. Fig. 2 gives a rear view of the interior of the set. On the right is seen the plug-in coil and next to that the regenerative detector tube. On the left are the two audio tubes with resistance couplers between them. The volume control devices are seen on the panel back of the tube at the extreme left. The main tuning condenser may be seen back of the first tube, that is, the screen grid tube, and the band spread condenser back of the middle tube.

The arrangement of the parts on the panel is shown in Fig. 3. There are four control devices. On the left is the dial for the main tuning condenser, in the middle the dial for the band spread condenser, and at the right, one above the other, are the regeneration control potentiometer and the filament control rheostat. The panel is tilted forward a bit to show the tops of the tubes.

All the essential values are given on the diagram, but they are collected in the list of parts.

A Line Noise Filter

(Continued from page 6)

makes them admirably suited for use in this filter.

The condensers should be of the mica type, moulded in bakelite, as they are non-inductive, have low leakage, and are impervious to atmospheric conditions. The value of each of the four fixed condensers used is 5500 mmf. (.0055 mfd.). Other sizes may be substituted, but the filter will not be as effective. The variable filter tuning condenser is a compensator type with a maximum capacity of 100 mmf. (.0001 mfd.).

Five 100-turn coils are needed. Four are used as they are, but the fifth one (L_T) is adjusted by the "cut and try" method until the tuned circuit (L_T and C_T) is peaked at the most efficient point. The coils are mounted on a bakelite, hard rubber, or wooden panel approximately 3½" x 7", as shown, using a small piece of bakelite ½" x 2" to hold L1-L2 and L3-L4 in place. A larger piece used to mount LT and CT is fastened on top of it. Screws running through these small pieces and the panel clamp the coils in place. The fixed condensers are mounted on the panel with screws in the positions shown. The ground leads of the condensers are wired to the ground binding post, which is mounted on the cover of the shield can.

The remaining equipment needed is a power cord with plug, an outlet receptacle, and a metal shield can approximately 4½" x 8" x 6" high. This may be a cracker tin, or a sheet steel or aluminum box.

After the filter has been assembled and wired exactly as shown in the diagram we are ready to install and adjust it. It should be located as near the receiver as possible and the power cord between the filter and the set should be shortened. The method of connection is clearly shown in the illustrations and needs no explanation. A good ground from a water pipe is connected to the ground post on the filter. Both power plugs should be reversed individually until the best combination is found.

To tune the filter we turn the volume control of the receiver up full and tune the receiver to the frequency at which the background noise is at its highest. Now vary CT from maximum to minimum, listening for a decrease in the noise. If none is noted remove approximately ten turns at a time from LT, varying CT as above until the point of minimum noise is found. The final size of LT may be as small as ten turns as its size is determined by the frequency of maximum interference. As a final touch the connections to the large coils may be reversed one at a time until the whole filter is functioning at peak efficiency.

The total cost of this unit was under three dollars and in the writer's estimation it is an investment paying big dividends in increased pleasure in operating the short-wave receiver.

The construction is extremely simple as there are but few parts. Although the adjustments are not overly critical, reasonable care must be exercised to achieve the desired results.

Radio University

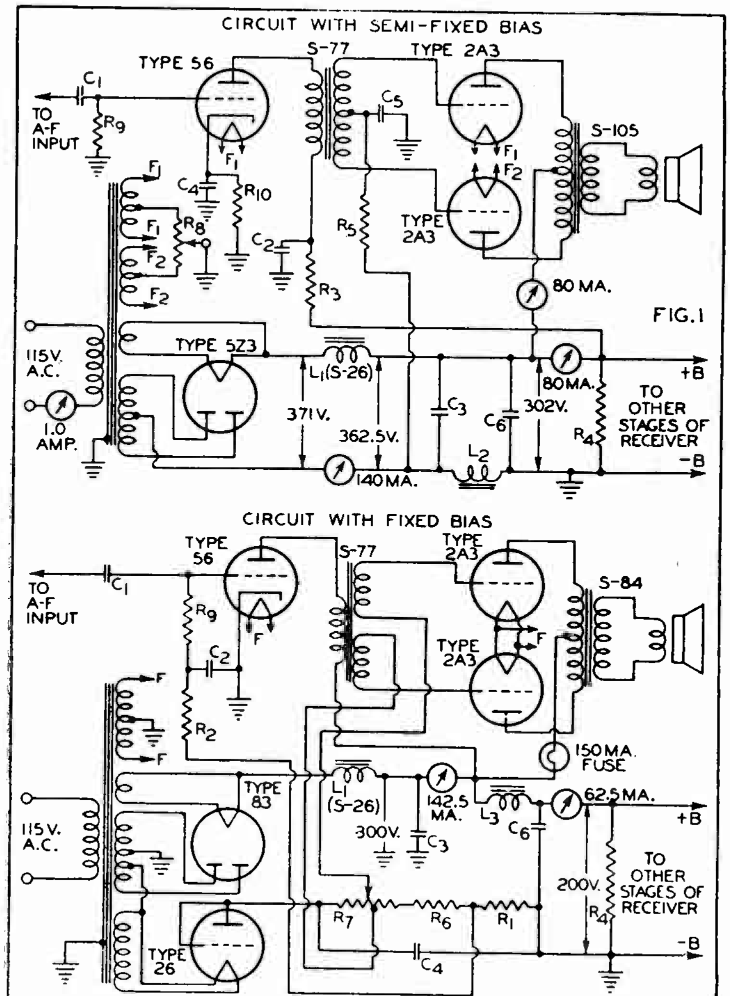
A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6 without any other premium.

