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1932

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Per Copy

RADIO WORLD

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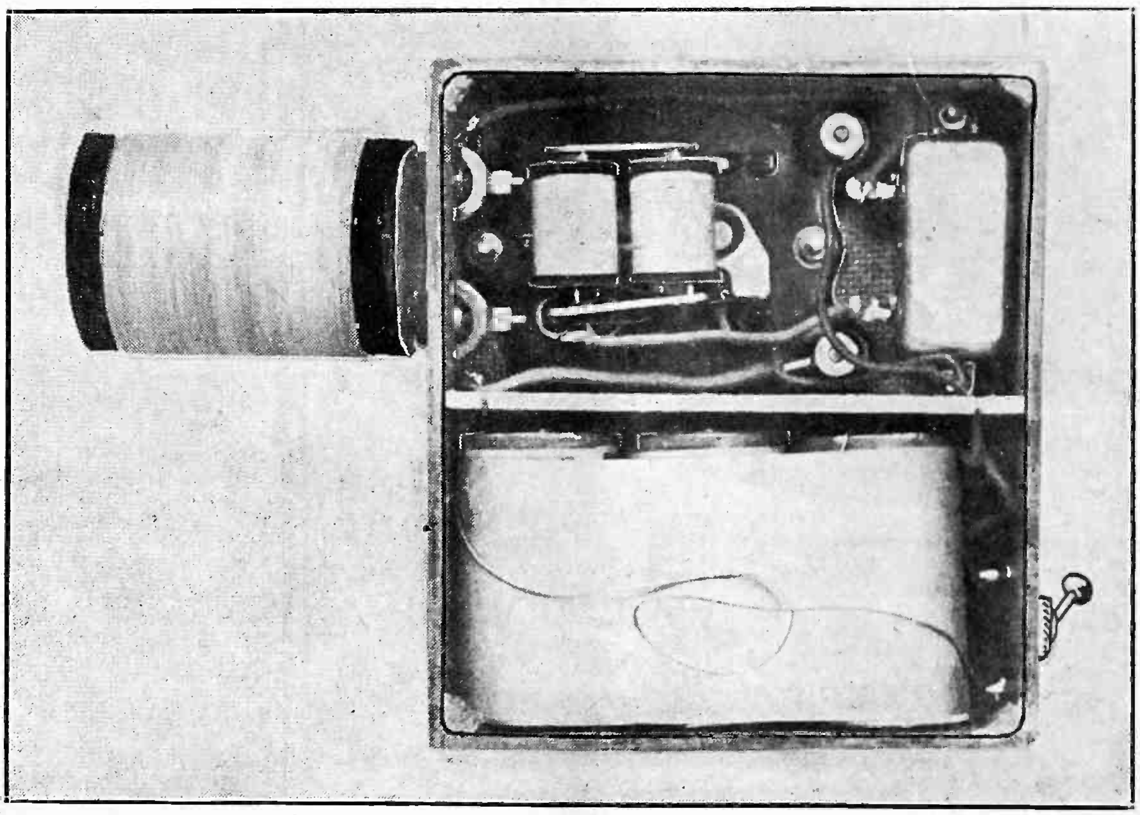
The First and Only National Radio Weekly

Eleventh Year—551st Issue

Check-up Oscillator Calibration Method for 1500-82 kc

A BUZZER TYPE OSCILLATOR



A compact oscillator, using buzzer modulation. See page 16.

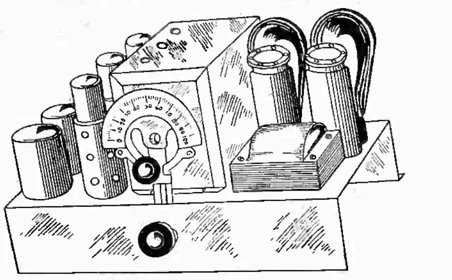
NOISE SUPPRESSION CONTROL CIRCUIT

How to Make Your Own Shunts

7-TUBE D-C SUPERHETERODYNE

5-TUBE DIAMOND

A TUNED radio frequency set, two stages of t-r-f (58 tubes) and tuned detector input (57 tube). One stage of audio ('47) and rectifier ('80). For 105-120 v. a-c, 50-60 cycles. Extremely high sensitivity for a t-r-f set —10 microvolts per meter at 1,000 kc. Brings in the high wavelength stations with tremendous volume, as well as the low wavelength stations. One knob for dial, one for volume control-switch. Selectivity to meet modern needs. Tone of the first quality.



Coils, tubes and tuning condenser in the Five-Tube Diamond are fully shielded.

COMPLETE KIT (Less Tubes and Cabinet) $15.69

The 5-Tube Diamond uses a three-gang tuning condenser with a midline tuning characteristic and affords a coverage of from 1520 to 500 kc (below 200 meters, to 600 meters). This affords excellent quiet spots past either extreme of the broadcast band for operation with short-wave converters.

Precision shielded coils are used in the circuit, matched to plus or minus 0.6 microhenry. The vernier dial, travelling light type, has 1-to-5 ratio, for close tuning.

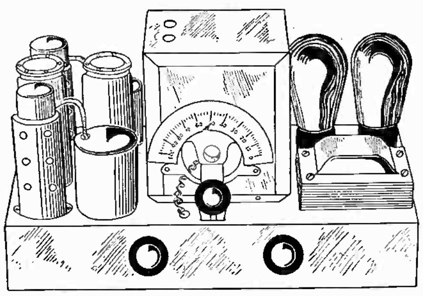
The complete parts—chassis, Rola 8" speaker, power transformer—everything except tubes and cabinet, is Cat. D5CK @ $15.69

FOUNDATION UNIT $6.19

Drilled metal subpanel, 13¾ x 8⅝ x 2¼", cadmium plated, with mounting flap at rear	$0.92
Three-gang Scovill 0.00035 mfd. condenser, midline tuning, brass plates, trimmers built in, ⅜-inch diameter shaft at both ends; full shield	1.95
Three special tube shields for the 58 and 57 tubes	.33
Six sockets (one for speaker plug)	.66
Two Polymet 8 mfd. wet electrolytic condensers, inverted type; insulators; lugs	.98
One set of three shielded coils (antenna coupler and two interstage transformers)	1.35
Foundation Unit (Cat. D5FU)	$6.19

Kit of five Eveready-Raytheon tubes for this circuit, Cat. D5T $4.97

4-TUBE DIAMOND



Excellent parts and an original circuit make the 4-Tube Diamond remarkable.

HOW much can be accomplished in an a-c set on only four tubes was revealed when the 4-Tube Diamond was announced and demonstrated recently. This remarkable circuit has the utmost in tone, and all that can be obtained in selectivity and sensitivity from a 4-tube design. It is heartily recommended and will give enduring satisfaction. The chief praise heard of the circuit concerns its tone. The other qualties are not deficient, however.

Complete Kit (Less Tubes, Less Cabinet) $13.58

All the parts, except cabinet and tubes, are supplied in the official kit, including Rola 8" dynamic, chassis, shielded condenser, dial, etc.

Kit of four Eveready-Raytheon tubes for this circuit, Cat. D4TK........$3.89

FOUNDATION UNIT $5.48

Drilled metal plated subpanel 13¾ x 2½ x 7"; cadmium plated, with mounting flap at rear	$ .85
Two-gang 0.00035 mfd. SFL condenser, brass plates, 2½" long shaft; full shield	1.39
Two special tube shields for 58-57	.22
Center-tapped 200-turn honeycomb coil	.40
Five sockets (one for speaker plug)	.55
Two Polymet 8 mfd. electrolytics; insulators; lugs	.98
One pair of r-f coils, consisting of impedance antenna coil and interstage transformer	.90
20-100 mmfd. Hammarlund equalizer for use as antenna series condenser	.19
Cat. D4FU @	$5.48

8 MFD.

ROLA SPEAKERS

The Rola Series F speakers with 1800-ohm field coil tapped at 300 ohms are now standard in the 4-Tube and the 5-Tube Diamonds. The list of parts specifies the 8" diameter speaker, but larger diameters may be used, to fit any particular console. The small model is intended for mantel set installations.

The Rola speakers are supplied with 5-lead cable and plug. The output transformer built in is matched to the impedance of a single '47.

8" diameter (Cat. RO-8)....$3.83
10.5" diameter (Cat. RO.-105) 4.27
12" diameter (Cat. RO-12).. 5.35

8 mfd. Polymet wet electrolytic condenser, inverted mounting, insulating washers (Cat. POLY-8) $0.49

POWER TRANSFORMERS } **4-Tube Diamond (Cat. D4PT) . $1.49** / **5-Tube Diamond (Cat. D5PT) . 2.16**

Travelling light vernier dial, 5-to-1 (0-100 for 5-tube, 100-0 for 4-tube); lamp; escutcheon; knob. Same dial takes either ¼ or ⅜" shafts.......................................$0.91

DIRECT RADIO CO., 143 West 45th Street, New York City

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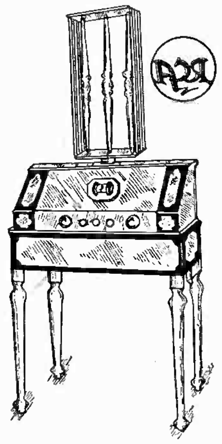
RADIOLA 28

8-Tube Superheterodyne Receiver



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LIMITED QUANTITY. Shipped brand new in factory sealed cases.

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Three 0.1 mfd. @ 29c

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CALIBRATION
Of an Harmonic Oscillator

By Herman Bernard

THE simplest and most inexpensive modulated oscillator to build is the harmonic type, using the a-c line hum for modulation. This oscillator was described in the September 24th issue. The diagram, with slightly different constants, is reprinted on the cross-section paper on the following page.

The only possible difficulty lies in the calibration, using broadcasting stations as standards. It is highly acceptable to do this, for the stations now are required to adhere to their assigned frequencies by plus or minus only 50 cycles, and it is not conceivable that the dial of the oscillator could be so set as to create a conscious difference of 350 cycles, nor would it be possible to read the difference on the dial, as, considering the broadcast band of 950 kc, the difference would be one part in 190,000.

So the standard is better than the oscillator, as of course it must be, to render the desired service. A standard frequency is nothing other than one maintained with high degree of accuracy.

Problem of Calibration

Virtually everybody who reads these lines has need of an oscillator, either constantly or occasionally, and that applies to home experimenters, students and tinkerers, no less than to service men and teachers. For less than $5 the harmonic oscillator can be built, but then the problem of calibration arises, and since an oscillator never can be any better than its calibration, some system should be devised that will enable the builder of the simple instrument to calibrate it understandingly and accurately. In the article in the September 24th issue data on calibration were given but it has become evilent that a more searching system has to be presented before the general run of readers, which includes many novices of course, can make a success of the calibration.

First, let us consider what we are building, and become familiar with the terms to be used in the exposition of a check-up system of calibration.

We are constructing a device consisting of a vacuum tube and a tuned circuit, with a-c on plate and heater. The plate voltage is therefore the a-c line voltage. The grid bias is normally zero. Soon after the switch is turned on the tube oscillates, or generates radio frequencies. These are always modulated by the hum frequency, 60 cycles.

Broadcast Station Analogy

A broadcasting station has an oscillator and a separate modulator tube, and the output of the microphone is fed to an amplifier, then mixed in the modulator with the oscillation frequency, and sent from the modulator or mixing tube to the aerial.

Here we have a little broadcasting station of our own, of modest power, our program is hum, and we may use a transmitting aerial if we like, to introduce the output frequency more strongly into a tested circuit, or we may simply rely on the inductive coupling between test and tested circuit. For instance, the present calibration was run on a broadcast receiver in the home of Richard B. O'Connor, in Brooklyn, New York, with the oscillator atop the receiver cabinet, and the resultant coupling such as existed because of the mutual fields of receiver and oscillator.

This oscillator has inductances in it of such a high order that the frequencies tuned in will be somewhere in the region encompassed by 100 and 200 kc, in conjunction with a 0.0002 mfd. tuning condenser. It is helpful to know something about the theoretical frequency range. With such a condenser we know that if the inductance runs into millihenries we shall be outside the lower limit of broadcast band of frequencies. The coils used this time were two 800-turn honeycombs, overall diameter about 1 inch, one coil between grid and cathode and the other between cathode and grid return. Their inductance is about 10 millihenries each. The tuning condenser was across the 1,600 turns.

Thy Name Is "Tenth"

Harmonics are multiples of the fundamental. Thus if we generate a frequency of 100 kc, and the tube is so circuited that its operation favors harmonic generation, as this one does because of zero grid bias, we have also, at smaller and smaller oscillation voltages, outputs of 200, 300, 400, 500, 600, 700, 800, 900, 1000 kc, etc. There is no limit to the number of harmonics, although there is a practical limit to the amount of oscillation voltage, it becoming very feeble indeed after the 50th harmonic or so.

At present we shall confine ourselves to ten harmonics, considering the fundamental as the first harmonic. There is a lack of agreement about this definition, some stating that the fundamental should not be referred to as a harmonic at all, and that the real first harmonic is the second harmonic. Whatever the terminology, it ought to be that which depicts the situation most clearly, and referring to the fundamental as the first harmonic does no violence to clarity. We then talk of ten harmonics, the tenth is the tenth, whereas by the other system the ninth harmonic might be the one known numerically as the tenth. When we call the tenth the tenth we know it is the ninth multiple harmonic, but all hands agree its name is tenth.

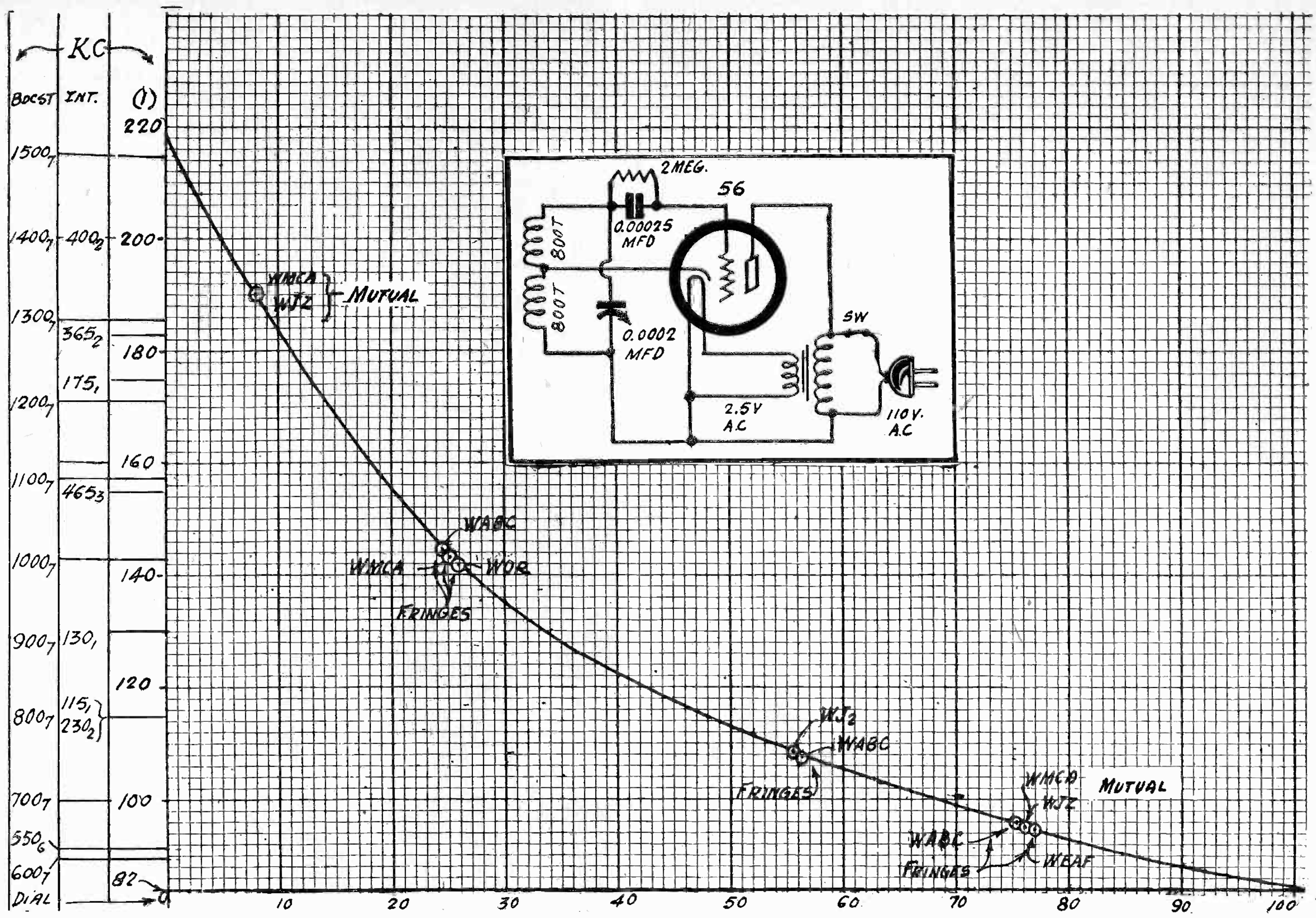
Having built the oscillator, and having been given a key to the approximate frequency range, we are ready to calibrate the oscillator. Indeed, even if we had not been given that key we still could calibrate the oscillator satisfactorily, but would have to prepare greatly enlarged tables. Here our tables are few and simple.

Selection of Station Standards

We select low-frequency local stations. Those living in localities where there are many stations are fortunate in having a larger choice. However, if one has a receiver that is at all sensitive, he can pick up a sufficient number of stations normally, at night, even if not locals, to render full service for the present calibration system. Frequencies between 1,000 and 550 kc should be used, as higher frequencies introduce confusion.

To be absolutely sure that the picture is firmly in our minds we shall review the fact that our oscillator is of the low radio frequency type, and therefore the stations

(Continued on next page)



Calibration curve of the fundamental frequencies of the oscillator diagramed in the insert. Dial readings are left to right at bottom, frequencies (of fundamentals) in column (1) at left. Intermediate frequencies, some by harmonics of oscillator, and broadcast frequencies, all by harmonics of oscillator, are given also. The inferior numbers in the kc column designate the harmonic of the oscillator's fundamental.

that we shall use as standards will have their fundamental frequencies, or first harmonics, mixed with the multiple harmonics of the oscillator, due to coupling "through the air." So if we ascribe numbers to the harmonics these numbers represent *the harmonics of our oscillator*, and compare with fundamentals of stations we are using as standards. In no case are we using harmonics of station frequencies, on only harmonics of our own oscillator.

Now, if we select five stations in the appropriate frequency spectrum, 1,000 to 550 kc, we may write their call letters in a perpendicular column, and next to the calls the frequencies of the stations, and above these frequencies the number (1) representing not the fundamental of the station, although it happens to be that too, but the theoretical fundamental of the oscillator, theoretical because we know that the oscillator will not have any fundamentals in the region of the broadcast band, and therefore that (1) will be of no use to us except as reference to station frequencies. On a horizontal line opposite the call put down the frequencies that are one-half, one-third, one-fourth, etc., of the fundamental, until one-tenth.

Early Procedure

Put the harmonic numbers (2) to (10) atop the respective columns, after all the stations have had their frequencies divided as stated. Those numbers (1) to (10), remember, represent harmonics of our oscillator. We can see therefore that the second harmonic column, like the first, will be of no practical value to us. In fact, the only numbers that will be of absolute use are those representing frequencies below parenthetical numbers that fall within the fundamental of the oscillator's frequency range. Thus in the third harmonic column there are only two frequencies that come within the expected frequency range of the oscillator, these being 190 and 220 kc. Therefore with a receiver going, and oscillator coupled, when we pick up a squeal when the set is adjusted to 570 kc, we suspect the oscillator is generating 190 kc, because 570 kc is the third harmonic of 190 kc.

We have suspected the 190 kc oscillation frequency, and that is all we can do so far. How do we know that the beat note of squeal produced by the mixing of the station's oscillating frequency with our own oscillator's frequency is not 142.5 kc? Or indeed 114 or 95 kc? And which is which? These also are fundamentals the fourth, fifth and sixth harmonics of which would beat with 570 kc station's frequency. That is the problem—how to be sure that what we have is what we think we have, or how to register the fundamental frequencies with certainty.

The object of going to the tenth harmonic of the oscillator was to be sure that we had enough frequencies to effectuate a complete and authentic check-up.

LIST OF PARTS

Two 800-turn honeycomb coils, 1 inch in diameter (to be stacked up close together on a screw passed through the dowels).
One 0.0002 mfd. variable condenser.
One 0.00025 mfd. grid condenser with clips.
One 2 meg. grid leak (larger value of leak may be used for greater output, smaller value if continuous high-pitched whistle is heard).
One UY socket.
One 2.5-volt filament transformer (if secondary is center-tapped, connect center instead of side to line).
One a-c cable with male plug.
One a-c switch.
One 56 tube (a '27 tube may be used, but is not quite so good an oscillator)
One panel.
One cabinet.
One dial.