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

Different Types of Biases

WHAT IS THE DIFFERENCE between fixed bias and semi-fixed bias, and what is self-bias, also how are the power outputs affected at all by the bias method?—J. K. W.

Fixed bias is bias that does not change. Particularly there is no bias change due to changes in B current through the set or any circuit of the set developing bias, to occasion direct voltage fluctuations. Self-bias is bias arising from the plate current of the biased tube flowing through a resistor, and since the intensity of the signal input changes the plate current, the bias changes with signal. This change is anti-regenerative, that is, degenerative, hence reduces the amplification. Semi-fixed bias is between the two. Fixed bias permits greater power output because there is no loss due to degeneration. Normally batteries would be used for fixed bias, or a separate C-supply rectifier. Self-bias permits only lowest power output. Semi-fixed bias would arise for instance if bias were due partly to the plate current of the biased tubes and partly to some constant voltage source, or where the total current drain of the receiver, and bleeder current through a resistor across the line, passed through the biasing resistor. The power output capabilities also are between those of the two other methods. The diagram discloses semi-fixed bias and fixed bias, the fixed example including a separate C-supply rectifier (26 tube). A filament type tube should be used for C bias rectifier so that the power tubes will not be without bias during any warming up of heaters of indirectly-heated tubes.



APPROXIMATE VALUES

C_1 = BLOCKING CONDENSER—0.01 µf
C_2 = BY-PASS CONDENSER—0.25 µf
C_3 = FILTER CONDENSER—10 µf
C_4 = BY-PASS CONDENSER—5 µf
C_5 = BY-PASS CONDENSER—0.05 µf
C_6 = FILTER CONDENSER—5 µf
L_1 = FILTER CHOKE—10 HENRIES AT MAX. MA., 60 OHMS
L_2 = SPEAKER FIELD—430 OHMS
L_3 = SPEAKER FIELD—1600 OHMS
R_1 = 5000 OHMS
R_2 = 200000 OHMS
R_3 = 10000 OHMS
R_4 = BLEEDER
R_5 = 50000 OHMS
R_6 = 22000 OHMS
R_7 = CENTER-TAPPED POTENTIOMETER—2500 OHMS
R_8 = POTENTIOMETER—100 OHMS
R_9 = 0.5 TO 1.0 MEGOHM
R_{10} = 2700 OHMS

Examples of fixed bias and semi-fixed bias, in a circuit using 2A3 push-pull output tubes. The constants are given in the legend.

* * *

Operation of Buzzer Oscillator

ON what principle does a buzzer oscillator operate? Is it in any way connected with a neon tube oscillator?—R. E. Q.

There is a similarity between these oscillators. Both are of the charge and discharge type. A condenser is charged by a battery to a certain potential and then it is discharged. The shock at discharge to the condenser and inductance circuit starts oscillation in that circuit. But the discharge and timing are different in the two. In the neon tube oscillator the discharge occurs when the ignition potential of the neon tube is reached. In the buzzer the discharge occurs when the armature makes contact. In the neon oscillator the period of the charge and discharge cycle is determined mainly by the value of the capacity and the resistance through which the capacity is charged. In the buzzer the period is determined by the rapidity with which the armature can go back and forth. The fundamental of the oscillators is determined by the charge and discharge period. If a tuned circuit is coupled to either device, the radio frequency oscillation is determined by the tuned circuit. Incidentally, in the buzzer oscillator there is not a single frequency but many. That is the main reason why a buzzer oscillator is broad.

* * *

Motorboating in Set

WHEN I first turn on my set there is a whistle, but it dies down after a few seconds. What is the cause of it? My set is a superheterodyne with two 2A3 tubes in push-pull in the output stage.—C. A. L.

There are two probable causes, one is that the last filter condenser, the one next to the B plus output, has gone bad. The other is that the two tubes in the push-pull stage are dissimilar. Perhaps one of them is nearly exhausted. Perhaps switching them around would help temporarily. Replacement of either the bad tube or the bad condenser should be tried. Perhaps both are necessary.

* * *

Standard Inductance

IT is comparatively easy to make a standard inductance coil by winding the requisite number of turns on a good form. But any coil, regardless of the form used, will change its inductance as the temperature changes. Can you suggest a way of compensating for this change?—R. E. N.

It wold have to be done with a thermostat of the continuously variable type. Suppose you wind a small spiral coil of phosphor bronze wire and the thermostatic element is arranged so that the coil will lengthen or shorten with changes of temperature. If this coil were connected in series with the other coil, there would at least be a partial compensation. Perhaps it would be enough to move one turn of the main coil in the same manner. Or another way would be to have the thermostat rotate a small turn inside the main coil. The adjustments would have to be made experimentally.

* * *

Double Response in Receiver

WHEN I tune my receiver there are two responses close together. In between the two, where the signal should come in, there is nothing. What is your explanation for this phenomenon and the remedy?—W. R. D.

This indicates overloading somewhere. Some tube amplifies or detects, according to its normal function, up to a certain signal voltage. When that voltage is exceeded the plate current is cut off. This often happens in receivers in which the bias on a tube depends on the strength of the signal. It may happen in circuits equipped with automatic volume control when one tube on the chain cuts off quicker than the others. However, the most common source of this trouble is the diode biased detector. Rectification does not stop as the signal goes up, and therefore the bias increases without check, and if the signal is strong enough the triode will cease to function. This naturally occurs near resonance. The easiest remedy is to use the volume control until this effect disappears. The trouble may also be cured by installing fixed bias of the proper value. But even then it is necessary to use the volume control, for the amplifier can still be overloaded.

* * *

Noise in Receivers

RECENTLY I bought a very good superheterodyne receiver. It is both sensitive and selective and I have no difficulty picking up stations from the Pacific Coast, clear across the continent. There is one defect, however, and that is noise in the set when I am receiving distant stations. Is there any way of eliminating it? It does not seem to be static. If it is not static, what could it be?—W. E. N.

There are two causes of noise in a sensitive radio receiver. One is the irregular emissions of electrons from the cathode and the other is irregular conductivity of wires due to temperature differences among the parts. Most of the noise of either kind originates in the tubes. Not a great deal can be done about it yet, but it is quite well understood.

* * *

Source of Audio Frequency

YOU have described many radio and intermediate frequency oscillators, but very few audio frequency oscillators. Since the object of having a radio receiver is to recreate sound, it would be desirable to have an audio frequency oscillator for comparison purposes. Can you suggest simple oscillators or sources of sound?—W. R. M.

Any musical instrument will provide a tone of approximately known frequency—many different tones. A tuning fork is a good source of constant frequency. It may either be struck or it may be driven electrically. A whistle is also a source of tone. Two radio frequency oscillators operating at slightly different frequencies will generate an audio frequency, the beat, and a single stage of transformer coupled amplification will make an audio oscillator if the P and G terminals of the transformer are connected to the same tube. It may be necessary to reverse the leads of one winding.

* * *

Electron Coupled Oscillators

SEVERAL oscillators purporting to be electron coupled have appeared in radio literature. In most cases I am unable to see where they differ from other standard oscillators. Just what does electron coupling mean?—T. R. J.

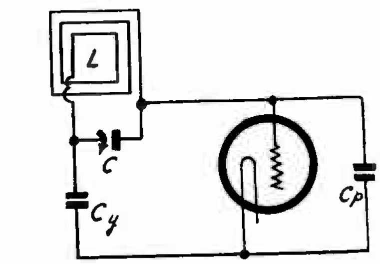
The oscillator proper is nearly always one of the common types. It must necessarily be. Electron coupling then refers only to the manner in which the load circuit is coupled to the oscillator. Jennings B. Dow, who originated this form of coupling and gave it is name, undoubtedly meant this. Others have since twisted the meaning, or have groped around for a meaning. The electron coupled oscillator has one marked advantage. The reaction of the load circuit is practically eliminated and this fact makes the frequency of oscillation nearly independent of changes in the load.

* * *

Push-Pull Amplifier Behavior

WHEN a push-pull amplifier is properly balanced and a signal is impressed on the grids, should there be any variation in the current drawn from the high voltage supply? If current varies, what is the cause of the variation, and what will it amount to?—M. L. G.

If both tubes were equal, which they are supposed to be in a push-pull amplifier, and if there were no curvatures in the grid voltage plate current characteristics, there would be no fluctuation in the plate current, that is, the sum of the plate currents of the



The direction-finding principle very simply expressed in a loop circuit, for which a plate series meter may serve as indicator.

two tubes. Due to curvature there will be a change, and this will occur whether the tubes are overbiased or underbiased. The change will be least when the bias is just right. The change is directly due to the curvature, or what is the same thing, to the generation of harmonics. The even harmonics generated by the two tubes add up in the common lead to the B supply. Just what the variation amounts to depends on the tubes, the plate voltage, the filament voltage, the grid bias, and the signal voltage applied.

* * *

Simple Direction-Finder

KINDLY SHOW a diagram of a very simple direction finder, not necessarily a sensitive one, but a very, very simple one.—K. G.

About the simplest diagram you could expect is the one printed herewith, where the coil L is a loop, C is the tuning condenser, Cy is balancing condenser to make the capacity to ground the same on either side, the same function to which the plate circuit condenser contributes. A grid leak of 1.0 meg. may be connected from grid to ground.

* * *

Shape of Plates

IS IT possible to have straight line capacity or straight line anything else when using variable condensers having warped plates? I have examined a large number of different commercial condensers and in all of them there is some warping. I cannot see that any two condensers can be equal even though made from parts stamped out with the same dies and assembled in the same jigs.—T. Y.

It is true that there is a slight amount of warping and distortion of both rotor and stator plates, but the effect of these irregularities is very small. Of course, there are applications where these differences would be intolerable, but then inexpensive commercial condensers would not be used. For extreme accuracy it would be necessary, perhaps, to make the plates so thick that they could not warp and then lap them on both surfaces to make them absolutely flat. And that would not help a great deal unless they were mounted parallel and with the shaft accurately at right angles to the planes of the plates.

* * *

Amplitude of Oscillation

IT IS said that the weaker the feedback in an oscillator, the stronger is the amplitude of the generated wave. If this be true, why not use no feedback at all? It seems to me that there is a discrepancy between statements and facts. Kindly explain how it is possible for the amplitude to be greater the weaker the feedback, if it be true.—R. L.