A Check-up System

We have learned in a preliminary test that several harmonics of a station at or near the low frequency end of the broadcast band will come within the scope of the tuning curve of our oscillator, and when we have written down these fundamental frequencies tentatively, and put dial numbers next to them, we proceed to our checkup.

Followers of this system in other parts of the country will use different stations or frequencies, but the results will be the same finally, that is, the oscillator will be accurately calibrated.

Assuming the user is in the New York metropolitan area he would naturally select WMCA or WNYC, both sharing 570 kc; WEAF, WOR, WJZ and WABC. So the tabe, "Harmonics of Oscillator Represented by Station Fundamentals" is given for these five stations on the next page.

By reading the harmonics across, one station at a time, and comparing each one to the harmonic frequencies on the lines of the other stations, we can ascertain where there is coincidence of oscillator fundamentals.

Repeaters Spotted

For instance, 190 kc on the oscillator would beat with the fundamental station frequencies of any stations with frequencies that are harmonics of 190 kc. We find that the third harmonic of 190 is WMCA's frequency, 570 kc, and also that of the fourth harmonic of 190 kc is WJZ's frequency, 760 kc. We can confirm this by subtracting WMCA's frequency (760) from WJZ's (570). The difference is 190. Also 95 kc is represented twice. To put it differently, two different harmonics of two different fundamentals coincide with the frequencies of WMCA and WJZ.

Therefore we have two absolute reference points, and when we seek our first authentic calibration points we do so with the knowledge that 95 and 190 kc are concerned. As we know the direction the condenser turns, and that the dial reads in reference to the condenser, we know that the two points will be disposed in a given direction. If the dial numbers increase with capacity increase then the higher numerical reading will be that of the lower frequency (95 kc) and the lower numerical reading will be that of the higher frequency (190 kc). So with receiver tuned to WJZ, for instance, obtain the two points by the beat note (or squeal) or zero beat, and for confirmation, tune the receiver to WMCA and verify the fact that a squeal is picked up at these same two points, representing the same fundamental frequencies, though different harmonics of them are beaten with the second station (WMCA). These two points on the curve on page 4 are designed "Mutual."

We Have a Guide

Now we know definitely the two points obtained, their fundamental frequencies and dial positions, and happily they are near the opposite ends of the tuning curve. Although many harmonics may confront us in further attempts at calibration, we know that the tuning curve will have some sort of regularity and we can quickly determine truant or deceptive frequencies because they will be so far off the curve that we shall be guided best by ignoring them.

HARMONICS OF OSCILLATOR REPRESENTED BY STATION FUNDAMENTALS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
WMCA	570	285	190	142.5	114	95	81.44	71.25	63.33	57
WEAF	660	330	220	165	132	110	94.44	82.5	73.33	66
WOR	710	355	236.66	177.5	142	118.33	101.43	88.75	78.88	71
WJZ	760	380	253.33	190	152	126.66	108.57	95	84.44	76
WABC	860	430	286.66	215	172	143.33	122.85	107.5	95.55	86

The parenthetical numbers represent the harmonics of the fundamentals under them that produce the station frequencies.

Let us ascribe dial numbers to the two frequencies already calibrated. Let us say 95 kc comes in at 76 on the dial and 190 kc at 8 on the dial.

We could proceed, by using fundamentals near those already obtained, and comparing with harmonics thereof coinciding with various broadcast frequencies, but we have not yet exhausted our more reliable and confirmatory method. The whole system depends on the check-up principle, and although we have found that only two frequencies were useful as absolute guides, we also find that other frequencies, not coinciding exactly, but close to coincidence, may be used on the same reliable basis. We find, for instance, that only two numbers are repeated under the "Harmonics of Oscillator Represented by Station Fundamentals," but fundamentals not far apart in frequency are useful and these we shall call fringes. That is, the harmonics are not of exactly the same fundamentals, but of fundamentals very closely related. The table in the next column gives the mutuals and fringes.

Thus we find 142 has a fifth harmonic equal to WOR's frequency, 142.5 has a fourth harmonic equal to WMCA's frequency, and 143.33 has a sixth harmonic equal to WABC's frequency. These come in at 24¾, 25⅛, and virtually 26, on our dial. Moreover there are fringes near the 95 kc point already established, and these are the fundamentals 95.55, the ninth harmonic of which is WABC's wave, and 94.44, the seventh harmonic of which is WEAF's wave. Also there are fringes at 108.57 and 107.5 kc fundamentals. the seventh harmonic of 108.57 being WJZ's wave and the eight harmonic of 107.5 being WABC's wave.

MUTUAL HARMONICS

kc		
190	WMCA (3)	WJZ (4)
142-143.33		
108.57-107.5		
95.55-94.44		
95	WMCA (6)	WJZ (8)

FRINGES

WOR (5)	WMCA (4)	WABC (6)
WJZ(7)		WABC (8)
WABC (9)		WEAF (7)

The way to make use of the fringes is to get the beat for WMCA and WJZ again at 76, tune the set to WABC and turn the dial to a lower numerical (higher frequency) reading just a bit, about one division, to pick up WABC's squeal, then about equally past 95 kc in the other direction, when the set is tuned to WEAF, to pick up that squeal. Dial positions so close together help the calibration only a very little, but the mainstay is the confirmation thus attained, and the safeguard against being fooled by incomprehensible harmonics.

First Curve

The same method of confirmation is followed in using the fringes in the 140-odd kc range, and this time the points are valuable because assumptively between the lower and higher frequencies already recorded. And, again, the WJZ-WABC fringes between the WMCA-WOR-WABC fringe group and 95 kc help us to find another point, or three points close together, in a hitherto unplotted portion of the curve.

Now with the points already obtained, which we shall call only four, counting bunched points as one, we can arrange plotting paper from 80 to 220 kc, 0-100 dial settings, register the confirmed points, and lightly draw in pencil on cross-section paper, like that used in the illustration, some semblance of a curve. We desire other points, too, but now we know just about on what line they should fall, considering the curve as the line, although we do not know their dial numbers. We shall find them out.

We do not know for certain yet how low in frequency the oscillator will tune, except that it will be lower than 95 kc. The tenth harmonic of 86 kc is WABC's wave, so with the receiver tuned to WABC, let us see if we don't pick up a squeal as we turn the oscillator dial to higher numerical settings. Yes, indeed! At 90 there is a squeal. Let us record in pencil a point on the plotting paper at 90, representing 86 kc. From now on there will not be much change in frequency until 100 on the dial is reached, but 84.44 raised to the ninth harmonic equals WJZ's wave, and if we pick up the squeal when WJZ is tuned in on the set, oscillator between 90 and 100, we know that that number on the dial represents 84.44 kc. And it turns out to be number 96.

More Points Registered

Now going to higher frequencies we re-encounter the tenth harmonic of 86, which is WABC's wave, nothing in the ninth harmonic column, except two fundamentals previously used (84.44 and 95.55), and in the eighth harmonic columns 88.75 (WOR), in the seventh harmonic columns,, 94.44, 101.43 and 122.85 that are useful, also one of no present use and one previously used.

And so we can go through the process and pick out as many points as we need (easily more than we actually need, in fact) and can confirm the curve more definitely in pencil, correcting for any misshape due to tentative recording, and after the pencil curve is nicely cleaned up can register the curve in ink by careful tracing over the pencil line. Soft solder of the uncored type may be bent into the shape of the curve and may be used to guide the pencil in the semi-final drawing of the curve, but hardly any pressure may be exerted against the solder after it is bent into shape, otherwise it will lose that shape.

Low Distributed Capacity

Now we have finished the calibration of the fundamental frequencies of our oscillator. The curve may be extended to its terminals by following the indicated contour as disclosed by previous registrations, as we find that the tuning range is definitely established. In the present instance it was 82 to 219 kc, a frequency ratio of 2.66.

From previous experience with broadcast coils, using the same 0.0002 mfd. Hammarlund junior equalizing condenser, we ascertained the practical frequency ratio, then 2.6. As the distributed capacity of the broadcast coil was small, for the coil was excellently made, we now know by comparison that the distributed capacity of the two honeycomb coils used in the present oscillator was even smaller, although the number of turns on them totalled 1,600. The oscillator of the same type described in the September 24th issue used an 800-turn coil between grid and cathode and a 300-turn coil between cathode and return, both honeycomb type, but the frequency span just barely reached 2-to-1, with the same condenser. Therefore the contraction in that case was due to the larger distributed capacity of the smaller coil. And this is confirmed by the fact that the more turns on a honeycomb coil, the smaller its distributed capacity, for the capacities of the turns are effectively in series. Therefore the distributed capacity of a honeycomb coil of 800 or 1,600 turns (considering the two coils as one) is less than that of a coil of a single turn!

Intermediate Frequencies

Now we have our fundamentals nicely arranged, 82 to 219 kc, and to the left, on the perpendicular line, we write in the frequencies, starting with 82 on the second frequency line and blotting out the first frequency line, which would be 80, not reached. We abscribed 20 kc to each frequency line, so that the more strongly ruled horizontal lines are 100, 120, 140, 160, 180, 200 and 220 kc. These frequencies we

(*Continued on next page*)

write in the perpendicular line under (1) on the curve, designating fundamentals.

Of the intermediate frequencies used in superheterodynes we find that 175 kc (at 12¾), 130 kc (at 33½) and 115 kc (at 48) fall on the fundamental, but we shall put all the popular intermediate frequencies in the next perpendicular column to the left, and by numerical subscripts of the intermediate frequencies designate which harmonic of the fundamental is used. From top to bottom therefore we shall account for 400 kc, using the second harmonic of 200 kc, and writing down the 400 with a subscripted figure 2 thus: 400_2. Also for 365 kc, using the second harmonic of 182.5 kc, and therefore recording 182.5_2. We have discussed 175 kc, and will give it the subscript figure 1, thus 175_1. For 465 we use the third harmonic of 155 kc, for 130 kc the fundamental as stated, for 115 kc the fundamental likewise, and at the same point account for 230 kc, another intermediate frequency sometimes encountered, using now the second harmonic of 115 kc.

It will be noticed that the intermediate frequencies, by harmonics or fundamentals of the oscillator, are distributed up and down the scale without recourse to any particular order, and this is perfectly acceptable, since there are only a few of them (seven, counting the coinciding point of 115-230 kc as two), and there is no trouble in keeping track of them.

The Broadcast Band

But we also desire to use this oscillator in connection with the broadcast band. And in that band, since there may be eleven different frequencies, we do not desire them scattered about at random, and would prefer to select different harmonics of different fundamentals to preserve a regular order, so that when we turn the dial in one direction we get ascending order of recorded frequencies and when we turn it in the other we get a descending order.

Fortunately this can be arranged nicely by selecting the seventh harmonic. The fundamental span was 219 to 82 kc, so the seventh harmonic span would be 1,526 to 574 kc. This is excellent, except that the lowest frequency is missed out, so we take the sixth harmonic of 91.67 to account for 550 kc. We keep in mind when using the oscillator that the frequencies increase with decrease in dial readings, except that after we come to 600 kc we have to turn the dial in the opposite direction a bit, instead of continuing in the same direction. For the broadcast band, as for the intermediate band, we confine ourselves to absolute values of definite frequencies, without attempting to read the curve for frequencies sandwiched between those recorded. For practical purposes the frequencies of the broadast band 100 kc apart are sufficient, with a recorded off-point, so to speak for the extreme, 550 kc. The subscripts on the broadcast frequencies denote the harmonics of the oscillator's fundamental frequencies.

If we have a recording dial we may record the intermediate frequencies and their dial settings, also the broadcast frequencies and their dial settings, and use the curve only to obtain other frequencies on such rare occasions as we need them.

Short Waves

One of these occasions may have to do with short waves. Of course we must know something of the frequency region in which the short-wave apparatus is working, and then we can use our oscillator, following the fundamental calibration. The fiftieth harmonic would take us to 10,950 kc at one extreme of the oscillator and 4,880 kc at the other, but unless we knew in advance approximately where we were at we would get confused about which harmonic the set was responding to, the same problem that the present article solves for the fundamental calibration, but which can not be solved so well where many frequencies and their harmonics are concerned.

A way out would be to build a 5,000 kc oscillator and calibrate it for its fixed frequency against the standard transmission on Tuesdays from WWV, the United States Government station, operated by the Bureau of Standards, from Washington, D. C. The schedule of transmissions is: 10 a.m. to noon, continuously; 8 p.m. to 10 p.m., continuously. The time is Eastern Standard. The accuracy is better than one part in 5,000,000 at all times.

The station is sending out continuous wave keyed telegraphy and therefore only by slight detuning can you pick up the code. If you detune to one side then the other to hear the signals, register 5,000 kc as the midpoint where the signals disappear (zero beat). Then 5,000 kc and harmonics from the oscillator of that fundamental frequency may be used for getting definite positions for short-wave calibration of a receiver (5,000, 10,000 and 20,000 kc etc.) and with that information the present harmonic oscillator with its hum modulation may be used, although considerable experience with radio, and particularly oscillators, is required before any half-way sufficient results are obtainable on short waves of a wide frequency span, with the oscillator that is the subject of this article.

A difference between the present oscillator and the one described September 24th is that there is no output load circuit now, but coupling may be the inductive one previously described, or if the harmonics are too weak, or the station waves are too weak, a wire may be wrapped around the tube base for a few turns and run to the aerial where the other end of this wire is similarly wrapped, no conductive connection at either point. This will transfer considerable energy from the oscillator to the test circuit, and therefore the reader may assume that the intensity of the oscillation is large.

Good Frequency Stability

Not only is it large but the frequency stability is good, due to the grid leak and condenser. The oscillation actually takes place during half a cycle—the positive half, for during the negative half the plate is negative—but there is no indication of this fact in the actual results, and a person not knowing of the suppressed alternation in advance, would never suspect its existence. It is well not to use a metal dial, as the hand may touch the dial, therefore one side of the line, and for a few moments the oscillation may stop due to damping. Besides, the line should not be exposed. Hence use an insulated dial.

The oscillator is good enough to establish a definite zero beat, or a low growl which is close enough thereto, these being finer settings than merely squeals, but if zero beat or low growl is not obtainable it is due to mistuning in the tested circuit. As it is well known that gang condensers in t-r-f systems can not track perfectly, and that in superheterodynes, although the oscillator frequencies are the controlling ones, and mistuned t-r-f of no serious drawback in testing with an oscillator, the intermediate transformers may not be perfectly adjusted, and these should be set first on the basis of intermediate frequency calibration, and for extremely fine readjustment later, when oscillation voltage is introduced into the oscillator or the tuner, for registration of the zero beat. Insulated screwdrive is needed fo this purpose.

The oscillator has been used for several months and has proved its real worth. The oscillation is sharply selective, and the hum indicating resonance is not present off resonance. Oscillators that hum all the time, only a little louder at resonance, are difficult to adopt to practical purposes, if not actually a nuisance.

American Sets Preferred in New Zealand Market

Washington.

Fully 75 per cent of all the radio sets sold in New Zealand are of American make, according to Trade Commissioner Julian B. Foster.

Local manufacturers, he says, are making substantial progress, but have not yet seriously threatened United States trade. English makers have not been able to produce a set capable of getting long-distance stations at a price which can compete with the American article.

The steady increase in radio sales throughout New Zealand has been a striking feature of the general business slump. Although 11,000 sets were distributed in the country during 1931, it appears probable, according to Foster, that 1932 will see a larger number sold and that sales will continue to expand for another two years at least.

The New Zealand demand, he points out, is for the low-priced 4-, 5- and 6-tube superheterodyne electrically operated sets.

According to figures compiled in the Commerce Department's Electrical Equipment Division, the United States in 1931 shipped to New Zealand 19,497 sets having a value of $614,012, as compared with 11,-963 valued at $640,000 in the preceding year. The average value of the American radio sets exported to this market last year was $31.50 as compared with $53.30 in 1930.

Ribbon Microphones in Opera Broadcasts

Metropolitan Opera will be brought to the radio audience this year with greater fidelity than ever before through the new velocity or "ribbon" microphones which the National Broadcasting Company will install.

These microphones, which will be used regularly by the NBC for the first time at the opera broadcasts, starting late in November, were recently perfected by the RCA-Victor Company.

Velocity microphones eventually will become standard equipment for NBC broadcasts, but they cannot be put into all studios immediately because they require an entirely new production and control technique, which in turn will require many weeks of experimental work.

Unlike existing types, the velocity microphone utilizes a sensitive ribbon of duralumin, instead of a diaphragm. This ribbon, two ten thousandths of an inch thick, vibrates exactly with the minute variations of the air particles set in motion v the sound waves.

Ousted Station Protests License to Banker's Son

Washington.

The Federal Radio Commission heard arguments by Peter J. Prinz of Jamaica, N. Y., against granting of a construction permit for a new station to Peter Goelet, son of the banker, Robert Goelet, to use the 1,210 kc channel now used by Mr. Prinz. At the original hearing on the application, Chief Examiner Ellis A. Yost recommended that Goelet's application be granted and that WMRJ, operated by Mr. Prinz, be taken off the air.

The examiner charged that WMRJ operated sometimes without a licensed operator and violated other regulations of the commission. Mr. Prinz denied the charges. Bethuel M. Webster, who appeared for Mr. Goelet, said that Mr. Goelet wanted only certain hours on Saturdays and Sundays to broadcast for the benefit of his immediate neighbors.

THE 48 IN A SUPER

Latest Tube Is Output of 7-Valve Set

By Brunsten Brunn

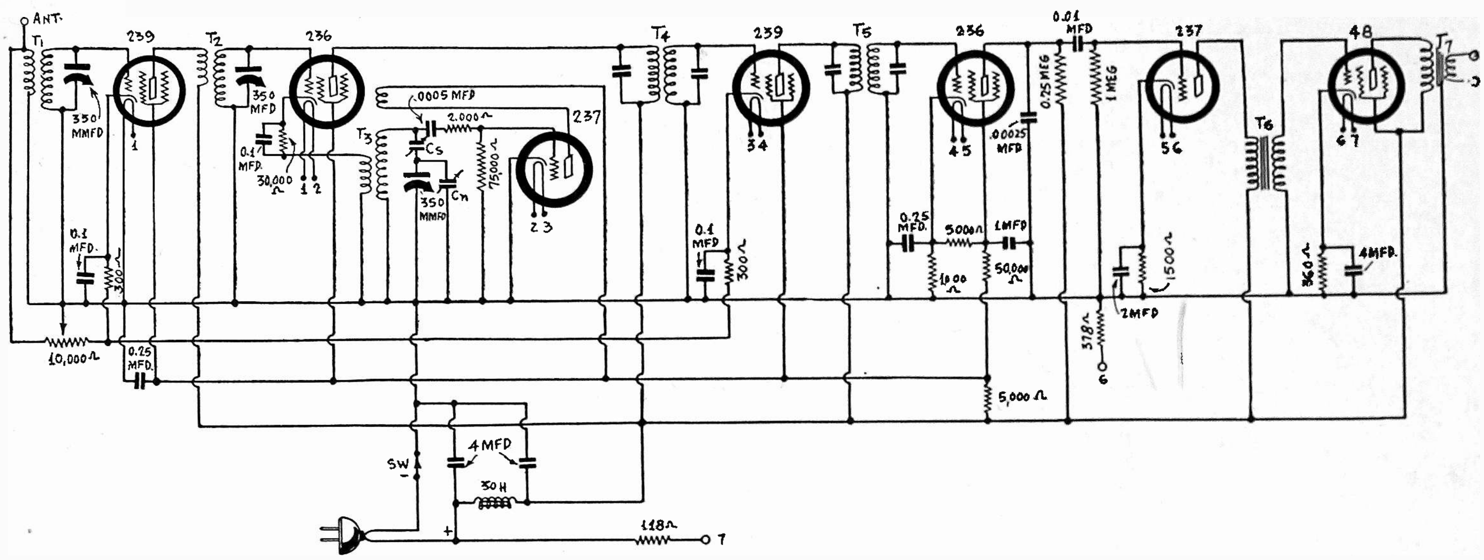


FIG. 1

This seven-tube superheterodyne employs series-connected heater type tubes of the automobile series and one of the new 48 power tubes.

THE LATEST tubes, apparently must be used in every receiver that is built. We have described d-c superheterodynes utilizing the 238 pentode as power tube. Then the 89 came out, and it was necessary to adapt the old circuits to this tube, and to design new circuits. Now the 48 tube has come out, a power tube especially designed for d-c work. Many requests for circuits incorporating this tube have already come in. Let us talk about one circuit, the seven-tube superheterodyne diagramed in Fig. 1.