Those who make the statements do not seem to be specific enough. They do not say, for example, where the amplitude increases as the regeneration is decreased. If ever the statement agrees with the facts, it must be that the current in the tuned circuit increases with decrease in the regeneration. That this is a fact appears to be obvious after just a little thought. In order for the circuit to oscillate at all there must be certain alternating potentials on the grid and the plate. If the coupling between the tuned circuit and the tube is loose, as it will be when the regeneration is weak, the amplitude in the tuned circuit current must be increased to keep the oscillator going. But when the oscillator is in this condition it is very close to stopping. It sems to be making last terrific effort to keep going.

* * *

High Resistance Oscillator Feed

WHAT happens in an oscillator when the plate is fed through a high resistance, not in parallel but in series with the plate lead? Does it make the circuit oscillate more readily and at a steadier frequency, or the reverse?—W. H. L.

If the resistance is appreciable and is placed in series with plate lead, the frequency stability is improved, because it adds to the plate resistance. An increase in the plate resistance, or the grid resistance, by any means whatever improves the stability of the frequency. This is especially the case when the added resistance is constant. The resistance subject to variation is then small in comparison with the total.

* * *

Admittances of Chokes

WHAT is the meaning of admittance as referred to a choke coil? How can it be obtained? In what units is it measured?—R. E. T.

The admittance of a choke is the reciprocal of its impedance. If the resistance of the coil is R ohms and the reactance is X ohms, the effective value of the impedance is $(R^2 + X^2)^{1/2}$ and the effective value of the admittance is $1/(R^2 + X^2)^{1/2}$, and it is expressed in mhos. That is the unit of conductivity and admittance.

* * *

Meaning of Radian

NOW and then you speak of frequencies as expressed in radians. What does that mean? In other words, what is a radian?—G. R. L.

The radian is the natural unit of angle. It is the angle in which the arc of any radius, R, is equal to that radius. Since there are 360 degrees in a circle and as the ratio of the circumference to the diameter is π, and there are two radii in one diameter, we have the relation 2π radians quals 360 degrees. One cycle contains 360 electrical degrees, or 2π radians. Since one cycle is one complete rotation, one cycle equals 2π radians. Further, since frequency is number of cycles per second, the frequency expressed in radians is given by $2\pi F$. But $\pi = 3.1416$, when $2\pi = 6.2832$. This number is often given in formulas and the above explains its origin.

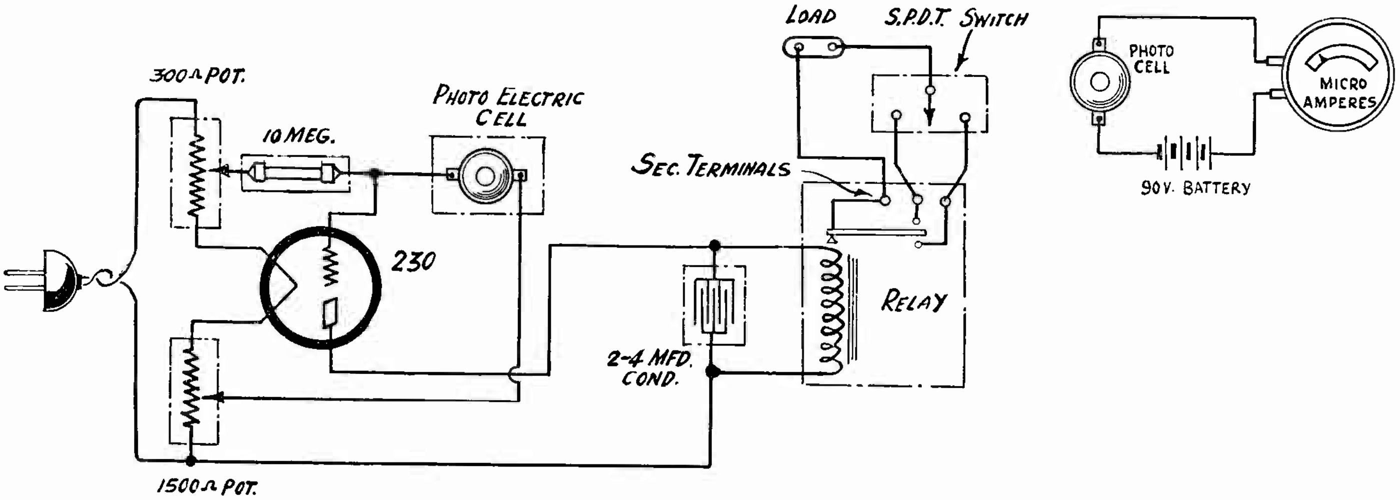
* * *

Kinks in Tuning Condensers

RECENTLY I purchased a good condenser with the idea of calibrating for capacity measurements. I mounted it inside an aluminum box and connected the rotor to this box. And I calibrated it too, taking frequent points. It is a good thing I did take many readings, for I had supposed that the curve was straight from about 5 to 95 on the dial. Well, it was approximately straight except that it had small kinks in it. I first thought these were due to errors in calibration, but double-checking against a standard condenser and also an oscillator of which this condenser formed a part, showed that the kinks were actually there. Had I not taken many points I would not have discovered the kinks. Now will you kindly tell me what causes the kinks?—W. J. S.

Without knowing what the kinks are or where they are on the dial, we cannot say definitely what might cause the kinks. However, we have had similar experiences and it may be that the cause of the kinks in your case as in ours. We found that they were due to lack of symmetry. For example, in one case the stator was supported by three metal rods. When the rotor came near

(Continued on next page)



Here alternating current from the line, or d.c., for that matter, is put into a 30 tube used as amplifier, so that there will be enough current to work the relay for a garage-door-opening motor. At upper right is the circuit for cell calibration.