Let us first consider the filament circuit. There are seven tubes in all. Six of them require 0.3 ampere and 6.3 volts. The seventh, a 48, requires 0.4 ampere and 30 volts. We start the filament circuit at the negative terminal of the first tube and connected to the chassis, for the chassis is connected to the negative terminal of the d-c line. Then we connect all the filaments in series, terminals of equal number being joined together. This includes the filament of the 48 although it requires more current that the rest. Terminal (7), which is the positive end, is connected to a ballast resistor, also marked (7) at one end. The other end of this ballast is connected to the positive side of the d-c line.

If we were to leave the circuit this way the filament of the 48 would not get enough current and those of the other tubes would get too much. We have to provide a shunt resistor across the first six filaments to pass the extra 0.1 ampere required by the 48. This resistance is connected between the chassis and point (6). What should the resistance of this shunt be? Well, the voltage across it is 6x6.3, or 37.8 volts. We also want 0.1 ampere to flow through it. Hence the resistance should be 378 ohms, and it is so marked. The wattage rating of this resistor need not be greater than 5 watts, for the dissipation in it is 3.78 watts.

Value of Ballast

We have assumed tacitly that the voltage across each filament is 6.3 volts. But it will not be that unless we insert a ballast resistor of proper value in series with the filaments. Let us see what the value should be, on the assumption that the average line voltage is 115 volts. The total drop in the filaments is 67.8 volts, for the first six take 37.8 and the power tube takes 30 volts. The drop in the ballast resistor must therefore be 115 less 67.8 volts, or 47.2 volts. The current through it is 0.4 ampere. Hence the value of the resistance should be 47.2/0.4, or 118 ohms. The power dissipated in this ballast is obtained by multiplying the voltage across it by the current through it. We get nearly 20 watts. Hence if the rating is 25 watts or more there will be no undue heating.

Bias Values

Self bias should be used on every tube because the drop in a bias resistor carries filtered current and therefore produces no hum, whereas if the bias is obtained from the filament circuit hum is likely, since this current is not filtered. Of course, grid batteries could be used, but they are not regarded practical these days, especially when we can get bias by the cathode resistor method.

The bias resistance on the two 239 tubes

(Continued on next page)

LIST OF PARTS

Coils

T1, T2—Two midget type r-f tuning coils, shielded
T3—One three winding oscillator coil for 350 mmfd. condenser and either 175 or 400 kc intermediate
T4, T5—Two intermediate frequency transformers, doubly tuned
T6—One audio frequency transformer
T7—One output transformer, 2,000 ohm a-c primary
One 30-henry choke coil

Condensers

One gang of three 350 mmfd. tuning condensers with trimmers
Three 0.1 mfd. by-pass condensers
One 0.25 mfd. by-pass condenser
One 0.5 mfd. by-pass condenser
One 2 mfd. condenser
One 0.00025 mfd. condenser
One 0.0005 mfd. condenser
One 0.01 mfd. stopping condenser
One 1 mfd. by-pass condenser
Three 4 mfd. by-pass condensers

Resistors

One 1,000 ohm resistor (brown body, red dot, black end)
One 1,500 ohm resistor (brown body, red dot, green end)
One 2,000 ohm resistor (red body, red dot, black end)
Two 5,000 ohm resistors (green body, red dot, black end)
One 30,000 ohm resistor (orange body, orange dot, black end)
One 50,000 ohm resistor (green body, orange dot, black end)
One 75,000 ohm resistor (violet body, orange dot, green end)
One 250,000 ohm resistor (red body, yellow dot, green end)
One 1 megohm resistor (brown body, green dot, black end)
Two 300 wirewound bias resistors
One 360 wirewound resistor
One 378 ohm wirewound resistor, 5-watt rating
One 170 ohm, 25 watt resistor
One 10,000 ohm tapered potentiometer with switch Sw attached

Other Requirements

One antenna binding post
One vernier dial
Six UY sockets
One 6-contact socket
Four grid clips
One small chassis

(*Continued from preceding page*)
are 300 ohms. Values as high as 600 ohms may be used if it is necessary to do so to stop oscillation. It is not likely that oscillation will occur since there is only one amplifier in each frequency level. The bias resistance of the 236 first detector is 30,000 ohms. Again, it may be advantageous to use a higher value, say 50,000 ohms, because the screen voltage on the tube is high, and that puts the best detecting point at a greater bias. This part of the circuit is not at all critical, for a change from 30,000 to 50,000 ohms will change the bias only a small amount.

There is no bias resistance for the oscillator, but it is biased just the same, by the grid current through the 75,000 ohm grid leak. There is one bias difficulty in the oscillator that often causes trouble, and that is blocking. This occurs when the amplitude of oscillation is so high and the grid current so great that the charge on the grid condenser does not have time to leak off. It gives rise to a high pitch squeal, so high in most instances that it is almost at the limit of audibility. Indeed it may be above audibility. The circuit is practically dead when this occurs.

Blocking is stopped by making the grid condenser smaller, by increasing the resistance in series with it, or by decreasing the grid leak.

There is also a possibility that the oscillator will overload the first detector over a part of the tuning range between zero and say 30 on the dial. The remedy for this trouble is the same as for blocking. This type of overloading is recognized by a strong rushing or roaring sound which suddenly appears as the condenser is moved toward the higher frequencies.

The Second Detector

The bias on the second detector is perhaps the most critical as it depends much, not only on the plate voltage but also on the screen voltage and on the resistance in the plate circuit. As a rule, a low screen voltage works better than a high one. If the applied plate voltage is 115 volts and the load resistance is 250,000 ohms, a possible combination is one volt bias and 5 volts on the screen. This will not stand a great deal of signal voltage, but if there is an intermediate audio amplifier the output will be enough to load up this amplifier, and that is sufficient. If we make the grid bias resistance 1,000 ohms and arranged the voltage divider so that 1 milliampere flows through it, the bias will be one volt. The screen voltage should measure 5 volts from the cathode. If then we put 5,000 ohms between the cathode and the screen, the screen voltage will be 5 volts. We may assume that the current in the bias resistor is the same as that in the screen resistor for the current through the cathode is very small. We have dropped 6 volts so far. If the voltage on the r-f screens is 67.5 volts, the drop in the next resistor should be 61.5 volts. Since the current is one milliampere we should need a resistor of 61,500 ohms. In the figure it is marked 50,000 ohms. The decrease will only increase the screen and bias voltages a little, and in the same proportion. The next resistance is the voltage divider should be about 5,000 ohms for this particular circuit.

We can increase the bias as well as the screen voltage by reducing the 50,000 ohm resistor, as was stated above, but if we want to keep the voltage up on the screens of the other tubes we also have to decrease the 5,000 ohm resistor between the high voltage and the r-f screens. Another way to increase the two voltages is to increase both the 1,000 and the 5,000 ohm screen resistor.

Readjusting the Voltages

If we make the current through the bias resistor 3 milliamperes the bias will be 3 volts and the screen voltage will be 15 volts. This is also a good combination of voltages. To get it we have to make the third resistor 20,000 ohms instead of 50,000 ohms. Now we have to lower the resistance next to the high voltage lead. The current through it will be about 12 milliamperes and the voltage drop across it about 50 volts. Hence the value of the resistor should be nearly 4,000 ohms. There is no one combination that works the best but in any case there should be the right ratio of the bias resistance and the screen resistor. By screen resistor is meant the resistor that is connected between the cathode and the screen.

It will be noticed that the arrangement amounts to connecting the cathode to the first tap on the voltage divider and the screen to the second. The bias resistor takes the place of the usual bleeder resistor.

A 1,500 ohm bias resistor is used for the 237 audio tube and a 360 ohm resistor for the 48 power tube.

Coils

The r-f coils T1 and T2 should be of the shielded midget type and wound for 350 mmfd. tuning condensers. They are standard. The oscillator coil, of course, depends on the r-f coils as well as on the intermediate frequency. Oscillator coils for 350 mmfd. condensers are available for both 400 and 175 kc intermediate frequencies. Likewise, intermediates of the type shown are also available in both 400 and 175 kc. They, too, are standard.

An audio transformer T6 is used between the first a-f tube and the power tube. The reason for this is that total resistance in the grid circuit, from the cathode to the grid, should not exceed 10,000 ohms. If resistance coupling were used such a low grid leak would not be efficient.

The output transformer T7 is shown with the receiver but it should be an integral part of the dynamic speaker. The optimum load resistance of the 48 tube is 2,000 ohms. At this time a suitable output transformer, as an integral part of the speaker, is not available but it will not be long before it is, for this new tube has many obvious advantages. If the voice coil has not been changed, the ratio of the transformer needed is much lower than the ratios required with other tubes. If the voice coil resistance is R ohms the ratio should be the square root of 2,000 divided by R. For example, if the voice coil a-c resistance

The field coil of the dynamic speaker may be connected directly across the line, provided it has been wound for this voltage. If it has been specially designed it may be used in place of the ballast resistor, or at least a part of it. There is one speaker available having a field resistance of 125 ohms, but it will carry only 0.3 ampere. If it were connected in this circuit it would have to carry 0.4 ampere and it would undoubtedly heat up too much. If it does not it is all right to use it. In that case the rest of the ballast would only be 45 ohms. The wattage dissipation would be only 7.2 watts, and this would be the only power wasted.

Filtering

Across each of the two r-f bias resistors and the detector bias resistor is a 0.1 mfd. condenser. The condenser across the bias resistor of the second resistor is 0.5 mfd., that across the resistor for the audio amplifier is 2 mfd., and that across the bias resistor for the power tube is 4 mfd. The large values are used to prevent degenerative feedback. In the filter are two 4 mfd. condensers and a 30-henry choke.

The line switch is put on the negative side because this is usually "hot."

Between the audio tube and the power tube we have the usual coupler consisting of a 0.00025 mfd. by-pass condenser, a 250,000 ohm plate resistor, a 0.01 mfd. stopping condenser, and a one megohm grid leak.

Trimming

There is, of course, a trimmer condenser attached to each of the three 350 mmfd. tuning condensers, but only that on the oscillator is shown. It is marked Cn. The series padding condenser is indicated by Cs. While the series condenser is put above the tuning condenser it may be put on the ground side in series with the coil.

First adjust the intermediate tuner, preferably with the aid of a calibrated i-f oscillator. Then adjust all the trimmers on the gang condensers at about 1,450 kc. Next convert the circuit to a t-r-f receiver by moving the grid cap of the first detector to the top of the second. Tune the circuit to any station around 600 kc. Leave the condensers as they are and then restore the receiver to a superheterodyne. Tune in the same station around 600 kc with the series condenser, that is, CS. That should complete the adjustment.

Tube Terminal Arrangement

The 48 tube has six pins at the base and none at top. The two large pins are the filament terminals. If we look at the bottom of the base, and hence at the bottom of the socket, with the two large pins near the observer, the three pins on the left, counting from the one farthest away, are grid No. 2, plate, and filament. The three on the right, counting as before, are grid No. 1, cathode, and filament. The terminal arrangement of the cathode, plate, and the filaments is the same as that of a 227. But there are two grids instead of one. The one nearer the cathode is grid No. 1, and this is the control grid. No. 2 grid is nearer the plate, and this the screen grid.

Data on 48 Tube

The cathode circuit in most d-c receivers is usually tied in either directly or through biasing resistors (or C-battery) to the negative side of the heater circuit. The potential difference thus introduced between heater and cathode of the 48 should not exceed 90 volts, as measured between the negative heater terminal and the cathode.

The 48 because of its large power-delivering ability at low plate and screen voltage enables the designer of d-c power line receivers to achieve easily superior d-c receiver performance.

As a power amplifier (Class A), the 48 is recommended for use either singly or in push-pull combination in the power output stage of d-c receivers. Recommended operating conditions are given under rating and characteristics.

If a single 48 is operated self-biased, the self-biasing resistor should be approximately 360 ohms. This resistor should be shunted by a suitable filter network to avoid degeneration effects at low audio frequencies. The use of two 48's in push-pull eliminates the necessity for shunting the resistor. The self-biasing resistor required for the push-pull stage is approximately 180 ohms.

Any conventional type of input coupling may be used provided the resistance added to the grid circuit by this device is not too high. Transformer or impedance coupling devices are recommended. In any case, the sum of the resistance of the coupling device in the grid circuit and the resistance of the filter network (if used) should not exceed 10,000 ohms.

An output transformer should be used in order to supply power to the winding of the reproducing unit. The optimum value of load resistance for a single tube is 2,000 ohms. For push-pull operation, the plate to plate load resistance should be 4,000 ohms. For best results, as in the case of power amplifier pentodes, the impedance in the plate circuit of the 48 over the entire audio-frequency range should be as uniform as possible.

How to Improvise Multipliers and Make
YOUR OWN SHUNTS
0-1 Milliammeter Put to Excellent Use

By Ralph Forbes

MUCH better use is obtained from a meter if the meter is put into an organized switch circuit. Voltages, currents and resistance may be read, and this may be done more safely, too, because the danger of mistake is less, compared to the awkwardness of using clips or other such means to introduce the right shunts and series resistors.

A switching circuit is diagramed herewith. It is assumed that the meter used is a 0-1 ma or 0. 0-0.5 ma, and values will be specified on that assumption. However, a method of making your own shunts, and of pressing into service series resistors of lesser accuracy than those you will finally buy for permanent use, will be detailed. Some experimenters have the meter, no shunts, no multipliers. Others have the meter, with multipliers but no shunts.

Leaks as Provisional Multipliers

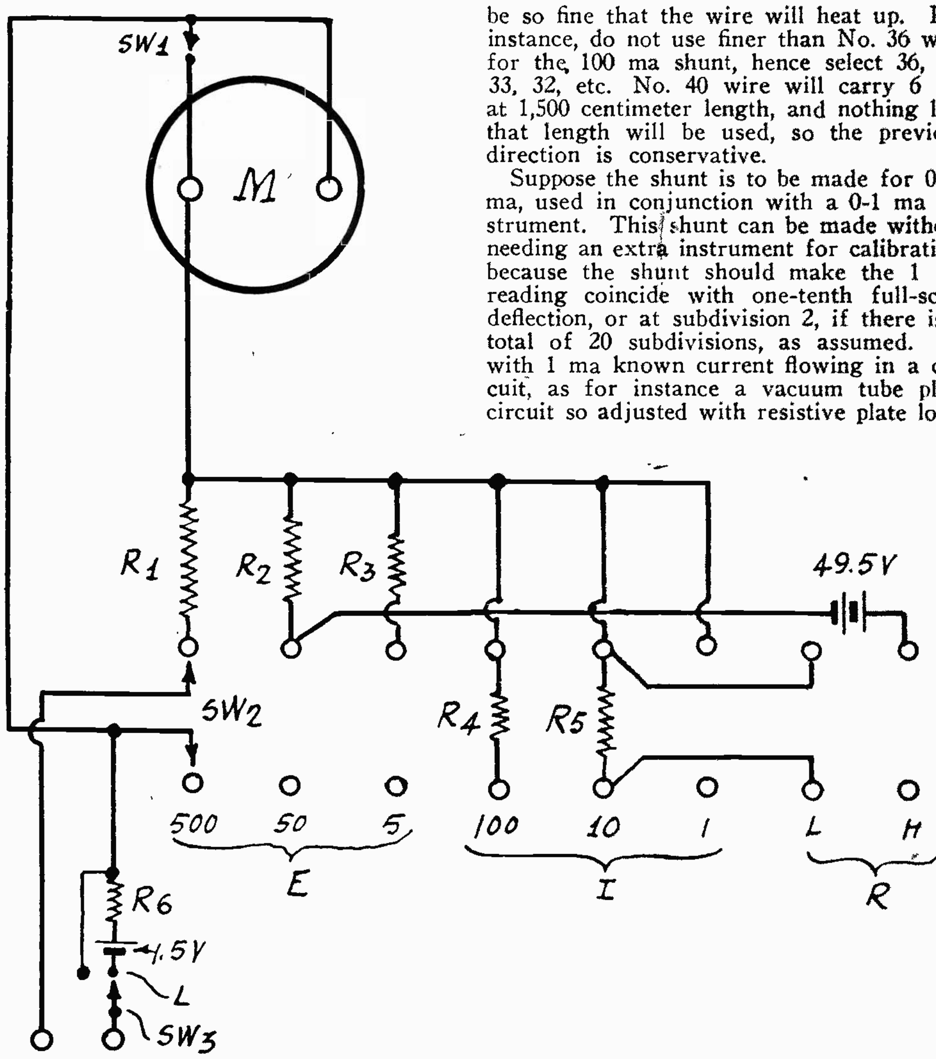
R1 is the high voltage multiplier, and may be for 500 volts, whereupon for a 0-1 ma the resistance should be 500,000 ohms. If you haven't this resistor, and want to make provisional use of the meter in this range, you may use a metallized grid leak type pigtail resistor, testing supposedly 0.5 meg. resistors on lower resistance scales, in the present instrument if you like, to be sure that the resistance is high, then using the 0.5 meg. as tentative multiplier, in series with the meter across a known voltage, as that of a B supply.

Suppose that the total B supply voltage used is 300 volts. Then for R1 to be 500,000 ohms the current through the meter should be 0.6 milliampere, for the scale is multiplied by 500 to read the 500 voltage range. If the voltage is known, therefore, the leak may be selected so that the proper voltage reading will be given.

If that were all there was to it there'd be no need for wire-bound resistors, but unfortunately the grid leak type will not hold its resistance value indefinitely, although the metallized types generally are held more closely to imprinted values originally, and keep their resistance more nearly during their early life at least. If you haven't a sufficient number of 0.5 meg. resistors (commercial values) to enable making the selection, you can ascertain the address of companies that render this service, and that sell the selected leak with actual resistance written thereon. The Trade Editor of RADIO WORLD will help you. Remember, however, that the entire use is only provisional, even though some leaks tested did not change more than 2,000 ohms out of 500,000 ohms in several months frequent use.

Use of 45-Volt Battery

The next voltage scale is 0-50 volts, requiring 50,000 ohms, and the same process may be followed, care being exercised that the resistor is first tested on low resistance scales, so that there is no noticeable deflection, denoting a higher resistance than the scale will read, and then that the actual voltage source used does not exceed 50 volts. For instance, a 45-volt B battery may be used, and the resistor selected that causes the needle to read 0.9. If all one



Switch type meter instrument for measuring voltages of 0-5, 0-50 and 0-500, currents of 0-1, 0-10, 0-100 ma, and resistances from 1 to 5,000 ohms and 1,000 to 2,000,000 ohms.

has at hand is such a battery or similar one, the higher value resistor in the first instance may be selected on the basis of 90 microamperes.

The 5-volt scale can be accommodated by a commercial wire-wound resistor of 5,000 ohms, and if one of greater resistance value is at hand, so much the better, for the wire can be unwound until the 5-volt reading obtains when there are 5 volts applied, or, more conveniently with batteries, until a 4.5-volt battery shows an indication of 0.9 milliampere. Since resistance wire cannot be soldered, care must be taken to establish firm connections mechanically, and this may not always be easy, as some wire-wound commercial resistors of the type used for biasing, etc., have this contact made with heavy-pressure machinery.