(*Continued from preceding page*)

these the capacity increased faster than it should, by a small amount to be sure, but nevertheless noticeable. Quite often a condenser is placed so that the capacity will increase when the rotor comes near it. We are sure that if you inspect your condenser closely and compare the structure with the kinky calibration curve, you will find the cause.

* * *

Circuit Does Not Oscillate

NO oscillation can be detected in a short-wave superheterodyne which I have just finished, and, of course, no signals. All voltages on all the tubes are correct. What can be the matter?—R. H. B.

The first possibility is that you have not connected the tickler correctly. Reverse it and see what happens. If that does not do the trick, perhaps the voltages on the oscillator tube are not right after all. Or it may be that there is an open in the wiring. Then, again, the circuit might be oscillating and you have no means of finding out. If you are looking for heterodynes and the blame the oscillator for their absence you are overlooking the fact that the defect may be anywhere in the circuit.

* * *

Photo-Cell Sensitivity

IS THE NORMAL photo-electric cell sensitive enough to work the average relay to throw a switch for motor-driven garage door, or is amplification necessary? Please illustrate the principle.—I. R.

The cell will not normally be sensitive enough, therefore the input voltage may be delivered to an amplifier, such as a 30 tube, the winding of the relay coil being in the plate circuit. There are commercial relays of suitable d-c resistance that work on changes of current of 250 microamperes, so there will be enough current change due to the illumination cast upon the photo-electric cell by car headlights to provide the switching you desire. The switch permits selection of closing an open circuit or opening a closed circuit, a worthwhile provision if the device is to be used experimentally. The photo-electric cell may be calibrated in microamperes per lumen by using the circuit shown in small size in upper right.

Trimmer Should Go in R-F Stage for Grid Current Type Detector

(*Continued from page 7*)

it one may build up the sensitivity and the protection or safeguard against dead spots until just this side of the audio howl level.

For such a circuit plug-in coils would be used, but any who have the engineering knowledge to develop their own switching system and coils may do so. The arrows simply denote succession of coils for successive bands. The commercial plug-in coils practically without exception may be used, since the capacity of the tuning condenser is 140 mmfd., for which such coils are wound. The condensers in these tuned circuits may be singles or a double may be used, whereupon a small manual trimmer would be preferable across the 140 mmfd. condenser tuning the grid circuit of the first 34. The reason is that the grid current in the detector tends to lower the frequency, being equivalent to a small capacity introduced in parallel, so one stage will keep in step with another if the identical secondaries are used and the trimmer, say, 15 or 20 mmfd., is placed where suggested.

It is a mistake to put the trimmer across the detector tuning condenser in a circuit where the antenna capacity is reduced to such a small value by the series adjustable condenser as not to lower the frequency comparable at all to the effect produced by the grid current in the next tube.

The load resistor of the detector is rather low, but was found to yield greater certainty of regeneration for all coils. However, the gain will be greater if this resistor is higher, and up to 0.5 meg. may be tried, and the high value retained if regeneration is always obtainable. For if regeneration fails the receiver practically fails. Only a few locals, nothing more, without regeneration.

Station Sparks

By Alice Remsen

AN UPHEAVAL?

There is to be a radio upheaval, not in the studios this time, but among the air-waves. The President aims to shift control of broadcasting and to alter the wave set-up; so it's quite likely that very soon you'll be having a great time turning your dials in search of familiar stations and not finding them in the right places. I remember the last time this happened it was rather annoying, but we soon got used to the new spots. . . .

NELLIE AND PETER AND OTHERS

Nellie Revell is back on the air again, this time twice weekly, Tuesdays at 2:45 p. m. EST, WJZ and network, and Fridays, at 4:15 p. m. EST., on WEAF and network. Glad to listen once again to Nellie's snappy interviews. . . . Memo to Peter Dixon: Dear Peter, are you sure that it is Gene Lockhart who plays "Lazy Dan"? I always thought it was Irving Kaufman; maybe I'm wrong! I know that Gene Lockhart's a fine artist, I had the pleasure of working with him on those "Piccadilly Circus" broadcasts a couple of years ago. . . . Freddie Rich, the CBS band leader, is doing a good turn to young American composers. On his "Columbians" show each Thursday night at eight o'clock, Freddie features an orchestral composition by some young composer who has never had the luck to have his scores published. Special arrangements are made of the numbers and every facility for excellent musical expression is given Freddie in ordr to put these new compositions over. . . .

TITO, BOAKE AND JIMMY

Tito Guizar's Midday Serenade has four new outlets in addition to the former large network; they are the CBS stations in Pittsburgh, Baltimore, Washington and Syracuse; each Sunday at 12:30 p.m. EST. . . . "Marie, the Little French Princess" celebrated its first anniversary on the air last week. This is a clever dramatic series, heard each Tuesday, Wednesday, Thursday and Friday at 1:00 p.m. EST, WABC and network. Ruth Yorke plays the role of the Princess; James Meighan, nephew of the famous Tom Meighan, plays the young hero, while Allyn Joslyn, well-known radio actor, is the villain of the piece. . . . Oh, oh, my word, Boake (Philco) Carter! What an appetite! But I feel just exactly the same way; Boake is crazy about roast beef, yorkshire pudding, mince pie, kippers and marmalade—put me down as being crazy about them, too! . . . And here's a little inside information as to why Jimmy Kemper, of "Song Stories" fame, is such a good boy. When he was a kiddie living in Warrensburg, Mo., Carrie Nation, a neighbor, pinned one of her little hatchets on Jimmy's lapel and told him to be a good boy when he grew up. . . . Dick Messner's Orchestra is a new addition to the roster of dance bands presented over the Columbia network. Dick broadcasts from the Piccadilly Hotel, New York, four times weekly. . . . Little Vivien Smolen, sixteen-year-old daughter of Max Smolen, who was for years the maestro of "Evening in Paris," is following in her daddy's footsteps. Vivien is a full-fledged radio artist, and appears regularly on such programs as the True Story Hour; and Cream of Wheat. Vivien is a very clever young dramatic artist and will, I believe, go far in radio. . . . Mae West's new picture, "It Ain't No Sin,' will have it's heating qualities increased by the hot music of Duke Ellington and his famous orchestra. . . .

Columbia's champion linguist is Andre Kostelanetz, who speaks French, Russian, German, Hebrew, Polish, Italian and Spanish—and he speaks English, too. . . . Celebrating his thirty-sixth birthday, Colonel Harry Stone, station manager of WSM, Nashville, Tennessee, was the guest of honor at a combination birthday-valentine party at the home of Mr. and Mrs. Lasses White. The whole station staff and many others gave the Colonel the traditional thirty-six slaps on the back; now he's inclined to be a bit round-shouldered. . . . Eddie Peabody, who plays dozens of different instruments on his broadcasts over NBC networks each Sunday night, has long been interested in Boy Scout work; so much so that he became an Eagle Scout only a few years ago and is honorary Scout Master of ten troops in various cities from Coast to Coast in the United States, as well as troops in England, Scotland and Ireland. . . . If radio hadn't beckoned: Frank Black might have been a chemical engineer; Frank Luther, a preacher; William Daly, a magazine editor; John Holbrook, a doctor; Graham McNamee a concert baritone; James Wallington, a singer or preacher; Phil Lord, a business executive; Raymond Knight, a lawyer; Howard Claney, a Broadway producer, and Phil Duey, a farmer. . . . Loretta Lee is singing with George Hall's Orchestra again after a month's vacation in New Orleans. . . . Scrappy Lambert has taken a screen test for M-G-M. No reason why Scrappy shouldn't be okay for pictures; he's a nice-looking lad, with a swell personality and a great voice. . . . The "March of Time" enters on its fourth radio year this month. . . .

BACKWARD AND FORWARD

There's a new folk song series on Station WLS, Chicago; each Saturday at 10:30 p.m. CST. The program features the Cumberland Ridge Runners with John Lair. . . . Victor Young and his orchestra will succeed Jack Benny and Frank Black's Orchestra on the Chevrolet program, beginning the first week in April. The program will consist solely of dance music; no vocalist will be used, and the sponsor intends to make the commercial credit the shortest on the air, with absolutely no ballyhoo. Won't that be great! . . . And now it comes out. Martha Boswell has had a deep, dark secret in her life. Four years ago, when the girls were struggling for radio recognition, Martha was on the air as the star of a dramatic skit. It was a blackface act, and she lent her New Orleans accent to the role of "Miss Somaphine," billed as "Darktown's Sweetheart." . . . Mary Ledgerwood, who was a protege of Madame Schumann-Heink, is now heard every Monday night at 10:00 p.m. with the Robert Hood Bowers Orchestra on Station WMCA, New York. . . . The Crazy Range Ramblers, who came to town with the Rodeo in a cloud of flying dust and swirling hoofs, have stayed on in New York to become radio favorites; they are heard every night at 8:30 p.m.. EST, from station WMCA. . . . A series of nine chamber music recitals has started over WABC and network, under the auspices of the Library of Congress. Each Monday afternoon at 4:15 p.m. EST. . . .

DONALD NOVIS IMPROVES

Well, the Colgate show proved to be another revue type of "Surprise Party," with Don Vorhees at the musical helm and Brad Browne as master of ceremonies One thing I especially liked—the voice of Donald Novis; it seemed more mature than when last heard via the ether; he has also lost the diffidence which marred his former work. Francis Langford did a good job on her solo. Arthur Boran, after a flowery introduction by M. C. Browne, did some of the usual radio impersonations—Eddie Cantor and Ed Wynn, the latter by far the better. A nice half-hour show, well balanced and produced.

A THOUGHT FOR THE WEEK

BROADCASTING STATIONS NOW SENDING OUT NEWS FLASHES twice a day, under the new arrangement between radio officials and news distributors, are meeting with the same difficulties that beset publishers. What does the public prefer? Who shall be the judges of what news angles will gain and hold the public ear? It all depends on the public likes and dislikes. A careful canvas of the situation indicates that listeners prefer a human touch to the news offerings rather than mere skeletonized reports of big events.

Our idea of news for radio fans is Edwin C. Hill's dramatic gathering of the essential values of a current event for ears that want even more than he gives them. Of course, Mr. Hill does not deal so much in mere flashes as in the heart and soul of the things he covers. Hence, his strength and his popularity.