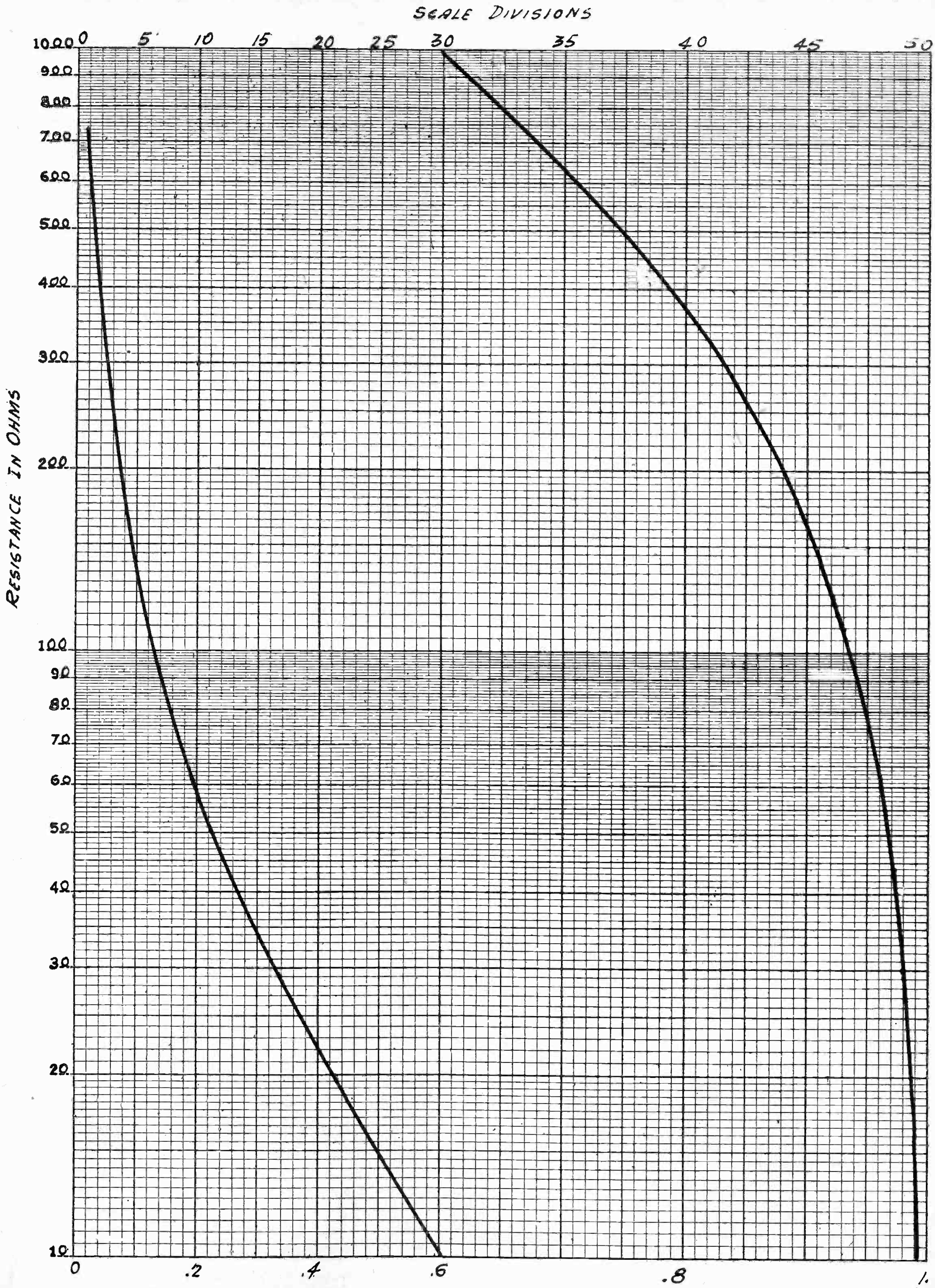
Now, as for the shunts. These you may make yourself, following the procedure to be outlined. Any fine wire will serve the purpose, especially for the 10 ma shunt, although for the 100 ma shunt it should not be so fine that the wire will heat up. For instance, do not use finer than No. 36 wire for the 100 ma shunt, hence select 36, 34, 33, 32, etc. No. 40 wire will carry 6 ma at 1,500 centimeter length, and nothing like that length will be used, so the previous direction is conservative.

Suppose the shunt is to be made for 0-10 ma, used in conjunction with a 0-1 ma instrument. This shunt can be made without needing an extra instrument for calibration, because the shunt should make the 1 ma reading coincide with one-tenth full-scale deflection, or at subdivision 2, if there is a total of 20 subdivisions, as assumed. So with 1 ma known current flowing in a circuit, as for instance a vacuum tube plate circuit so adjusted with resistive plate load, check up the current with the 0-1 ma, and taking a piece of the wire intended to be used, short the meter. Now no current will flow through the meter. Next wind a few turns of the wire on a pencil and connect again across the meter. Just the faintest deflection may be noticed. Try another piece of wire, a little more of it. If the deflection is less than half of that desired (meter reads less than the first subdivision) double the number of turns on the next piece, and continue that process until 1 ma is registered at the desired point. A new shunt is wound each time. Then 10 ma will be the full-scale deflection, as the scale reading is proportionate to the current.

Wire Resistance

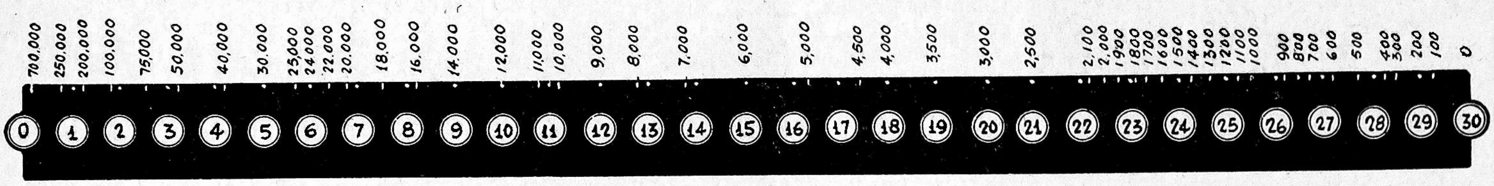
Now establish a circuit with 10 ma current, check the current with the meter, now using the first shunt, and select the wire for the 100 ma shunt. Short the meter as

(*Continued on page 11*)



These two curves are for 1.5 volts, limiting resistor 1,500 ohms, meter 0-1 ma. The right scale reads ohms of the values imprinted. The left scale reads 1% of the imprinted resistance, so multiply the numbers by 100. Either 0-1 or 0-5 scale divisions of the meter, or multiples of such divisions, apply. The scales may be used for multiples of 1.5 volts and multiples of 0-1 ma.

Resistance Scale for 0-0.5 Milliameter



D-c galvanometers of the 0-0.5 ma type frequently have their scales in 30 divisions each side of the zero line. For such an instrument, using 3 volts, and 6,000 ohms as limiting resistor, the resistances read would be as shown on the above scale. This affords a practical range for most purposes, although the extreme values are 100 and 700,000 ohms.

before. Use one turn and check for deflection. Use two turns and check, and so on until the 10 ma current is read at subdivision 2.

This method does not require the use of any extra meter, but if you have a 0-100 ma you can put both that meter and the 0-1 ma, the latter shunted for 100 ma in the same circuit, and check your shunt service against the other instrument used as standard. If no tube circuit is handy, 1,500 ohms in series with a 0-1 ma and 1.5-volt cell will afford 1 ma full scale, 150 ohms 10 ma full scale.

In applying this method it is unnecessary to know the approximate resistance of the normal wire sizes per foot, but they are given nevertheless:

No. 40, 1 ohm; No. 39, 0.848 ohm; No. 38, 0.672 ohm; No. 37, 0.533 ohm; No. 32, 0.423 ohm; No. 35, 0.335 ohm; No. 34, 0.266 ohm; No. 33, 0.211 ohm; No. 32, 0.167; No. 30, 0.1 ohm; No. 28, 0.067 ohm.

This information is valuable only to those who know the coil resistance of the meter and who desire to estimate how much of the wire is to be used before making any test applications. Internal coil resistance values for 0-1 milliammeters are often 27, 30 or 50 ohms. The information may be obtained from the manufacturer, in reference to the particular meter you have.

However, the method outlined above does not require knowledge of the resistance of the coil in the meter, but only the establishment of the desired currents, in one instance 1 ma, in the other 10 ma.

Non-Inductive Winding

The only possible drawback to the method is that the resistors are not wound non-inductively, but this is not of such great consequence in d-c meters where such small current values are concerned and there is no iron core, and moreover if desired the resistors may be made non-inductive by rewinding the amount of wire ascertained to be the necessary value of resistance. Wind half the number of turns in one direction, an then wind the other half in the other direction, continuing in the same progressive fashion, that is, not winding any wire on top of previously wound wire. Some sort of a dowel should be used for convenience. It may be a pencil, or ¼-inch wooden dowel or the like.

The resistance measurements must be accounted for now. The low range is special, in that the 10 ma shunt is in service, and as the multiple switch Sw2 has only two decks, one side of meter permanently to one slider, it is necessary to have the No. 6 dry cell and series resistor for low resistance measurements switchable. Sw3 is a single pole double throw switch that serves the purpose well. When the low resistance measurement is to be made one of the posts to which the unknown resistance is connected is switched to include the series circuit comprising the cell and the resistor R6. For the 10 ma scale this resistor should be 150 ohms. If a somewhat higher value of commercial resistor, wire-wound type, is used for biasing circuits, is selected, turns may be removed until full-scale deflection results when the adjusted resistor in series.

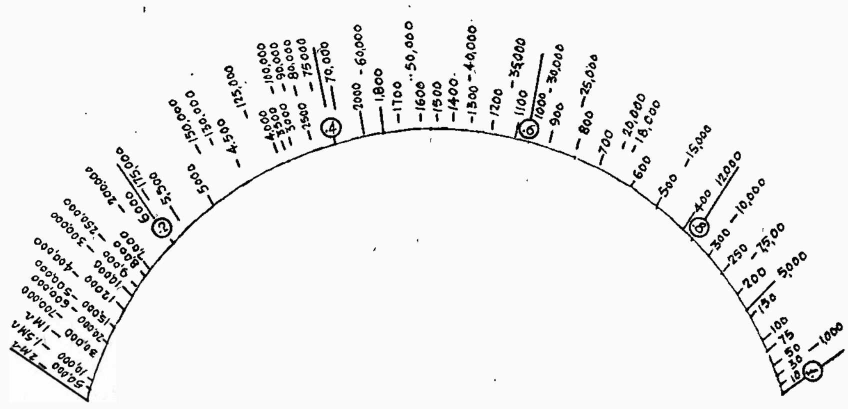
Resistance Measurements

At full-scale deflection the "unknown" resistance is zero, that is, reading of 1 on the meter equals 0 resistance or short circuit of the two binding posts. The lowest resistance that can be read easily is represented next lowest definitive current. For 20 subdivisions, 0-1 ma, let us select the 19th division. This is equivalent to 9.5 ma, or 0.0095 ampere, the total resistance is about 158 ohms, and as the series resistor is 150 ohms the unkown resistance is about 8 ohms. Lesser values may be computed and 1, 3, 5, 7, 10 ohms recorded. The first division would give a resistance value determined by the 0.0005 ampere setting current, or 28,500 ohms, limiting resistor deducted.

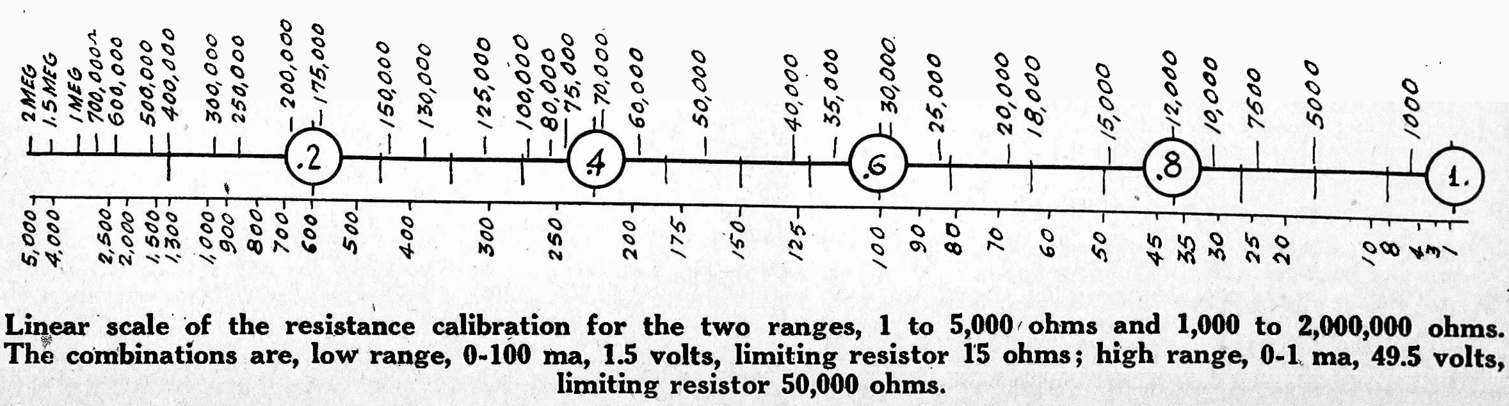
High Resistance Readings

The high resistance measurements would be with the 0-1 ma without shunt, but with the 50-volt multiplier, using a small 45-volt B battery with 4.5-volt C battery in series, to constitute 49.5 volts, which is as high as we can get with dry cells without overstepping the mark, but our high resistance measurement is reduced only a little. The reading at 0.95 ma through the meter is for a value of the unknown resistor of 2,105 ohms (nineteenth subdivision) but as low as 1,000 ohms may be recorded, whereas at the first subdivision the equivalent resistance value of the unknown is 940,000 ohms, but it is very easy to estimate accurately the midpoint between 0 and the first subdivision (50 microamperes), and the current then is 25 microamperes, and the resistance of the unknown

(Continued on next page)



The two resistance ranges calibrated by protraction. The size is such that the scale may be put on a panel above the extreme of the meter case and the needle will point to the resistance. The number below 50,000 on the low scale should read 40,000, not 10,000.



Linear scale of the resistance calibration for the two ranges, 1 to 5,000 ohms and 1,000 to 2,000,000 ohms. The combinations are, low range, 0-100 ma, 1.5 volts, limiting resistor 15 ohms; high range, 0-1 ma, 49.5 volts, limiting resistor 50,000 ohms.

Noise Suppression

And A-V-C in an A-C Su

By J. E. Anderson

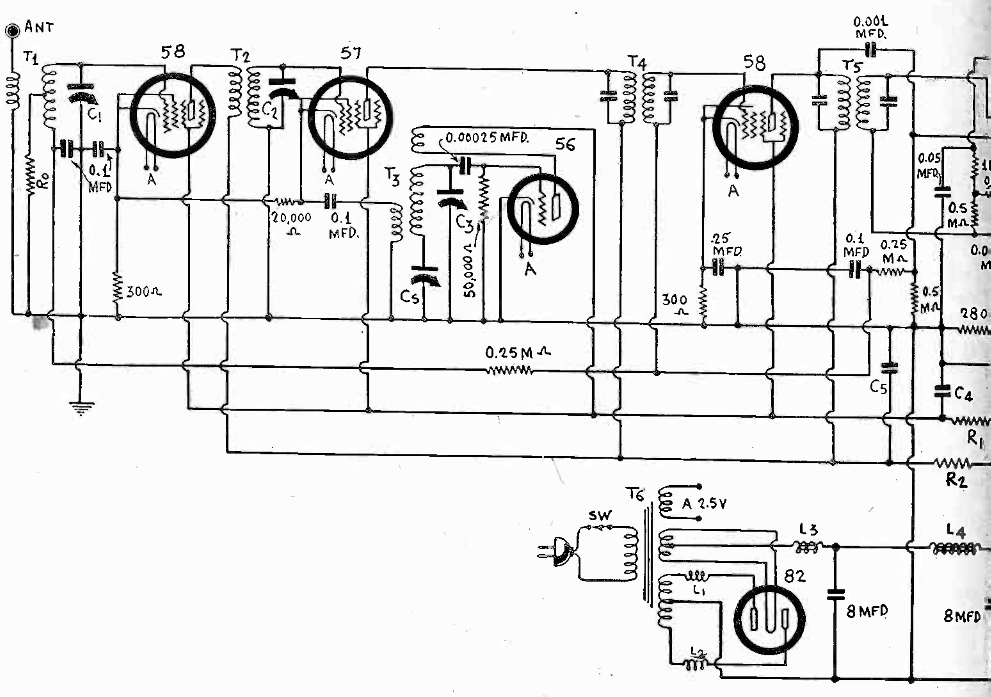


FIG. 1

This is a diagram of an eight-tube superheterodyne in which automatic porates noise suppression control.

THIS is an experimental superheterodyne and is shown only for the purpose of illustrating one of the latest developments in radio receivers, the suppression of noise during the absence of a carrier in sets equipped with automatic volume control. We shall describe the entire circuit for those who wish to try their skill.

The circuit employs a 57 as first detector, but this tube may be a 58, for this is often used as the first detector. The first audio amplifier is a 57, and this should not be replaced by any other tube because the noise suppression feature depends on the cut-off property of this high-mu tube. For a change we have made the power tube a 245 because of its excellence. It may be replaced by a 47 if sensitivity is of more importance than quality, but to make the change the bias on this tube will have to be changed. At present it is approximately 42 volts.

The Real Detector

The real detector in the circuit is one of the diodes in the 55. The diode plate is connected to the top of the secondary of the second intermediate frequency transformer, as is customary in diode detection. The load on the detector diode is made up of one 0.5 megohm resistor and a 0.25 megohm potentiometer, connected in series, with the potentiometer next to the cathode. Across the load resistor is a 0.0001 mfd. by-pass condenser, which serves to filter out the carrier, but is not large enough to suppress appreciably any of the essential audio frequencies.

The 0.25 megohm potentiometer serves as a manual volume control as by moving the slider over the resistance the input to the first audio amplifier, the 57, is varied from about zero to the maximum audio drop across the potentiometer resistance. The maximum is only one-third of the output of the detector but the high gain in the audio amplifier offsets this loss.

The second diode plate of the 55 is used for the automatic volume control. The input to this rectifier is taken from the primary of the second intermediate transformer, the diode plate being joined to the plate of the intermediate amplifier by a 0.001 mfd. condenser. From this diode plate to ground is a 0.5 megohm resistor across which the automatic bias voltage develops. The filter condenser across this resistor is made up of two parts, the 0.001 mfd. coupling condenser just referred to and the tuning condenser across the primary. Of course, the filter condenser across the high voltage is also in series, but this condenser neither adds nor subtracts any appreciable amount to the filter capacity across the resistor. From the diode plate end of the load resistance a 0.25 megohm resistor is connected to the grid return of the intermediate amplifier, a by-pass of 0.1 mfd. being used to insure that only d-c is fed back to the grid.

Another 0.25 megohm resistor is connected between the i-f grid return to the grid return of the r-f amplifier tube and another condenser of 0.1 mfd. is connected from the grid end of this resistor to ground. This is done to permit grounding the rotor of the first tuning condenser. There is nothing unusual about the automatic volume control except that the input to the rectifier is taken from the primary of the i-f transformer. There is a special reason for making the connection to the primary that has to do with the noise suppression circuit that follows.

The Noise Suppression Circuit

The 55 triode is used as the noise suppression tube. A variable voltage which is practically pure d-c is impressed on the grid of the triode. This voltage is the d-c drop in the 0.25 megohm potentiometer that is a part of the load on the detector diode. It is reduced to nearly pure d-c by means of a 0.05 mfd. condenser between the grid and ground and a 1 megohm resistor between the grid and the 0.25 megohm potentiometer. Both the resistor and the condenser are necessary for without the resistor the a-f signal would be short-circuited and without the condenser audio voltage would be applied to the triode grid. Only d-c is required. The triode is a d-c amplifier, which is a new feature in a radio receiver.

There is a load resistance of 0.05 megohm—that is, 50,000 ohms—in the plate circuit of the triode. The drop in this is the noise suppression voltage. As the d-c bias on the grid varies the current in the 50,000 ohm resistor varies, and hence the drop in it varies. Since the 50,000 ohm resistor is so connected that any change in the voltage across it will change the bias on the next audio tube, it is clear that the bias on the audio tube varies with the signal. Also, since the lower the grid bias the greater the current through the 50,000 ohm resistance, it is clear that the bias on the 57 varies with the bias on the 55 triode. That is, it varies with the carrier.

When there is no signal on the grid of the 55 the current is the highest and then the bias on the 57 is also the highest. The values are so chosen that when there is no signal, or when there is a weak signal, the bias on the 57 is so high that no current can flow in its place circuit, and hence there is no amplification. As soon as there is a carrier of appreciable magnitude there is a voltage drop in the detector load resistance and there is a bias on the grid. Hence the plate current in the 55 is small and the bias on the 57 is low enough to permit amplification.

Conditions for Functioning

The correct functioning of the noise suppression arrangement depends on the relative values of the voltages involved. Th 57 tube should have a bias of 3 volts whe it is to amplify. This should be the valu when no current flows through the loa resistance on the 55, that is, when the bia on the 55 is high. That occurs when ther is a considerable carrier present and whe there is something for the 57 to amplif by virtue of the presence of this carrier assuming that it is modulated. The mini mum bias is determined by the drop in 60 ohm resistor placed between the cathod of the 57 and the effective grid return o the same tube.

We must determine the current throug this 60 ohm resistor so that the drop wil be 3 volts. Clearly, the current require is 50 milliamperes. In arriving at the valu of 60 ohms it was assumed that the plat current of the 245 was 32 milliamperes that the plate and screen current of th 57 was 2 milliamperes, and that the bleede

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Plotting

(*Continued from preceding page*)

is 1,930,000 ohms, and the 2,000,000 ohm mark may be registered close thereto.

Plotting Curve or Scale

The only remaining problem in connection with the resistance measurements is to obtain the scale or curve. Any one familiar with Ohm's law can work out the scale or curve for himself and paste it on the back of the box containing the meter, switch and batteries. This is a good location, much preferable to tampering with the meter scale. So that readings may be legibly obtained a large curve is printed on page 10, also scales, and these may be reduced to the size of the box photographically. The curve is for 0-1 ma, 1.5 volts,

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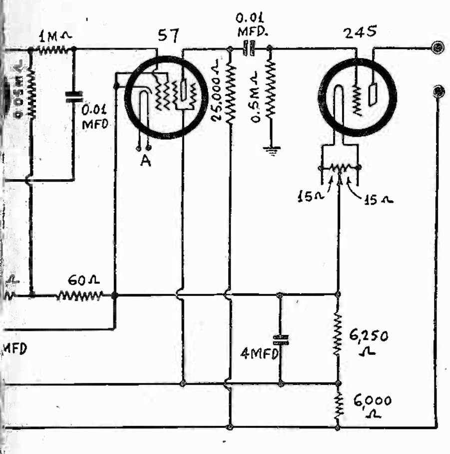
rheterodyne



e control is used and which incor-

rrent was 16 milliamperes. It is always ssible to vary the bleeder current so that e current through the 60 ohm resistance 50 milliamperes even if the other two rents have different values from those sumed.

It is sufficient to apply a voltage of 25 lts in the plate circuit of the 55. This ltage is determined by a 500 ohm resistor ace between the cathode of the 55 and e plate return of the 55, which is also e grid return of the 57. In selecting this lue it was assumed that the current to e 55 was negligible in comparison with milliamperes. This assumption is perissible even when the 55 plate current is aximum, for a small variation in the apied voltage is of no consequence.

Refinements

Now we have the essential features of

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esistance

it may be read for 0-10 ma, 1.5 volts tween 0.6 and 1.0 on the meter, rightnd curve, by dividing the resistance vals in ohms by ten. For 0-1 ma, 49.5 lts, read the left-hand scale and multiply e resistance value by 3,300 for the reads between 0 and 0-6 ma.

The multiple switch used is a doublele eight-throw type, that is, two decks, ght different positions for each deck, but there are extra positions, no more decks, e extra may be used for "off," addinally, and others for any additional purses you may devise.

The resistors should be mounted on an sulated strip, which strip may be bracked to the inside of the box.

The measurements are for d-c voltages rrents and resistances only.

LIST OF PARTS

Coils

T1—One shielded r-f transformer with centertapped secondary, for 350 mmfd.
T2—One r-f shielded r-f transformer for 350 mmfd.
T-3—One three-winding oscillator for 350 mmfd. condenser and 175 kc i. f.
T4, T5—Two 175 mmfd. i-f transformers
T6—One power transformer having two 2.5 volt windings, one centertapped, and one centertapped high voltage winding
L1, L2—Two 1 millihenry r-f choke coils
L3—One 10 to 30 henry filter choke
L4—One 30-henry choke

Condensers

C1, C2, C3—One gang of three 350 mmfd. tuning condensers with trimmers
Cs—One 700-1,000 mmfd. adjustable trimmer condenser
Four 0.1 mfd. fixed condensers
One 0.0001 mfd. fixed condenser
One 0.00025 mfd. fixed condenser
One 0.001 mfd. fixed condenser
Two 0.01 mfd. condensers
One 0.05 mfd. condenser
One 0.25 mfd. by-pass condenser
Two 4 mfd. by-pass condensers
Two 8 mfd. by-pass condensers
C4, C5—Two 0.25 mfd. by-pass condensers, or larger (used only if R1 and R2 are used)

Resistors

R0—A resistor of about 10,000 ohms, or as required
R1—One 4,000 ohm resistor (its use is optional). (Yellow body, red dot, black end)
R2—One 2,500 ohm resistor (its use is optional). (Red body, red dot, green end)
Two 300 ohm bias resistors (Orange body, brown dot, black end)
One 280 ohm wirewound resistor
One 500 ohm wirewound resistor
One 60 ohm wirewound resistor
One 30 ohm centertapped resistor
Three 0.25 megohm resistors (Red body, yellow dot, green end)
Three 0.5 megohm resistors (Green body, yellow dot, black end)
Two 1 megohm resistors (Brown body, green dot, black end)
Two 50,000 ohm resistors (Green body, orange dot, black end)
One 0.25 megohm potentiometer
One 6,250 ohm wirewound resistor
One 5,000 wirewound resistor

Other Requirements

Four grid clips
Five six-contact sockets
One UY socket
Two UX sockets
One line switch, may be attached to 0.25 megohm potentiometer
One vernier dial
One eight-tube chassis

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a noise suppression circuit in conjunction with an automatic volume control, an audio amplifier that amplifies only when there is a carrier present, and hence when there is something to amplify, assuming the carrier is modulated, and a means for varying the amplification in inverse proportion to the strength of the carrier.

At first thought it would seem that nothing could come through the circuit, for when the automatic volume control cuts down the signal the audio amplifier is active and when there is nothing to amplify the audio tube is dead. But it is a matter of degree.

Clearly, when there is no carrier present there is no need for having an active audio amplifier and a good reason for having a dead one, for when there is no carrier the automatic volume control is not active but the noise suppression circuit functions. That is, it does not let through the noise. When there is a carrier the automatic volume control cuts it down to reasonable values but what is left should be amplified at audio frequency. And the circuit does.

Certain refinements of the basic idea are needed to make the noise suppression circuit take hold at the right carrier value in respect to the carrier value at which the automatic volume control takes hold. There is in the automatic volume control rectifier a permanent voltage with such polarity that no current can flow in this circuit until this voltage is exceeded by the signal. This voltage is supplied by a 280 ohm resistor placed between the cathode of the 55 and ground. Since our current in this section of the circuit is 50 milliamperes, by adjustment, the drop in the 280 ohm resistor is 14 volts.

The a.v.c. diode plate is negative by this amount. Therefore, when there is no signal voltage in the circuit no rectified current can flow through the a.v.c. circuit. Indeed, no current can flow until the peak voltage of the carrier as applied on the diode circuit exceeds 14 volts. This fact delays the operation of the a.v.c. until the signal voltage has become higher than 14 volts. But there is no corresponding delay in the detector circuit, and hence none in the noise suppression circuit. Hence the noise suppression circuit takes hold before the a.v.c.

This has a tendency to eliminate weak carriers as well as noise. It would seem that this feature is undesirable, and may be from one point of view. But if the carrier is so weak that it is of the same order of magnitude as the noise, there is no use listening to it and it might as well be eliminated.

Independence of Circuits

It is clear that the noise elimination feature is not dependent on the presence of the automatic volume control. The a.v.c. could be eliminated and the noise suppression would work just as well. But there would be no advantage in using it alone, except, perhaps, to cut out those weak stations the carriers of which are about equal to the noise level. The real usefulness of the noise suppression feature is in conjunction with an automatic volume control in which the noise would rise to unpleasant values in the absence of a carrier if the noise suppression circuit were not used.

There is another feature which may be classed as a refinement. We have already referred to the fact that the input to the a.v.c. diode is taken from the primary of the second i-f transformer. Why is it not taken from the secondary as usual? As a rule, the selectivity of the primary is less than that of the secondary. Suppose we detune the circuit a little bit, say 10,000 cycles. The input to the detector and the noise suppression circuit will be tuned out first, because the secondary is more selective than the primary. This means that on detuning the automatic volume control continues to be effective in suppressing the r-f gain until the noise suppression circuit has had time to take effect to kill the amplification in the audio amplifier. Thus making use of the primary for the a.v.c. and the secondary for the detector and the noise suppression acts as an automatic overlap to insure that no noise will get through during the transition from exact resonance to complete detuning.

The fixed bias on the first tube, which is working as an r-f amplifier, should be about 3 volts and it is obtained from a

(Continued on next page)

LOW SCREE

By Conrad

THERE is one fact about the use of screen grid tubes as detectors and audio frequency amplifiers in resistance coupled circuits which radio engineers have failed to recognize, and that is the necessity for using a very low screen voltage if the tube is to function properly. In part this is due to the fact that the tube manufacturers have failed to stress the point, if indeed, they have recognized it.

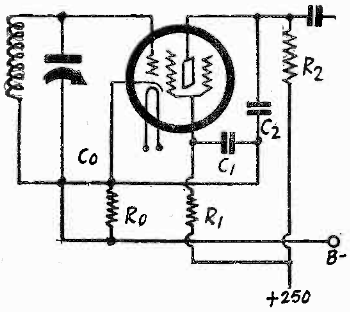

FIG. 1
Low screen voltage is required for detection or amplification when the tube is loaded with a high resistance. One way of getting it is to put a resistance in the screen lead

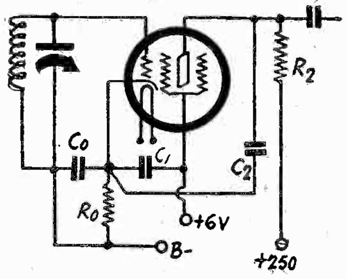

FIG. 2
Another way of getting the low screen voltage is to connect the screen to a low voltage tap on a battery or on the voltage divider as shown in the circuit.

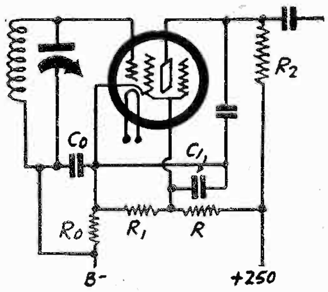

FIG. 3
This arrangement eliminates a high grid bias resistor, whether tube is used as amplifier or detector. The bias is mostly due to the bleeder current through R and R1.

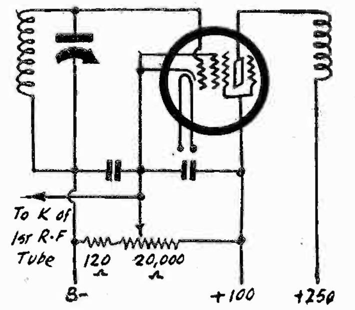

FIG. 4
Complete volume control can be accomplished by connecting a potentiometer from the screen to B minus, the slider being connected to the cathode or cathodes.

As far as detection is concerned the difficulty is avoided by specifying the grid current that should flow in the plate circuit, the current at which, under a given combination of plate and screen voltages, the tube functions best as a detector. Such a point may always be found by increasing the grid bias sufficiently. But when a tube is self-biased it may not be practical to obtain the necessary bias because it would require an exceedingly high bias resistor.

In respect to audio frequency amplification there is no such easy way out of the difficulty, for there is no bias at which amplification without a great deal of distortion will take place. One of three things may be done. First, the plate voltage may be increased enormously. Practical considerations limit the high voltage. Second, the resistance in the plate circuit may be reduced greatly. This is limited by the fact that as the resistance is reduced the amplification drops. Third, the screen voltage may be reduced very much, and that is the most practical solution.

Detection

When we are detecting we wish to operate where the curve bends most rapidly. If the screen voltage is high this point is very far in the negative direction. That is, it requires a very high grid bias to bring the tube in the detecting condition. But the plate current is nearly always about the same when this occurs. Hence if we use a self-biasing resistor we must use a very high value if we are to get a sufficient bias. Let us illustrate. Suppose the tube requires a bias of 6 volts and also suppose that the best detecting efficiency occurs at 0.1 milliampere. Then we must have a bias resistor of 60,000 ohms. But it is more likely that the best detecting point is at 7.5 volts where the current may be only 0.05 milliampere. In that case we would have to use a bias resistor of 150,000 ohms.

Now if the screen voltage is much less the best detecting point may be at 3 volts. If we made the plate current 0.1 milliampere we would need a bias resistance of 30,000 ohms, and if we made the current 0.05 milliampere and the bias 4 volts we would have to make the bias resistance 80,000 ohms. Of course, these are not actual values but they illustrate the point.

One might think that a greater output would be obtainable with the higher bias, but this is not the case. Quite the reverse is the fact. The curvature of the characteristic at the best detecting point is not nearly as great when the bias is high as when it is low. Hence the sensitivity is less. The plate current does not rise any higher for high screen voltage than for low, provided that it is not entirely too low. Therefore the tube is less sensitive and will not stand any more input without causing distortion.

The Curve

The plate current grid voltage curve starts at a certain grid bias rising first slowing then more rapidly. At one point it rises suddenly to a certain value and then it does not rise any more. There is a horizontal region, and this region is wider the higher the screen voltage. Optimum adjustment would seem to be where the horizontal region just vanishes. For a 224 with 180 volts in the plate circuit and a 250,000 ohm coupling resistor this occurs when the screen voltage is approximately 7.5 volts. The cut-off is about 4.5 volts. Thus the entire rise in the curve occurs within 4.5 volts. If the screen voltage is of the order of 67.5 volts, other conditions between the same, the bias would have to be about 7.5 volts but from zero to about 4 volts there would not be any change in the plate current at all.

Obviously, if the tube is biased so that the operating point is on the horizontal portion of the curve there would not be any detection at all. Neither would there be any amplification. If anything at all occurs it is distortion.

Theory of the Tube

It has been argued that when the screen voltage is very low the tube assumes the nature of a three element tube and it is no longer a screen grid tube. Hence the conclusion is that we do not take advantage of the tube's screen grid characteristics. That may be true, but the screen grid characteristics in this case are not desirable; they are most undesirable. The object of using the tube is to get good detecting efficiency, or good amplification efficiency without distortion, not to operate the tube as a screen grid tube, regardless of the consequences.

The theory of the screen grid tubes shows

Noise Suppr

(*Continued from preceding page*)

300 ohm resistor in the cathode lead. It is shunted with a 0.1 mfd. condenser. The bias on the first detector should be about 4 volts. Part of this voltage is obtained from the bias resistance on the preceding tube and part from a 20,000 ohm bias resistor in the detector cathode. The bias resistors for the first detector are shunted by a 0.1 mfd. condenser and the pick-up coil on the oscillator, the two being connected in series. This method permits grounding one end of the pick-up coil and at the same time to make use of the first tube's bias for part of the detector bias.

The i-f amplifier also has a fixed bias of 3 volts, obtained from another 300 ohm resistor. This resistor is shunted with a 0.25 mfd. condenser, the larger capacity being used here because the frequency is lower.

The power tube is biased by the three resistances associated with the noise suppression circuit. The bias is about 42 volts. This is 8 volts short of the recommended value for the 245 tube. It could be made up by increasing the 500 ohm resistor by 160 ohms or by putting in a resistor in the lead from the center tap on the filament shunt resistor. If the added resistance is put here it should have a value of 250 ohms. In this case also the 4 mfd. by-pass condenser across the bias should be connected between the center tap of the 30 ohm shunt resistor and ground.

The Screen Voltage

The screen voltage on the 57 audio tube is 100 volts, adjusted to this value by the 6,250 ohm resistor in the voltage divider. The voltage on the screens of the other screen grid tubes and the plate voltage on the oscillator are higher by the drop in the resistors associated with the 55 tube. To drop the voltage to the proper value a resistor R1 may be inserted in the lead to these screens, adjusting its value so that

N VOLTAGE

Phelps

that the screen voltage should be high for a given plate voltage. The theory may be all right but the application is faulty. The theory says plate voltage, not voltage applied in the plate circuit. The trouble is that in a resistance coupled circuit there is a wide discrepancy between the two. It is just a case of the old "saw" that "figures never lie but many figurers do."

It is the actual plate voltage that counts, the voltage applied less the voltage dro in the plate coupling resistor. Likewise, it is the actual screen voltage that counts. The actual screen voltage should never be equal to or exceed the actual plate voltage. If that condition is met there is no trouble.

We may obtain the low screen voltage required by various methods. We may use a battery, we may return the screen lead to a low voltage point on the voltage divider, or we may put a high resistance in the screen lead. There is no practical difference between a battery and the voltage divider, provided that we by-pass the section of the voltage divider used with a large enough capacity. In either case the sensitivity is high and the input limited.

When we put in a high resistance in the screen lead another effect occurs which alters the characteristic. The actual screen voltage varies in about the same way as the actual plate voltage. When the plate voltage is high, so is the screen voltage, but it is less than the plate voltage. When the effective plate voltage is low, so is the screen voltage, but it still is less than the plate voltage. So the conditions necessary are met, that is, the effective plate voltage is always larger than the effective screen voltage.

Experimental Test

An experiment on a screen grid tube to determine the effect of a resistor in the screen circuit showed that the horizontal portion of the curve was shortened but that the curve rose to about the same plate current value. The irregularity in the curve was removed and the slope was decreased. Therefore the effect of the screen circuit resistor is to decrease the amplification when the tube is used as an amplifier and to decrease the detecting efficiency when it is used as a detector. In both cases it increases the signal voltage that may be applied on the grid before distortion sets in, yet in neither case does it decrease the output, the input being sufficient.

In Fig. 1 we have a typical screen grid, resistance coupled circuit. It is a detector or amplifier depending on the value of the grid bias resistor Ro. In this case a screen resistor R1 is used to prevent distortion due to excessive screen voltage. It is returned to the 250 volt lead. When it is returned there R1 must have a very high value or the proper voltages will not be obtained. Another possibility is to connect the resistor to the plate of the tube. In that case it is absolutely certain that the screen voltage will always be less than the effective plate voltage, for it starts with that voltage and then is dropped some by R1. In this case the resistor does not have to have such a high value. Just what the value should be depends on several factors and the best combination can only be found experimentally.

Still another possibility, and the one that is most frequently used, is to return the screen resistor R1 to the screen returns of the r-f tubes, where the voltage may be from 45 to 100 volts, depending on the tube and the circuit. In this case there is no certainty that the screen voltage will always be less than the voltage on the plate. If we assume that the screen current is one-third as the plate current and that the applied voltages are 90 and 250 volts, and that the resistors R1 and R2 are 0.5 megohm and 250,000 ohms respectively, will the screen voltage be low enough? The danger will be when the plate current is highest. Let us suppose that it is 0.3 milliampere. Then the screen current is 0.1 milliampere. The voltage on the screen is 40 volts and the plate voltage is 175 volts.

More Examples

Suppose we make the two resistors equal and 250,000 ohms. If we still assume that the currents are 0.3 and 0.1 the screen voltage will be 65 volts and the plate voltage will remain at 175 volts.

The assumption that the plate current is only 0.3 milliampere was very conservative. Actually it might amount to 1 milliampere with 250 volts in the plate circuit. If it does the effective plate voltage is just zero, that is a possibility in a screen grid tube. Indeed, the plate current may be negative. If the screen current still remains one-third of the plate current the effective voltage on the screen, with 250,000 ohms in the lead, is about 2 volts.

If we did not have the resistance in the screen lead the screen voltage would be 90 volts and the effective plate voltage zero, approximately.

In Fig. 2 we have a circuit in which the screen voltage is 6 volts, obtained either from a battery or from a voltage divider. As in the preceding circuit, the tube is either a detector or an amplifier according to the value of Ro. The six volts are supposed to be measured from the cathode, so that if it is measured from B minus it should be augmented by the bias voltage. The screen voltage may be made a little higher than six volts when the plate voltage is as high as 250 volts, but it should not exceed about 16 volts.

Effect of By-pass Condenser

In Fig. 1 we have a by-pass condenser, C1, from tthe screen to the cathode. What effect does this have on the performance of the circuit? If it is large enough it maintains the screen voltage constant at the signal frequency. Trial shows that it reduces the gain on the high audio frequencies. One would expect the opposite effect. However, if the screen voltage is excessive R1 is effective only on the low frequencies, if R1 is large. The tube, then remains, to some extent, the poor amplifier or detector at high frequencies which it is at all frequencies when R1 is not used. The same does not apply to C1 in Fig. 2 for the screen voltage is low. Indeed, it is not essential to use it, though desirable. Condenser C2 in either circuit has the effect of reducing the high frequency gain, but it is essential to use it.

In order to reduce the grid bias resistance in a screen grid detector the bleeder current may be sent through the resistance, as in Fig. 3. Suppose, for example, that we need a bias of 3 volts. The screen current at the detecting point is very low so we can easily select a bleeder current so large that the current in the tube is negligible in comparison. Suppose we make the bleeder current 5 milliamperes. Then Ro should be only 600 ohms. For this bias we need a screen voltage of about 16.5 volts. At that rate the value of R1 should be 3,300 ohms. If the applied plate voltage is 250 volts, measured from ground, the value of R should be 46,100 ohms. A 50,000 ohm resistor would be close enough.

Although 16.5 volts may be a little higher than the voltage that should be used for best detecting efficiency, it works out satisfactorily, and the use of 50,000 ohms makes the bias and the screen voltages slightly lower than the values assumed.

The arrangement illustrated in Fig. 3 has the advantage that the screen and grid voltages are little affected by the signal since the varying current due to the signal is only a small part of the current that determines the voltages. This tends to make the detecting efficiency nearly equal at all audio frequencies, because degenerative feedback is practically eliminated. The arrangement in Fig. 3 is more sensitive than either of the others for that reason.

Reducing the Plate Resistance

It was said above that one way of preventing the screen voltage from becoming equal to or greater than the plate voltage is to use a low value of plate resistance, that is, of R2 in Figs. 1, 2 and 3. This decreases the output of the tube, whether it is used as amplifier or detector, because the output is directly proportional to the load resistance, provided that the current remains constant. The current increases a little as the load resistance is decreased so the output does not fall quite as rapidly as the decrease in the resistance. But the drop is enough to justify the use of a high resistance value, and then to use one of the other methods of preventing distortion or inefficiency.