No Frequency Shift in Changing Power in Oscillator

(*Continued from page 10*)

a-c to d-c use there is no shift in frequency, thus confirming the assertion of frequency stability. Besides, the usual selectivity loss from a self-modulated d-c operated tube are avoided by using a low leak and thus on a.c. the line frequency (hum) is the modulation, while for d.c. and batteries, a neon tube is used as separate audio oscillator. Thus is selectivity high throughout.

The universal dynatron, Fig. 1, for battery operation, has no modulation, nor has the universal model dynatron, Fig. 2, any for d.c. or batteries, but only hum frequency on a.c. However, the neon tube method could be introduced in Fig. 2 for d.c. or batteries, but not in Fig. 1 unless the voltages are raised, since the neon tube will not strike on much less than 70 volts.

It is therefore submitted that unless and until the dynatron is stabilized as a single-tube circuit not requiring another tube for rectifier that more conventional circuits be followed, especially in the light of recent developments in frequency-stabilization of these more customary circuits.

As for frequency stability, it is just as necessary as traction in an automobile, the ability to hold the road. The oscillator may be likened to a car traveling at high speed. If the front wheels shimmy, the steering gear is loose and the car has not the proper center of gravity and strung weight for holding the road, the course can not be determined exactly by the driver. To be sure, the car may not topple into a ditch (which would be a disaster equivalent to an oscillator "stability" of one part in 1,000), but the usefulness of the car is greatly impaired.

While a car is not a measuring instrument, it would be, in the sense that on a certain occasion it was necessary to travel in a true line, and safely, to achieve a certain goal in a certain time. A stabilized oscillator is like a stabilized car or airplane, in that it does not wobble, hence a given setting will produce the same frequency time and again (instead of one frequency now and another the next time) and whatever frequency is established is the one that endures during testing and at all other times, since with the same adjustable constant (condenser) setting, there will be no shifting and drifting of frequency during tests.

RCA CITES 1933 ADVANCE MADE IN TELEVISION

The report of the board of directors of Radio Corporation of America to the stockholders, on activities of the corporation during 1933, sets forth television was brought nearer, and short-wave development advanced. The report sets forth:

"It has been the policy of the management to refrain from definite prediction as to the time when television might be brought from the research laboratory and offered on a commercial basis to the American public.

"Definite progress has been made each year in research and development incident to sight transmission by radio. Outstanding in television research during the past year was the perfection by RCA engineers of the 'iconoscope'—an electric eye—which has advanced the technique of television by facilitating the pickup of studio action and permitting the broadcast of remote scenes, thereby giving to the television transmitter the function of a camera lens.

Iconoscope's Use

"Through the use of the iconoscope, street scenes and performances in studios have been satisfactorily transmitted and received by television, on an experimental and laboratory basis.

"Nevertheless, some important problems relating not only to the technical side, but also the commercial side of television still call for solution. These problems relate principally to the cost of erecting and operating the necessary television transmitting stations, their interconnection for a wide-range service, the price at which television receiving sets can be successfully manufactured and sold to the public, and the production of suitable programs.

"While it is impossible to anticipate the exact time when this development can be introduced on an industrial basis, it may nevertheless be said that the progress made by the Corporation's laboratories and engineers, especially during the year under review, has brought us much nearer the goal, when transmission of sight will supplement transmission of sound.

Research and Engineering

"Particular importance, both with respect to new radio communication services and to television, is attached to the research and engineering carried on during the year in the field of ultra short radio waves.

"The creation by RCA engineers of extremely small radio tubes has provided a new avenue of approach to the problem of using these waves. Tubes have been developed of a diameter of only five-eighths of an inch, with internal elements fitted into a space about the size of a pea. They are especially effective on wave-lengths in the region of one meter and below.

Velocity Microphone

"Other important developments have included the personal type velocity microphone for a speaker to wear in his buttonhole or breast pocket; improved short-wave relay apparatus for broadcasts from aircraft and similar uses; improved mobile short wave equipment, and new double purpose radio tubes."

The report was signed by James G. Harbord, chairman, and David Sarnoff, president.

TRADIOGRAMS

By J. Murray Barron

Harrison Radio Company, 142 Liberty Street, New York City, has taken additional floor space at the same address which will more than double the original total space. This was made necessary by the large incerase in the mail-order department and also by the necessity of enlarged ham and short-wave departments.

* * *

Postal Radio Corp., 135 Liberty Street, New York City, announces a new Booster Unit for short-wave receivers. It is a pre-selector and is designed to work on any short-wave set, even the older type. Its purpose is to add more sensitivity and selectivity. There is free literature.

* * *

From the laboratories of Leotone Radio Co., 63 Dey Street, New York City, come a new short-wave chassis, in two type kits; a foundation kits of parts and a wired model.

* * *

Two new Test Oscillators designed by Herman Bernard are featured by Edward M. Shiepe, 135 Liberty Street, New York City. One is a new Universal Test Oscillator with line blocked. This model, 30-AB, is equipped with attenuator, a new feature. The other model is the 3430, which is a small precision portable signal generator of the battery-operated type. The 30-AB works on 90-120 volts a.c., d.c. or batteries (same test oscillator does all three), while the 3430 works on batteries only and has direct-reading percentage modulation (20 to 100) and output attenuation (0 to 20 decibels down in steps of 2 DB). Both models are direct-frequency reading for lining up intermediate and broadcast frequencies, and both may be used for short-wave calibration (hence are all-wave) by a simple computation applied to low-frequency readings. These two models are said to be the fastest-selling ones on the American market.