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the drop in it is about 40 volts. About 4,000 ohms will do it. If this resistor is used condenser C4 should also be used, and it may be 0.25 mfd.

The plate voltage on the power tube and on the 57 audio tube is 250 volts, but the plate voltage on the r-f tubes is more by about 40 volts. As before, if it is desired to drop this excess, R2 should be used. About 2,500 ohms will be all right here. If this is used condenser C5 should also be used, and it may be 0.25 mfd. or more.

To drop the voltage from 250 to 100 in the voltage divider a 6,000 ohm resistor is put at the top of the voltage divider, that is, between the output of the filter and the tap for the screens.

The B Supply

The supply employs the 82 rectifier which takes 2.5 volts on the filament. In each plate lead is a small r-f choke coil, L1 and L2, which must be used to prevent noise in the set. Each should be from one to two millihenries. Choke input is used to prevent heavy surges of current into the first 8 mfd. by-pass condenser. This choke, L3, may be from 10 to 30 henries. L4 is a regular filter choke of 30 henries or so. This is followed by another 8 mfd. condenser.

Resistor Ro is an oscillation control. If the r-f amplifier does not oscillate without it, it should not be used. When used it is connected from a tap on the coil to ground and its value should be about 10,000 ohms. Since the feedback causing the oscillation may be of different degrees, the same size resistor should not be used in all cases. Always, the largest resistance that will stop oscillation should be used. The position of the tap is at the middle of the winding. If a manual volume control in the r-f frequency level is desired Ro may be in the form of a potentiometer, say of 250,000 ohms, the antenna, with the primary coil, being connected to the slider.

Noise Suppression

And A-V-C in an A-C Su

By J. E. Anderson

THIS is an experimental superheterodyne and is shown only for the purpose of illustrating one of the latest developments in radio receivers, the suppression of noise during the absence of a carrier in sets equipped with automatic volume control. We shall describe the entire circuit for those who wish to try their skill.

The circuit employs a 57 as first detector, but this tube may be a 58, for this is often used as the first detector. The first audio amplifier is a 57, and this should not be replaced by any other tube because the noise suppression feature depends on the cut-off property of this high-mu tube. For a change we have made the power tube a 245 because of its excellence. It may be replaced by a 47 if sensitivity is of more importance than quality, but to make the change the bias on this tube will have to be changed. At present it is approximately 42 volts.

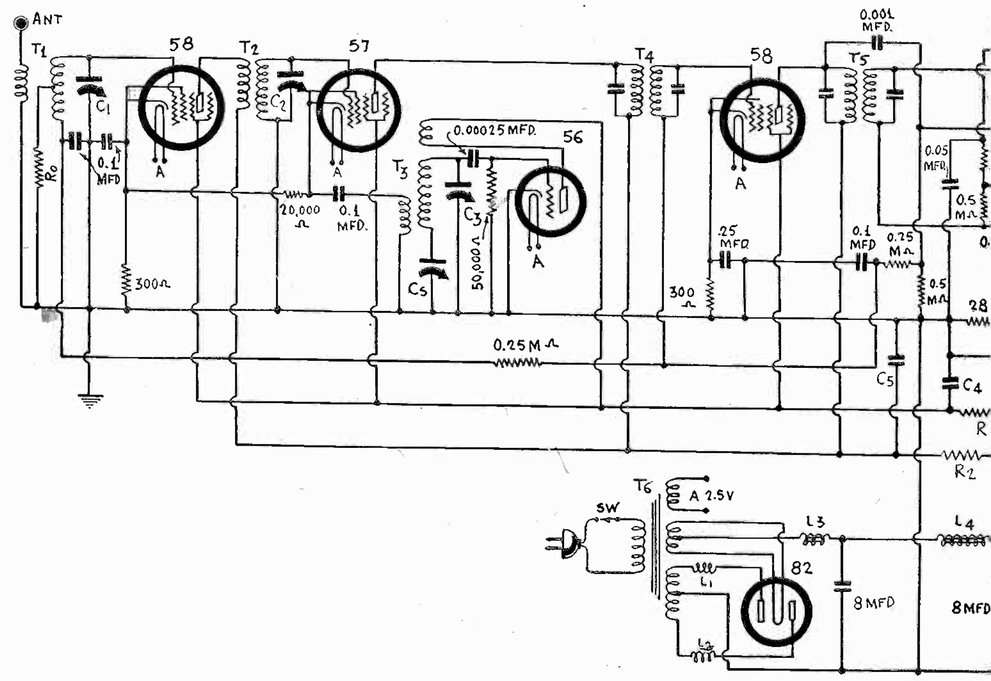

FIG. 1

This is a diagram of an eight-tube superheterodyne in which automatic porates noise suppression control

The Real Detector

The real detector in the circuit is one of the diodes in the 55. The diode plate is connected to the top of the secondary of the second intermediate frequency transformer, as is customary in diode detection. The load on the detector diode is made up of one 0.5 megohm resistor and a 0.25 megohm potentiometer, connected in series, with the potentiometer next to the cathode. Across the load resistor is a 0.0001 mfd. by-pass condenser, which serves to filter out the carrier, but is not large enough to suppress appreciably any of the essential audio frequencies.

The 0.25 megohm potentiometer serves as a manual volume control as by moving the slider over the resistance the input to the first audio amplifier, the 57, is varied from about zero to the maximum audio drop across the potentiometer resistance. The maximum is only one-third of the output of the detector but the high gain in the audio amplifier offsets this loss.

The second diode plate of the 55 is used for the automatic volume control. The input to this rectifier is taken from the primary of the second intermediate transformer, the diode plate being joined to the plate of the intermediate amplifier by a 0.001 mfd. condenser. From this diode plate to ground is a 0.5 megohm resistor across which the automatic bias voltage develops. The filter condenser across this resistor is made up of two parts, the 0.001 mfd. coupling condenser just referred to and the tuning condenser across the primary. Of course, the filter condenser across the high voltage is also in series, but this condenser neither adds nor subtracts any appreciable amount to the filter capacity across the resistor. From the diode plate end of the load resistance a 0.25 megohm resistor is connected to the grid return of the intermediate amplifier, a by-pass of 0.1 mfd. being used to insure that only d-c is fed back to the grid.

Another 0.25 megohm resistor is connected between the i-f grid return to the grid return of the r-f amplifier tube and another condenser of 0.1 mfd. is connected from the grid end of this resistor to ground. This is done to permit grounding the rotor of the first tuning condenser. There is nothing unusual about the automatic volume control except that the input to the rectifier is taken from the primary of the i-f transformer. There is a special reason for making the connection to the primary that has to do with the noise suppression circuit that follows.

The Noise Suppression Circuit

The 55 triode is used as the noise suppression tube. A variable voltage which is practically pure d-c is impressed on the grid of the triode. This voltage is the d-c drop in the 0.25 megohm potentiometer that is a part of the load on the detector diode. It is reduced to nearly pure d-c by means of a 0.05 mfd. condenser between the grid and ground and a 1 megohm resistor between the grid and the 0.25 megohm potentiometer. Both the resistor and the condenser are necessary for without the resistor the a-f signal would be short-circuited and without the condenser audio voltage would be applied to the triode grid. Only d-c is required. The triode is a d-c amplifier, which is a new feature in a radio receiver.

There is a load resistance of 0.05 megohm—that is, 50,000 ohms—in the plate circuit of the triode. The drop in this is the noise suppression voltage. As the d-c bias on the grid varies the current in the 50,000 ohm resistor varies, and hence the drop in it varies. Since the 50,000 ohm resistor is so connected that any change in the voltage across it will change the bias on the next audio tube, it is clear that the bias on the audio tube varies with the signal. Also, since the lower the grid bias the greater the current through the 50,000 ohm resistance, it is clear that the bias on the 57 varies with the bias on the 55 triode. That is, it varies with the carrier.

When there is no signal on the grid of the 55 the current is the highest and then the bias on the 57 is also the highest. The values are so chosen that when there is no signal, or when there is a weak signal, the bias on the 57 is so high that no current can flow in its place circuit, and hence there is no amplification. As soon as there is a carrier of appreciable magnitude there is a voltage drop in the detector load resistance and there is a bias on the grid. Hence the plate current in the 55 is small and the bias on the 57 is low enough to permit amplification.

Conditions for Functioning

The correct functioning of the noise suppression arrangement depends on the relative values of the voltages involved. Th 57 tube should have a bias of 3 volts whe it is to amplify. This should be the valu when no current flows through the loa resistance on the 55, that is, when the bia on the 55 is high. That occurs when ther is a considerable carrier present and whe there is something for the 57 to amplif by virtue of the presence of this carrie assuming that it is modulated. The mini mum bias is determined by the drop in 60 ohm resistor placed between the cathod of the 57 and the effective grid return o the same tube.

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Plotting

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is 1,930,000 ohms, and the 2,000,000 ohm mark may be registered close thereto.

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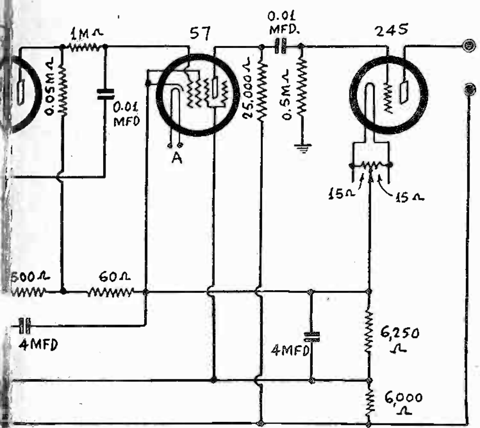

me control is used and which incor-

current was 16 milliamperes. It is always possible to vary the bleeder current so that the current through the 60 ohm resistance is 50 milliamperes even if the other two currents have different values from those assumed.

It is sufficient to apply a voltage of 25 volts in the plate circuit of the 55. This voltage is determined by a 500 ohm resistor place between the cathode of the 55 and the plate return of the 55, which is also the grid return of the 57. In selecting this value it was assumed that the current to the 55 was negligible in comparison with 50 milliamperes. This assumption is permissible even when the 55 plate current is maximum, for a small variation in the applied voltage is of no consequence.

Refinements

Now we have the essential features of

esistance

but may be read for 0-10 ma, 1.5 volts between 0.6 and 1.0 on the meter, right-hand curve, by dividing the resistance values in ohms by ten. For 0-1 ma, 49.5 volts, read the left-hand scale and multiply the resistance value by 3,300 for the readings between 0 and 0-6 ma.

The multiple switch used is a double-pole eight-throw type, that is, two decks, eight different positions for each deck, but if there are extra positions, no more decks, one extra may be used for "off," additionally, and others for any additional purposes you may devise.

The resistors should be mounted on an insulated strip, which strip may be bracketed to the inside of the box.

The measurements are for d-c voltages currents and resistances only.

LIST OF PARTS

Coils

T1—One shielded r-f transformer with centertapped secondary, for 350 mmfd.
T2—One r-f shielded r-f transformer for 350 mmfd.
T-3—One three-winding oscillator for 350 mmfd. condenser and 175 kc i. f.
T4, T5—Two 175 mmfd. i-f transformers
T6—One power transformer having two 2.5 volt windings, one centertapped, and one centertapped high voltage winding
L1, L2—Two 1 millihenry r-f choke coils
L3—One 10 to 30 henry filter choke
L4—One 30-henry choke

Condensers

C1, C2, C3—One gang of three 350 mmfd. tuning condensers with trimmers
Cs—One 700-1,000 mmfd. adjustable trimmer condenser
Four 0.1 mfd. fixed condensers
One 0.0001 mfd. fixed condenser
One 0.00025 mfd. fixed condenser
One 0.001 mfd. fixed condenser
Two 0.01 mfd. condensers
One 0.05 mfd. condenser
One 0.25 mfd. by-pass condenser
Two 4 mfd. by-pass condensers
Two 8 mfd. by-pass condensers
C4, C5—Two 0.25 mfd. by-pass condensers, or larger (used only if R1 and R2 are used)

Resistors

R0—A resistor of about 10,000 ohms, or as required
R1—One 4,000 ohm resistor (its use is optional). (Yellow body, red dot, black end)
R2—One 2,500 ohm resistor (its use is optional). (Red body, red dot, green end)
Two 300 ohm bias resistors (Orange body, brown dot, black end)
One 280 ohm wirewound resistor
One 500 ohm wirewound resistor
One 60 ohm wirewound resistor
One 30 ohm centertapped resistor
Three 0.25 megohm resistors (Red body, yellow dot, green end)
Three 0.5 megohm resistors (Green body, yellow dot, black end)
Two 1 megohm resistors (Brown body, green dot, black end)
Two 50,000 ohm resistors (Green body, orange dot, black end)
One 0.25 megohm potentiometer
One 6,250 ohm wirewound resistor
One 5,000 wirewound resistor

Other Requirements

Four grid clips
Five six-contact sockets
One UY socket
Two UX sockets
One line switch, may be attached to 0.25 megohm potentiometer
One vernier dial
One eight-tube chassis

a noise suppression circuit in conjunction with an automatic volume control, an audio amplifier that amplifies only when there is a carrier present, and hence when there is something to amplify, assuming the carrier is modulated, and a means for varying the amplification in inverse proportion to the strength of the carrier.

At first thought it would seem that nothing could come through the circuit, for when the automatic volume control cuts down the signal the audio amplifier is active and when there is nothing to amplify the audio tube is dead. But it is a matter of degree.

Clearly, when there is no carrier present there is no need for having an active audio amplifier and a good reason for having a dead one, for when there is no carrier the automatic volume control is not active but the noise suppression circuit functions. That is, it does not let through the noise. When there is a carrier the automatic volume control cuts it down to reasonable values but what is left should be amplified at audio frequency. And the circuit does.

Certain refinements of the basic idea are needed to make the noise suppression circuit take hold at the right carrier value in respect to the carrier value at which the automatic volume control takes hold. There is in the automatic volume control rectifier a permanent voltage with such polarity that no current can flow in this circuit until this voltage is exceeded by the signal. This voltage is supplied by a 280 ohm resistor placed between the cathode of the 55 and ground. Since our current in this section of the circuit is 50 milliamperes, by adjustment, the drop in the 280 ohm resistor is 14 volts.

The a.v.c. diode plate is negative by this amount. Therefore, when there is no signal voltage in the circuit no rectified current can flow through the a.v.c. circuit. Indeed, no current can flow until the peak voltage of the carrier as applied on the diode circuit exceeds 14 volts. This fact delays the operation of the a.v.c. until the signal voltage has become higher than 14 volts. But there is no corresponding delay in the detector circuit, and hence none in the noise suppression circuit. Hence the noise suppression circuit takes hold before the a.v.c.

This has a tendency to eliminate weak carriers as well as noise. It would seem that this feature is undesirable, and may be from one point of view. But if the carrier is so weak that it is of the same order of magnitude as the noise, there is no use listening to it and it might as well be eliminated.

Independence of Circuits

It is clear that the noise elimination feature is not dependent on the presence of the automatic volume control. The a.v.c. could be eliminated and the noise suppression would work just as well. But there would be no advantage in using it alone, except, perhaps, to cut out those weak stations the carriers of which are about equal to the noise level. The real usefulness of the noise suppression feature is in conjunction with an automatic volume control in which the noise would rise to unpleasant values in the absence of a carrier if the noise suppression circuit were not used.

There is another feature which may be classed as a refinement. We have already referred to the fact that the input to the a.v.c. diode is taken from the primary of the second i-f transformer. Why is it not taken from the secondary as usual? As a rule, the selectivity of the primary is less than that of the secondary. Suppose we detune the circuit a little bit, say 10,000 cycles. The input to the detector and the noise suppression circuit will be tuned out first, because the secondary is more selective than the primary. This means that on detuning the automatic volume control continues to be effective in suppressing the r-f gain until the noise suppression circuit has had time to take effect to kill the amplification in the audio amplifier. Thus making use of the primary for the a.v.c. and the secondary for the detector and the noise suppression acts as an automatic overlap to insure that no noise will get through during the transition from exact resonance to complete detuning.

The fixed bias on the first tube, which is working as an r-f amplifier, should be about 3 volts and it is obtained from a

(*Continued on next page*)

Noise Suppression

And A-V-C in an A-C Su

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The circuit employs a 57 as first detector, but this tube may be a 58, for this is often used as the first detector. The first audio amplifier is a 57, and this should not be replaced by any other tube because the noise suppression feature depends on the cut-off property of this high-mu tube. For a change we have made the power tube a 245 because of its excellence. It may be replaced by a 47 if sensitivity is of more importance than quality, but to make the change the bias on this tube will have to be changed. At present it is approximately 42 volts.

The Real Detector

The real detector in the circuit is one of the diodes in the 55. The diode plate is connected to the top of the secondary of the second intermediate frequency transformer, as is customary in diode detection. The load on the detector diode is made up of one 0.5 megohm resistor and a 0.25 megohm potentiometer, connected in series, with the potentiometer next to the cathode. Across the load resistor is a 0.0001 mfd. by-pass condenser, which serves to filter out the carrier, but is not large enough to suppress appreciably any of the essential audio frequencies.

The 0.25 megohm potentiometer serves as a manual volume control as by moving the slider over the resistance the input to the first audio amplifier, the 57, is varied from about zero to the maximum audio drop across the potentiometer resistance. The maximum is only one-third of the output of the detector but the high gain in the audio amplifier offsets this loss.

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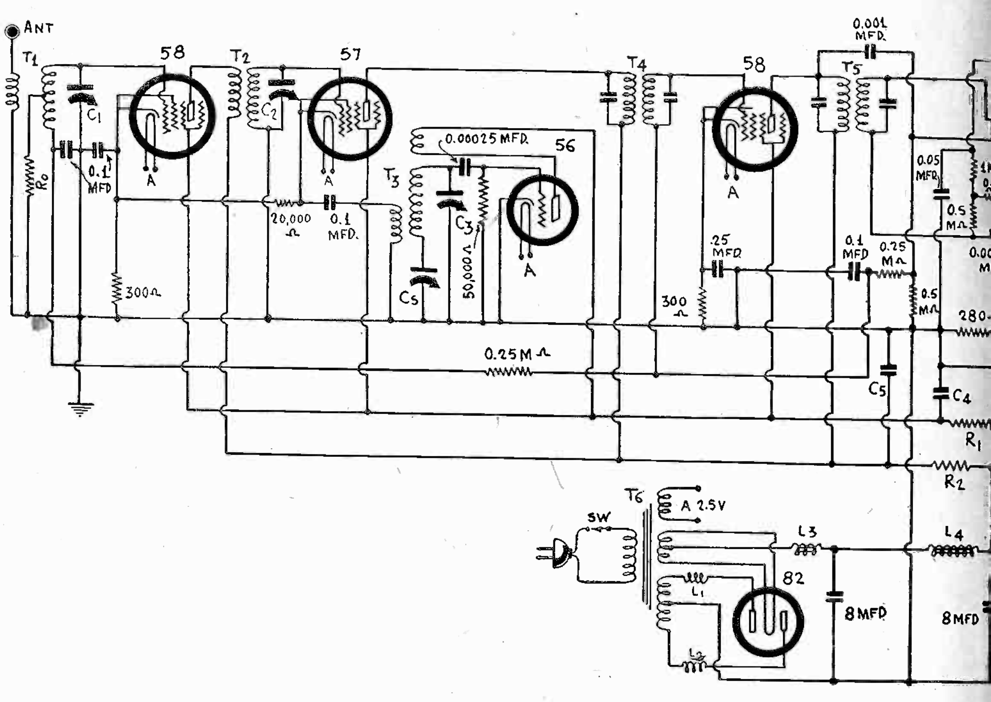

FIG. 1

This is a diagram of an eight-tube superheterodyne in which automatic porates noise suppression control.

is a part of the load on the detector diode. It is reduced to nearly pure d-c by means of a 0.05 mfd. condenser between the grid and ground and a 1 megohm resistor between the grid and the 0.25 megohm potentiometer. Both the resistor and the condenser are necessary for without the resistor the a-f signal would be short-circuited and without the condenser audio voltage would be applied to the triode grid. Only d-c is required. The triode is a d-c amplifier, which is a new feature in a radio receiver.

There is a load resistance of 0.05 megohm—that is, 50,000 ohms—in the plate circuit of the triode. The drop in this is the noise suppression voltage. As the d-c bias on the grid varies the current in the 50,000 ohm resistor varies, and hence the drop in it varies. Since the 50,000 ohm resistor is so connected that any change in the voltage across it will change the bias on the next audio tube, it is clear that the bias on the audio tube varies with the signal. Also, since the lower the grid bias the greater the current through the 50,000 ohm resistance, it is clear that the bias on the 57 varies with the bias on the 55 triode. That is, it varies with the carrier.

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Conditions for Functioning

The correct functioning of the noise suppression arrangement depends on the relative values of the voltages involved. The 57 tube should have a bias of 3 volts when it is to amplify. This should be the value when no current flows through the load resistance on the 55, that is, when the bias on the 55 is high. That occurs when there is a considerable carrier present and when there is something for the 57 to amplify by virtue of the presence of this carrier, assuming that it is modulated. The minimum bias is determined by the drop in a 60 ohm resistor placed between the cathode of the 57 and the effective grid return of the same tube.

We must determine the current through this 60 ohm resistor so that the drop will be 3 volts. Clearly, the current required is 50 milliamperes. In arriving at the value of 60 ohms it was assumed that the plate current of the 245 was 32 milliamperes, that the plate and screen current of the 57 was 2 milliamperes, and that the bleeder

Plotting

(*Continued from preceding page*)

is 1,930,000 ohms, and the 2,000,000 ohm mark may be registered close thereto.

Plotting Curve or Scale

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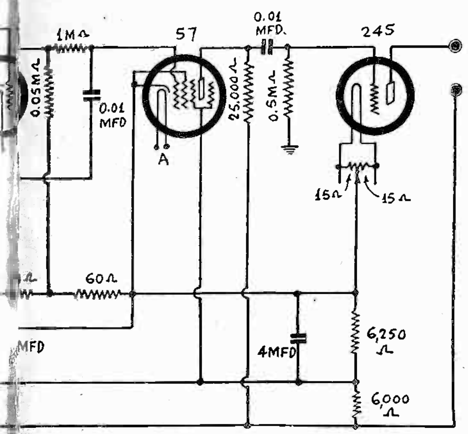

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Two 50,000 ohm resistors (Green body, orange dot, black end)
One 0.25 megohm potentiometer
One 6,250 ohm wirewound resistor
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Other Requirements

Four grid clips
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Two UX sockets
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a noise suppression circuit in conjunction with an automatic volume control, an audio amplifier that amplifies only when there is a carrier present, and hence when there is something to amplify, assuming the carrier is modulated, and a means for varying the amplification in inverse proportion to the strength of the carrier.

At first thought it would seem that nothing could come through the circuit, for when the automatic volume control cuts down the signal the audio amplifier is active and when there is nothing to amplify the audio tube is dead. But it is a matter of degree.

Clearly, when there is no carrier present there is no need for having an active audio amplifier and a good reason for having a dead one, for when there is no carrier the automatic volume control is not active but the noise suppression circuit functions. That is, it does not let through the noise. When there is a carrier the automatic volume control cuts it down to reasonable values but what is left should be amplified at audio frequency. And the circuit does.

Certain refinements of the basic idea are needed to make the noise suppression circuit take hold at the right carrier value in respect to the carrier value at which the automatic volume control takes hold. There is in the automatic volume control rectifier a permanent voltage with such polarity that no current can flow in this circuit until this voltage is exceeded by the signal. This voltage is supplied by a 280 ohm resistor placed between the cathode of the 55 and ground. Since our current in this section of the circuit is 50 milliamperes, by adjustment, the drop in the 280 ohm resistor is 14 volts.

The a.v.c. diode plate is negative by this amount. Therefore, when there is no signal voltage in the circuit no rectified current can flow through the a.v.c. circuit. Indeed, no current can flow until the peak voltage of the carrier as applied on the diode circuit exceeds 14 volts. This fact delays the operation of the a.v.c. until the signal voltage has become higher than 14 volts. But there is no corresponding delay in the detector circuit, and hence none in the noise suppression circuit. Hence the noise suppression circuit takes hold before the a.v.c.

This has a tendency to eliminate weak carriers as well as noise. It would seem that this feature is undesirable, and may be from one point of view. But if the carrier is so weak that it is of the same order of magnitude as the noise, there is no use listening to it and it might as well be eliminated.

Independence of Circuits

It is clear that the noise elimination feature is not dependent on the presence of the automatic volume control. The a.v.c. could be eliminated and the noise suppression would work just as well. But there would be no advantage in using it alone, except, perhaps, to cut out those weak stations the carriers of which are about equal to the noise level. The real usefulness of the noise suppression feature is in conjunction with an automatic volume control in which the noise would rise to unpleasant values in the absence of a carrier if the noise suppression circuit were not used.

There is another feature which may be classed as a refinement. We have already referred to the fact that the input to the a.v.c. diode is taken from the primary of the second i-f transformer. Why is it not taken from the secondary as usual? As a rule, the selectivity of the primary is less than that of the secondary. Suppose we detune the circuit a little bit, say 10,000 cycles. The input to the detector and the noise suppression circuit will be tuned out first, because the secondary is more selective than the primary. This means that on detuning the automatic volume control continues to be effective in suppressing the r-f gain until the noise suppression circuit has had time to take effect to kill the amplification in the audio amplifier. Thus making use of the primary for the a.v.c. and the secondary for the detector and the noise suppression acts as an automatic overlap to insure that no noise will get through during the transition from exact resonance to complete detuning.

The fixed bias on the first tube, which is working as an r-f amplifier, should be about 3 volts and it is obtained from a

(*Continued on next page*)

LOW SCREE

By Conrad

THERE is one fact about the use of screen grid tubes as detectors and audio frequency amplifiers in resistance coupled circuits which radio engineers have failed to recognize, and that is the necessity for using a very low screen voltage if the tube is to function properly. In part this is due to the fact that the tube manufacturers have failed to stress the point, if indeed, they have recognized it.

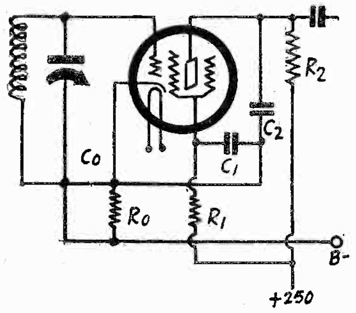


FIG. 1
Low screen voltage is required for detection or amplification when the tube is loaded with a high resistance. One way of getting it is to put a resistance in the screen lead

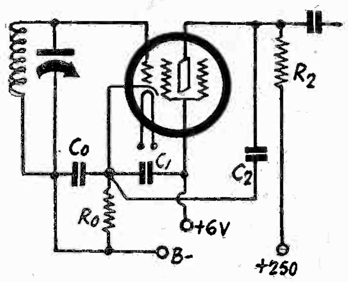


FIG. 2
Another way of getting the low screen voltage is to connect the screen to a low voltage tap on a battery or on the voltage divider as shown in the circuit.

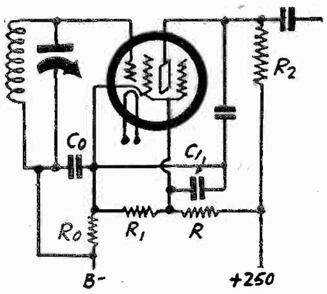


FIG. 3
This arrangement eliminates a high grid bias resistor, whether tube is used as amplifier or detector. The bias is mostly due to the bleeder current through R and R1.

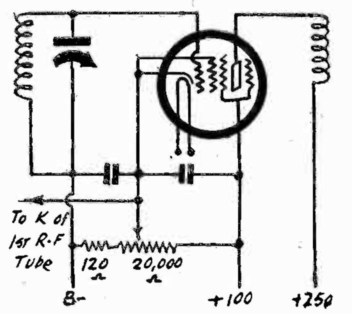


FIG. 4
Complete volume control can be accomplished by connecting a potentiometer from the screen to B minus, the slider being connected to the cathode or cathodes.

As far as detection is concerned the difficulty is avoided by specifying the grid current that should flow in the plate circuit, the current at which, under a given combination of plate and screen voltages, the tube functions best as a detector. Such a point may always be found by increasing the grid bias sufficiently. But when a tube is self-biased it may not be practical to obtain the necessary bias because it would require an exceedingly high bias resistor.

In respect to audio frequency amplification there is no such easy way out of the difficulty, for there is no bias at which amplification without a great deal of distortion will take place. One of three things may be done. First, the plate voltage may be increased enormously. Practical considerations limit the high voltage. Second, the resistance in the plate circuit may be reduced greatly. This is limited by the fact that as the resistance is reduced the amplification drops. Third, the screen voltage may be reduced very much, and that is the most practical solution.

Detection

When we are detecting we wish to operate where the curve bends most rapidly. If the screen voltage is high this point is very far in the negative direction. That is, it requires a very high grid bias to bring the tube in the detecting condition. But the plate current is nearly always about the same when this occurs. Hence if we use a self-biasing resistor we must use a very high value if we are to get a sufficient bias. Let us illustrate. Suppose the tube requires a bias of 6 volts and also suppose that the best detecting efficiency occurs at 0.1 milliampere. Then we must have a bias resistor of 60,000 ohms. But it is more likely that the best detecting point is at 7.5 volts where the current may be only 0.05 milliampere. In that case we would have to use a bias resistor of 150,000 ohms.

Now if the screen voltage is much less the best detecting point may be at 3 volts. If we made the plate current 0.1 milliampere we would need a bias resistance of 30,000 ohms, and if we made the current 0.05 milliampere and the bias 4 volts we would have to make the bias resistance 80,000 ohms. Of course, these are not actual values but they illustrate the point.

One might think that a greater output would be obtainable with the higher bias, but this is not the case. Quite the reverse is the fact. The curvature of the characteristic at the best detecting point is not nearly as great when the bias is high as when it is low. Hence the sensitivity is less. The plate current does not rise any higher for high screen voltage than for low, provided that it is not entirely too low. Therefore the tube is less sensitive and will not stand any more input without causing distortion.

The Curve

The plate current grid voltage curve starts at a certain grid bias rising first slowing then more rapidly. At one point it rises suddenly to a certain value and then it does not rise any more. There is a horizontal region, and this region is wider the higher the screen voltage. Optimum adjustment would seem to be where the horizontal region just vanishes. For a 224 with 180 volts in the plate circuit and a 250,000 ohm coupling resistor this occurs when the screen voltage is approximately 7.5 volts. The cut-off is about 4.5 volts. Thus the entire rise in the curve occurs within 4.5 volts. If the screen voltage is of the order of 67.5 volts, other conditions between the same, the bias would have to be about 7.5 volts but from zero to about 4 volts there would not be any change in the plate current at all.

Obviously, if the tube is biased so that the operating point is on the horizontal portion of the curve there would not be any detection at all. Neither would there be any amplification. If anything at all occurs it is distortion.

Theory of the Tube

It has been argued that when the screen voltage is very low the tube assumes the nature of a three element tube and it is no longer a screen grid tube. Hence the conclusion is that we do not take advantage of the tube's screen grid characteristics. That may be true, but the screen grid characteristics in this case are not desirable; they are most undesirable. The object of using the tube is to get good detecting efficiency, or good amplification efficiency without distortion, not to operate the tube as a screen grid tube, regardless of the consequences.

The theory of the screen grid tubes shows

Noise Suppr

(*Continued from preceding page*)

300 ohm resistor in the cathode lead. It is shunted with a 0.1 mfd. condenser. The bias on the first detector should be about 4 volts. Part of this voltage is obtained from the bias resistance on the preceding tube and part from a 20,000 ohm bias resistor in the detector cathode. The bias resistors for the first detector are shunted by a 0.1 mfd. condenser and the pick-up coil on the oscillator, the two being connected in series. This method permits grounding one end of the pick-up coil and at the same time to make use of the first tube's bias for part of the detector bias.

The i-f amplifier also has a fixed bias of 3 volts, obtained from another 300 ohm resistor. This resistor is shunted with a 0.25 mfd. condenser, the larger capacity being used here because the frequency is lower.

The power tube is biased by the three resistances associated with the noise suppression circuit. The bias is about 42 volts. This is 8 volts short of the recommended value for the 245 tube. It could be made up by increasing the 500 ohm resistor by 160 ohms or by putting in a resistor in the lead from the center tap on the filament shunt resistor. If the added resistance is put here it should have a value of 250 ohms. In this case also the 4 mfd. by-pass condenser across the bias should be connected between the center tap of the 30 ohm shunt resistor and ground.

The Screen Voltage

The screen voltage on the 57 audio tube is 100 volts, adjusted to this value by the 6,250 ohm resistor in the voltage divider. The voltage on the screens of the other screen grid tubes and the plate voltage on the oscillator are higher by the drop in the resistors associated with the 55 tube. To drop the voltage to the proper value a resistor R1 may be inserted in the lead to these screens, adjusting its value so that

N VOLTAGE

Phelps

that the screen voltage should be high for a given plate voltage. The theory may be all right but the application is faulty. The theory says plate voltage, not voltage applied in the plate circuit. The trouble is that in a resistance coupled circuit there is a wide discrepancy between the two. It is just a case of the old "saw" that "figures never lie but many figurers do."

It is the actual plate voltage that counts, the voltage applied less the voltage dro in the plate coupling resistor. Likewise, it is the actual screen voltage that counts. The actual screen voltage should never be equal to or exceed the actual plate voltage. If that condition is met there is no trouble.

We may obtain the low screen voltage required by various methods. We may use a battery, we may return the screen lead to a low voltage point on the voltage divider, or we may put a high resistance in the screen lead. There is no practical difference between a battery and the voltage divider, provided that we by-pass the section of the voltage divider used with a large enough capacity. In either case the sensitivity is high and the input limited.

When we put in a high resistance in the screen lead another effect occurs which alters the characteristic. The actual screen voltage varies in about the same way as the actual plate voltage. When the plate voltage is high, so is the screen voltage, but it is less than the plate voltage. When the effective plate voltage is low, so is the screen voltage, but it still is less than the plate voltage. So the conditions necessary are met, that is, the effective plate voltage is always larger than the effective screen voltage.

Experimental Test

An experiment on a screen grid tube to determine the effect of a resistor in the screen circuit showed that the horizontal portion of the curve was shortened but that the curve rose to about the same plate current value. The irregularity in the curve was removed and the slope was decreased. Therefore the effect of the screen circuit resistor is to decrease the amplification when the tube is used as an amplifier and to decrease the detecting efficiency when it is used as a detector. In both cases it increases the signal voltage that may be applied on the grid before distortion sets in, yet in neither case does it decrease the output, the input being sufficient.

In Fig. 1 we have a typical screen grid, resistance coupled circuit. It is a detector or amplifier depending on the value of the grid bias resistor Ro. In this case a screen resistor R1 is used to prevent distortion due to excessive screen voltage. It is returned to the 250 volt lead. When it is returned there R1 must have a very high value or the proper voltages will not be obtained. Another possibility is to connect the resistor to the plate of the tube. In that case it is absolutely certain that the screen voltage will always be less than the effective plate voltage, for it starts with that voltage and then is dropped some by R1. In this case the resistor does not have to have such a high value. Just what the value should be depends on several factors and the best combination can only be found experimentally.

Still another possibility, and the one that is most frequently used, is to return the screen resistor R1 to the screen returns of the r-f tubes, where the voltage may be from 45 to 100 volts, depending on the tube and the circuit. In this case there is no certainty that the screen voltage will always be less than the voltage on the plate. If we assume that the screen current is one-third as the plate current and that the applied voltages are 90 and 250 volts, and that the resistors R1 and R2 are 0.5 megohm and 250,000 ohms respectively, will the screen voltage be low enough? The danger will be when the plate current is highest. Let us suppose that it is 0.3 milliampere. Then the screen current is 0.1 milliampere. The voltage on the screen is 40 volts and the plate voltage is 175 volts.

More Examples

Suppose we make the two resistors equal and 250,000 ohms. If we still assume that the currents are 0.3 and 0.1 the screen voltage will be 65 volts and the plate voltage will remain at 175 volts.

The assumption that the plate current is only 0.3 milliampere was very conservative. Actually it might amount to 1 milliampere with 250 volts in the plate circuit. If it does the effective plate voltage is just zero, that is a possibility in a screen grid tube. Indeed, the plate current may be negative. If the screen current still remains one-third of the plate current the effective voltage on the screen, with 250,000 ohms in the lead, is about 2 volts.

If we did not have the resistance in the screen lead the screen voltage would be 90 volts and the effective plate voltage zero, approximately.

In Fig. 2 we have a circuit in which the screen voltage is 6 volts, obtained either from a battery or from a voltage divider. As in the preceding circuit, the tube is either a detector or an amplifier according to the value of Ro. The six volts are supposed to be measured from the cathode, so that if it is measured from B minus it should be augmented by the bias voltage. The screen voltage may be made a little higher than six volts when the plate voltage is as high as 250 volts, but it should not exceed about 16 volts.

Effect of By-pass Condenser

In Fig. 1 we have a by-pass condenser, C1, from tthe screen to the cathode. What effect does this have on the performance of the circuit? If it is large enough it maintains the screen voltage constant at the signal frequency. Trial shows that it reduces the gain on the high audio frequencies. One would expect the opposite effect. However, if the screen voltage is excessive R1 is effective only on the low frequencies, if R1 is large. The tube, then remains, to some extent, the poor amplifier or detector at high frequencies which it is at all frequencies when R1 is not used. The same does not apply to C1 in Fig. 2 for the screen voltage is low. Indeed, it is not essential to use it, though desirable. Condenser C2 in either circuit has the effect of reducing the high frequency gain, but it is essential to use it.

In order to reduce the grid bias resistance in a screen grid detector the bleeder current may be sent through the resistance, as in Fig. 3. Suppose, for example, that we need a bias of 3 volts. The screen current at the detecting point is very low so we can easily select a bleeder current so large that the current in the tube is negligible in comparison. Suppose we make the bleeder current 5 milliamperes. Then Ro should be only 600 ohms. For this bias we need a screen voltage of about 16.5 volts. At that rate the value of R1 should be 3,300 ohms. If the applied plate voltage is 250 volts, measured from ground, the value of R should be 46,100 ohms. A 50,000 ohm resistor would be close enough.

Although 16.5 volts may be a little higher than the voltage that should be used for best detecting efficiency, it works out satisfactorily, and the use of 50,000 ohms makes the bias and the screen voltages slightly lower than the values assumed.

The arrangement illustrated in Fig. 3 has the advantage that the screen and grid voltages are little affected by the signal since the varying current due to the signal is only a small part of the current that determines the voltages. This tends to make the detecting efficiency nearly equal at all audio frequencies, because degenerative feedback is practically eliminated. The arrangement in Fig. 3 is more sensitive than either of the others for that reason.

Reducing the Plate Resistance

It was said above that one way of preventing the screen voltage from becoming equal to or greater than the plate voltage is to use a low value of plate resistance, that is, of R2 in Figs. 1, 2 and 3. This decreases the output of the tube, whether it is used as amplifier or detector, because the output is directly proportional to the load resistance, provided that the current remains constant. The current increases a little as the load resistance is decreased so the output does not fall quite as rapidly as the decrease in the resistance. But the drop is enough to justify the use of a high resistance value, and then to use one of the other methods of preventing distortion or inefficiency.

ession Super

the drop in it is about 40 volts. About 4,000 ohms will do it. If this resistor is used condenser C4 should also be used, and it may be 0.25 mfd.

The plate voltage on the power tube and on the 57 audio tube is 250 volts, but the plate voltage on the r-f tubes is more by about 40 volts. As before, if it is desired to drop this excess, R2 should be used. About 2,500 ohms will be all right here. If this is used condenser C5 should also be used, and it may be 0.25 mfd. or more.

To drop the voltage from 250 to 100 in the voltage divider a 6,000 ohm resistor is put at the top of the voltage divider, that is, between the output of the filter and the tap for the screens.

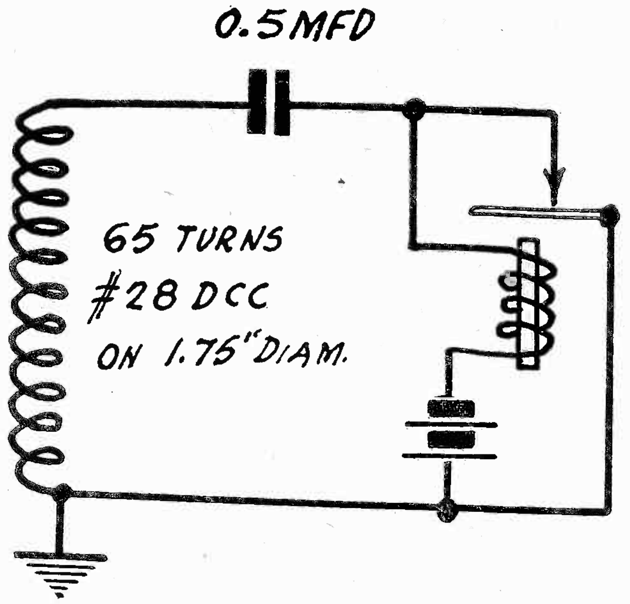
The B Supply

The supply employs the 82 rectifier which takes 2.5 volts on the filament. In each plate lead is a small r-f choke coil, L1 and L2, which must be used to prevent noise in the set. Each should be from one to two millihenries. Choke input is used to prevent heavy surges of current into the first 8 mfd. by-pass condenser. This choke, L3, may be from 10 to 30 henries. L4 is a regular filter choke of 30 henries or so. This is followed by another 8 mfd. condenser.