* * *

"The plugfuse with a light," as approved by Underwriters Laboratories is now being demonstrated by Blan the Radio Man, 177 Greenwich Street, New York City. It is not only novel, but actually a time-saving device. As soon as the fuse is blown the indicator will ignite a neon lamp, indicating at a good distance just where the blow out is.

* * *

Bud Radio, Inc., Cleveland, O., has just released for the experimenter and service man a new screw holder. Its construction permits the starting of any size screw in hard-to-get-at places. The device comes in four sizes and makes a valuable gadget for any kit. There will also be released early a new insulated handle socket wrench in a variety of sizes.

All this merchandise may be had at local stores and further information may be had by addressing this column.

* * *

In looking over the market we find that every week new short-wave kits are making their appearance. Some of these are one- and two-tube affairs, using the 2-volt type tubes. with either type, with a good standard circuit and good parts, sufficient stations should be received to satisfy the beginner, and many an old-timer will be surprised at the results. For those who want to construct their own short-wave receivers it is now possible to obtain effective parts with coils, chokes and every necessary part at very reasonable prices in the Metropolitan market. Its construction may be made on a wood base if necessary. Anyone interested and having any difficulty in obtaining any short-wave parts may address this column and the desired information will be sent you.

New York Show Dates

September 19th to 29th

The second annual combined National Electrical and Radio Exposition will be held at Madison Square Garden in New York City starting Wednesday, September 19th, and continuing for eleven days through Saturday, September 29th, said Ralph Neumuller, managing director of the Electrical Association of New York, Inc.

As in 1933, when the new combined exposition was organized, the New York association will act as sponsor, while the Madison Square Garden Corporation will undertake the general management. Joseph Bernhart, who managed the first annual exposition last autumn, and has since been appointed booking and exposition manager at Madison Square Garden is to again direct the show.

Triplett Offers Folder for Display of Meters

The Triplett Electrical Instrument Co., Bluffton, O., has a folder that pictures and describes the complete line of Triplett Electrical Measuring Instruments.

The folder is made in such a way that an excellent thumb index of each page is provided. A new counter display card, holding twenty different Triplett instruments, is on the back.

This folder is sent to anyone interested. Write The Triplett Electrical Instrument Company, Bluffton, O.

Literature Wanted

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

George G. Fornelius, 18 Washington Ave., Clifton, N. J.
Runard C. Seglund, 605 Munising Ave., Munising, Mich.
Walter F. Oldynski, Route No. 3, Catawissa, Penna.
James Joys Hopp (short wave information and goods), 541 Porter St., San Antonio, Texas.
Modern Radio Laboratories, 151 E. Liberty St., San Francisco, Calif.
M. Garrink, Mogilna 284-Y-17, Ucraina, U.S.S.R.
Louis E. Howell, W5DXB, Box 87, Gilliam, La.
E. P. Johnston, 532 Lovelace St., Pittsburgh, Pa.
F. R. Garber, 3030 Springer Ave., Cincinnati, Ohio.
Clayton Emerson, 8570 N. Charleston Ave., Portland, Ore.
Willie Kraulter, 1021 North St., Little Rock, Ark.
Carl E. Kapfstein, 2038 W. Liberty Ave., Pittsburgh, Pa.
Gilmore R. Webber, P. O. Box 965, Plainfield, N. J.
L. Flores, 1025 Dakin St., Chicago, Ill.
James Baikie, 160 West Huron St., Buffalo, N. Y.
E. K. Vickery, Manager, The Book Room, 141 Granville St., Halifax, N. S., Canada.
Joseph Barrett, 39 Birch St., Manchester, N. H.
George J. Hucks, 1289 Church St., San Francisco. Calif.
Robert Crapp, 802 Bullock Ave., Yeadon, Pa.
A. C. Smith, Jr., 360 Voorhees Ave., Buffalo, N. Y.
W. R. Darby, 111 E. Dudley Ave., Westfield, N. J.
E. J. Shortt, 38 Livermore Ave., Westerleigh, S. D.
Thos. H. Brown, 2431 Franklin St., N.E., Washington, D. C.
R. P. Miles, 24 E. Mosher St., Falconer, Chaut. Co., N. Y.
W. L. Connet, 446 San Jose Ave., Burbank, Calif.
J. L. Johnson, Fairfield, Idaho.
Dr. J. C. White, Hazlehurst, Miss.
Donald C. Culver, Taylor Hall "C"—Bethlehem, Penna.
Ralph Kistler, 63 South Bellvista Ave., Youngstown, Ohio.
F. A. Colquette, Box 14, Fisher, Louisiana.
William Corley, 229 No. 2nd St., Nashville, Tenn.
A. F. Gerichten, 4871 San Francisco Ave., St. Louis, Mo.
Stephen Sholtez, 138 Wilson St., Lackawanna, N. Y.
Floyd E. Cates, 629 S.E. 2nd St., Minneapolis, Minn.
Philip Dickel, 238 N. 52nd St., Philadelphia, Pa.
Raymond P. Snyder, 121 Hummel Ave., Lemoyne, Penna.
Leo E. Otis, 222 W. Chestnut St., E. Rochester, N. Y.

RADIO WORLD AND POPULAR MECHANICS MAGAZINE—Radio World is $6.00 a year, and Popular Mechanics Magazine is $2.50 a year. Popular Mechanics Magazine does not cut rates, but Radio World will send both publications to