Resistor Ro is an oscillation control. If the r-f amplifier does not oscillate without it, it should not be used. When used it is connected from a tap on the coil to ground and its value should be about 10,000 ohms. Since the feedback causing the oscillation may be of different degrees, the same size resistor should not be used in all cases. Always, the largest resistance that will stop oscillation should be used. The position of the tap is at the middle of the winding. If a manual volume control in the r-f frequency level is desired Ro may be in the form of a potentiometer, say of 250,000 ohms, the antenna, with the primary coil, being connected to the slider.

A Buzzer Oscillator

By Paul Irwin



LIST OF PARTS

One r-f coil as described
One 0.5 mfd. condenser
One buzzer
One battery of voltage sufficient to drive buzzer
One 350 mmfd. variable condenser (optional)

WE HAVE been searching for an inexpensive modulated oscillator for years and all this time we have overlooked the simple buzzer circuit. Before the invention of the three-element vacuum tube the buzzer was always used, and it gave good service. Why should it not be used now for testing sets? There is no reason at all why it should not. And it can be constructed for a nominal sum.

Just what is needed for a buzzer that will generate a modulated radio frequency wave? Nothing but a small battery, a tuned circuit, and an interrupter, or buzzer. If we are satisfied with a single frequency, with its harmonics, we do not even need a variable condenser. A coil will be sufficient.

The coil may be wound with about 65 turns of No. 28 double cotton covered wire on a three inch diameter, or any other size wire that is handy, provided it is not too fine. Just one winding is sufficient.

The buzzer may be any type of interrupter that breaks the circuit rapidly. There are many types of buzzers, the high frequency type being preferable, but any buzzer that will generate a noise that can be heard is all right. Such buzzers can be bought in any electrical store or in the 5 and 10 cent stores.

The Buzzer Circuit

In Fig. 1 is a typical buzzer oscillator. It has a coil in series with a rather large condenser, a battery with a voltage high enough to drive the buzzer, and the buzzer. When the current is started the core of the buzzer becomes a magnet and attracts the armature, which is of soft iron. The armature is pulled away from the contact point and thus breaks the circuit. But as soon as the circuit opens the coil ceases to be a magnet and the armature spring pulls the armature back again, making the circuit once more. Thus the magnet and the spring keep the armature moving rapidly back and forth, making and breaking the circuit every time.

Every time the circuit is broken the radio frequency coil gets a shock, and this shock sets up high frequency vibrations in the coil. The frequency of these vibrations is determined by the natural frequency of the circuit. The generated wave is modulated because the vibrations start suddenly and die down gradually, the frequency of modulation being determined by the frequency of the interrupter. It is because of this that a high frequency buzzer is preferable, since it is desirable to have a comparatively high modulation frequency.

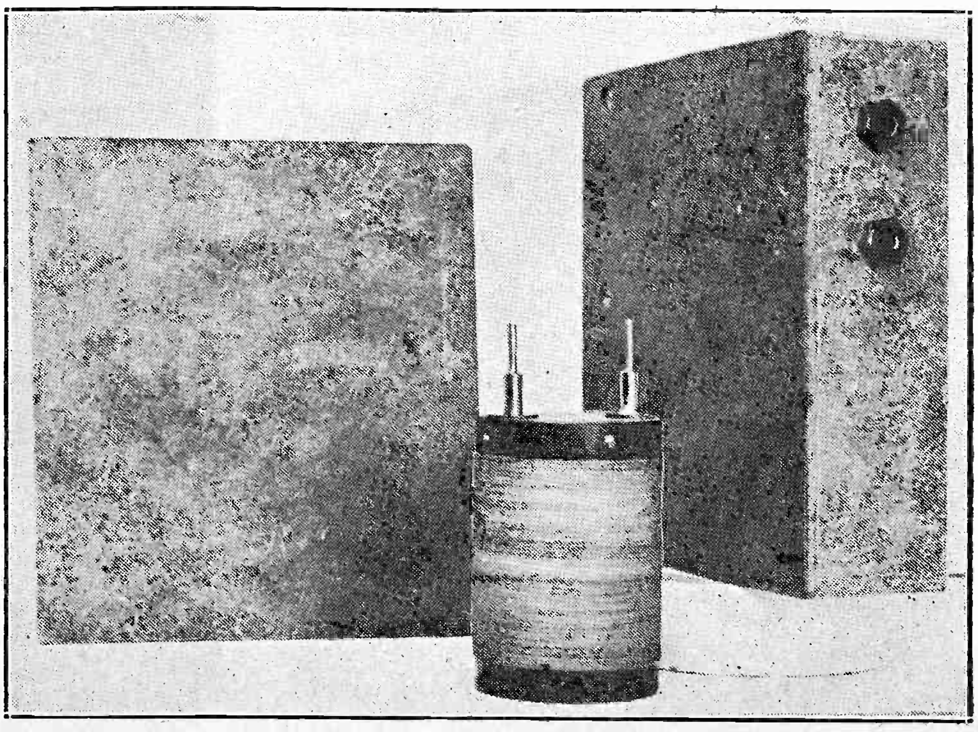
The generated wave is rich in harmonics and therefore we have available many different frequencies. However, if we want to vary the natural frequency of the circuit so as to get different frequencies, all we have to do is to put a variable condenser across the coil to augment its self capacity.

Using the Oscillator

This oscillator is used just as any other radio frequency oscillator. If a radio receiver is placed near it while it is going, the buzzer tone can be picked up with the receiver, provided it is tuned to the frequency generated by the high frequency circuit. If we want selectivity all that is necessary is to couple very loosely. It is easy to overload a radio receiver with the output of this oscillator if it is placed too close to it, or if the antenna wire is placed too close.

The buzzer circuit can be used for lining up radio receiver tuners when there is no convenient broadcast station within reach. If the buzzer is started and tuned to a frequency near the high end of the radio tuner the trimmer condensers may be adjusted until the circuits are all in resonance with the frequency generated.

When there is a variable condenser across the r-f coil the circuit can also be used as a wavemeter, of the oscillating type. For example, we may wish to find the frequency limits of a tuner. The tuner is then set at one extreme and the frequency of the buzzer adjusted until the buzzing noise is loudest. The setting of the buzzer generator will then tell what the frequency is, the buzzer circuit having previously been calibrated. In the same way we can find the other frequency limit. Or if we want to find the frequency of some station in the interior of the tuning range we can leave the tuner on this station and then vary the buzzer generator until the noise comes in with maximum strength. Then the setting of the buzzer generator dial in conjunction with the calibration curve will tell what the frequency is. In the same way we can find the frequency of any resonant circuit, such as a wave trap. However, if the circuit is not a part of a receiver we must have some other means for determining whether the frequency generated is equal to the natural frequency of the circuit tested. If we have a thermocouple type meter we can put this in series with the tested circuit and vary the buzzer generator frequency until the meter reads maximum. In the absence of a meter of this type we could use a crystal rectifier and a headset, or we could arrange a tube detector to render the noise audible.



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Why A-C Reduces Current

PLEASE let me know why alternating current has an effect on a coil that reduces the current, as compared to application of direct current voltage to the coil, which produces more current.—A. T. W., Beloit, Wisc.

The current is less when a-c is applied due to both the inductance and the frequency. The greater the inductance and the higher the frequency, the less the current through the coil. The combined effect of inductance and frequency is the reactance. Since the coil also has direct current resistance, and in many circuits there is considerable direct current as well as a-c flowing, as in the plate circuit of a tube, the d-c resistance has to be reckoned with. The quantity that takes into account the inductance, frequency and d-c resistance is the impedance. The formulas for deriving any of these quantities may be found in any of the standard textbooks on radio.

* * *

Plate Current Cut-off

STATE the value of biasing resistor in a self-biased circuit, using the '27 or the 56 tube, for plate current cutoff, as I desire to use the tube in that manner in a vacuum tube voltmeter.—P. O'D., San Francisco, Calif.

In general it is practically impossible to cut off the plate current by using a self-biasing resistor. For these tubes it would be well to use a regular voltage divider, and apply a negative bias from the divider of more than 50 volts, with a plate voltage of 300 to 400 volts. As the readings are not definitive from full cutoff you might start with a very small amount of plate current, and calibrate from that point on. The lowest current that you can read easily on your meter would be a good starting point.

* * *

Oscillation Trouble

IN A TUNED RADIO FREQUENCY circuit that I built I have suffered regenerative effects, hard to control. I tried reversing the connections to coils, but this did not help. Have you any suggestion to make for introducing a stabilization system?—H. R. W., Ottawa, Can.

There are many methods of stabilizing such a circuit. Since coil terminal reversal did not help, it seems that you suffer oscillation because of capacitative or resistive feedback. Look to the resistive side first. If you have two or more tubes on a common biasing resistor the bypass condenser across that resistor may not be large enough, if the feedback through the resistor is positive, as it seems to be, therefore increase this capacity very substantially, as trivial values of feedback voltage will cause oscillation. If you are using coils you wound yourself, rewind the secondaries in any tube circuit that's oscillating, and tap the coil at 20 turns from the ground end. From tap to ground a resistor may be placed. If it is 1,200 ohms it will surely stop oscillation. Use as high a resistance as consistent with oscillation stoppage. Of course your coils should be shielded.

Distance of Ultra Waves

MARCONI was reported in your columns as having sent on an ultra frequency, enabling reception some 167 miles away. What were the details of that accomplishment? I did not see them published anywhere. Has much been done on beyond-the-horizon distances with ultra frequencies?—U. W. Q., Ames, Ia.

Just what Marconi accomplished, beyond the bare fact of reception of an ultra frequency over the distance stated, is not known, as he did not disclose the details. It is not known, for instance, from what altitude he transmitted, yet that would be an important factor. During the recent eclipse ultra frequencies sent from the Empire State Building in New York City were picked up 135 miles away, and while there is not necessarily any connection between the fact of the eclipse and the 135-mile reception range, the demonstration does prove that at suitable heights, and the Empire State Building is more than a thousand feet high, greater than 25-mile range can be expected. One of the limitations of the ultra frequencies is the circumscribed distance the waves travel, but since the horizon is farther away the greater the height of the aerial, the demonstrations thus far do not prove that much has been accomplished in extending the distance range of these still unsolved frequencies.

* * *

Three-Circuit Tuner

CAN A SINGLE-CIRCUIT tuner still be used to advantage? About what sensitivity would result, and how about the selectivity?—O. T., Long Beach, Calif.

A single circuit tuner has little use for broadcast reception to-day. If the circuit is regenerative, with a primary not directly tuned, you have a three-circuit tuner, and this affords better results. With regeneration the sensitivity may be very high, as great as 10 microvolts per meter. The selectivity depends on many factors, including the quality of the coil and tuning condenser, but in general might not be good enough. Of course an objection to regenerative circuits that feed into the aerial is the radiation they cause, and if regenerative circuits of this type had not gone out of vogue there would be much less likelihood of being able to pick up even a local program today without considerable squealing interference.

* * *

The Seventh Lead

IN THE CONSTRUCTION of a set analyzer is it necessary to be able to put the meter between the seventh lead of the new seven-pin tubes, and also to measure the voltage from this seventh pin?—J. W. S., Salt Lake City, Utah.

Satisfactory results will be obtained if this seventh lead is simply represented by the seventh wire in the cable, and is brought to the grid clip on the tester and to a pin or inset on the analyzer plug. See how this is done in the analyzer described last week (Oct. 8th). There are very few seven-pin tubes in use, and the largest tube manufacturers have not yet announced a tube with seven base pins. Of course the 57 and 58 tubes have seven different connections, but the seventh is the control grid at cap of tube, and this also is taken care of by the seventh wire in the cable and the grid clip on tester, with accompanying grid cap or equivalent on the analyzer plug.

* * *

Resistance Meter

I HAVE A VOLTMETER of the old style, 0-6 volts. Will you please let me know how I may use this as a resistance meter, and how I may calibrate it? The meter was on a Freed-Eisemann battery-type set.—I. F. W., St. Louis, Mo.

The meter you refer to is probably the one made by Roller Smith and used in receivers of the battery type made by Freed-Eisemann. If so the coil in the meter has a resistance of 500 ohms. You can check up on this by applying 6 volts and putting a milliammeter in series with the voltage source and the voltmeter. Use a 0-50 milliammeter, if you have it, or 0-25 ma. Note the current reading on the milliammeter at full-scale deflection. This would be 12 ma if the above assumption of identity is correct. You can remove the voltage scale and paste a piece of cardboard over the metal plate that held the scale. Then you may write in the resistance values for particular points on the scale. The resistance range would be from about 25 ohms to about 2,000 ohms. There is no need for a limiting resistance where the coil in the meter is of required resistance. The scale can be arranged without any further tests, as the resistance values will be proportional to the current reading, and the current reading is linear. Thus at full-scale deflection the current is 12 ma, at half of full-scale it is 6 ma, at one-third of full-scale it is 4 ma. The resistance in ohms equals the voltage in volts divided by the current in amperes. Hence as the voltage is known (it is always 6 volts) the current is known (for all positions on the meter scale) and the resistance may be computed. From the result subtract 500 ohms, the resistance of the meter coil (or subtract whatever that resistance actually is, for that too may be computed by the above formula). To calibrate the meter readily it is handy to have a protractor, so that the scale may be drawn nicely, and small current differences recorded. Many of the even values of resistance (of the unknown) coincide with odd current readings. Use 25, 100, 200, 300, 400, 500, 600, 700, 1,000, 1,500 and 2,000 ohms as the registration points.

* * *

Oscillator Constants

IN THE CONSTRUCTION of an oscillator I desire to have the broadcast band frequencies read from harmonics of my oscillator, whereas some of the fundamentals should include popular intermediate frequencies. A few intermediate frequencies could be determined by a low order of harmonics. Please give coil data. —H. U. S., Bangor, Me.

If you use a coil with an inductance of about 20 millihenries, and a 0.00035 mfd. tuning condenser, you will be able to cover the desired frequency ratio, about 3-to-1, with fundamentals of about 70 to 210 kc. Thus 175 kc would be in the fundamental range, also 135 kc. The broadcast band would be represented by seventh harmonics, and all the frequencies would then appear in regular order, without skipping about on the dial or calibration for broadcast frequencies. A good way of obtaining oscillation is to use a center-tapped coil, center to cathode. For oscillator purposes, since low distributed capacity is necessary for a high ratio of frequency coverage, honeycomb coils are suggested, and these may be two of 800 turns, about 1 inch diameter, comprising about 20 millihenries when combined as advised.

A THOUGHT FOR THE WEEK

ISN'T IT TRUE, in the final analysis, that the perfect sale is one that means the right price for the right goods? And surely this is as true of radio as it is of any other line of merchandise—and as true in 1932 as it was in 1929. Perhaps if some of those concerns that are complaining about business were to devote sober thought to this fact they would have less reason for kicking and all they have to do is to see how much better off are their competitors who still believe that "Right goods at the right price" is the answer to the selling problem.

You can't buy public confidence—you must earn it! (Sounds bromidic, you say? Perhaps it does—but so does "2+2=4"—but it's true just the same).

RADIO WORLD

Trade Mark Reg. U. S. Pat. Off.

The First and Only National Radio Weekly

Eleventh Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; J. Murray Barron, advertising manager.

Farewell, Necromancers!

FOR so many years the necromancers have been having their way on the air that no more can be said in favor of the Federal Radio Commission's new rule against fortune-telling that it is about time it was adopted. Not only fortune-telling, but lotteries have had their prosperous days, and astrologists, numerologists, and other exponents of the mystic well may be deemed to have reaped the last of their harvest. Decline of popular taste for much of the occult on the air has been more effective in causing the riddance of the mysterious folk than anything the Commission has done.

The Commission has always been most careful not to do or say anything that might be construed as attempted or actual censorship. In this respect it has been rather squeamish. Barring pretenders from capitalizing their pretensions on the public-owned air channels does not come under the heading of what folk generally regard as censorship. It is not censorship simply to rule that a thing must not be done.

When the Congress vested the Commission with the right to decide the fitness of stations and applicants on the basis of "public interest, convenience or necessity," it also decreed that the Commission should not exercise any censorship powers, and therefore the construction the Congress put on censorship was not a special one, but the one generally accepted. Otherwise the granting of the power to rule off the air a station that offended against public interest would be denied by the law that granted that power.

A little more stiffness on the part of the Commission toward these commercialized raids on the pocketbooks of the credulous and the superstitious by the pretended possessors of occult powers, and toward all other self-styled diviners of future events, would be appreciated. Many of these profiting folk not only can not see into the future but can't tell you much about what has gone on in the past.

TUBE EXPORTS INCREASE

Arcturus Radio Tube Company, Newark, N. J., reports for the first six months of this year export sales increased over 70% in comparison to the first six months of 1931.

Ten Years Ago This Week

A GOOD deal got into print in 1922 that made interesting reading, even if it wasn't very important or completely true. For instance, two photographs in the October 14th, 1922, issue of RADIO WORLD bore captions informing the readers that in one instance a radio receiver was installed at the box-office of the Globe Theatre, in New York City, to receive radioed reservations for tickets to the theatre, and in the other instance a telephone operator at a hotel similarly received room reservation orders.

Well, there were the photographs, and the good-looking girls served their eminent purpose posing in the performance of the work they were supposed to be doing. The theatre set palpably was home-made, and had three main knobs and two switch knobs, 20 positions for each switch. The other set looked suspiciously factory-made, had one main knob, two minor knobs and a couple of rheostats. Its name-plates could not be read, but that was unfortunate for what may have been the original purpose of the photographer's client.

The Contrast

There wasn't any such point-to-point communication going on in those days, although much more freedom from Governmental restriction existed then. Secretary of Commerce Hoover had charge of radio affairs, an authority that later was declared non-existent by a court decision, but meanwhile was exercised as fully as circumstances required.

These little digressions from the real reports of the state of the art that crowded the columns of RADIO WORLD are amusing to regard in the light of this day, because of the contrast between the public's impression of radio now and radio then. Almost everybody now knows that general telephoning by radio is not permitted, and that messages intercepted must be kept secret. Fortunately not so much consideration is given now to the "wizardry" of radio, and all hands seem to appreciate that, after all, there is nothing metaphysical about radio, any more than there is about a can of beans or a putty-blower.

How to get long-distance stations was a topic that thrilled the radioists of ten years ago, and week after week articles were published telling of both endeavors at DX and distant stations received. For instance, Mrs. W. C. Blackburn, of Cleveland, O., wrote: "On August 16th, 1922, we heard the entire program from WSB, Atlanta, Ga."

Now, wasn't that something?

30 Miles DX?

It was generally agreed that the best opportunities for DX were associated with regeneration, although there was a sprinkling of crystal enthusiasts who thought that DX with a crystal set was pretty dependable. However, their records of actual DX reception were meagre or absent. Most crystal DX work (assuming no r-f amplification) was freaky, but perhaps this fact was not well understood then. However, an article in the October 7th issue did tell of the normal receiving range of a crystal receiver was 25 to 30 miles. Possibly this was DX of a sort in those days.

The front cover illustration showed "Necessary Parts for a Short-Wave Receiver." These were two variometers (one for grid, one for plate) and a tapped variocoupler, one tap at each ten turns. Short waves then were not what short waves are today. No, sir! The receiver brought in "short wavelengths up to 600 meters."

There was some attempt at broadcasting World Series games in those days. Actually the broadcast was made, but the conditions were not as good as they are today, by any means, a poor portable transmitter being used. Still, one fellow at Quebec reported hearing Grantland Rice's description of the game, over WJZ.

Station's Anniversary

And it was at this time that WJZ celebrated its first anniversary. The announcement read:

"WJZ, radio call letters on the lips of thousands of radio enthusiasts, held its first anniversary services during the evening of October 5, when several of the artists who broadcast from WJZ last fall again visited this station.

"It is generally regarded that KDKA is the father of broadcasting; also that WJZ popularized the broadcasting idea and introduced it in the Metropolitan area, where it attracted the best of talent and, with the assistance of New York radio publications, aroused the nation to the great possibilities of radio broadcasting.

"WJZ was officially opened October 5, 1921, at 1:55 p.m., when several records were played to enable the radio audience to tune in their radio sets to receive, a few minutes later, the play by play results of the World Series.

"The response to the broadcasting by WJZ was immediate, as suggested by letters received from Massachusetts, West Virginia, Ontario, Pennsylvania, New York, and New Jersey.

"The first artists to broadcast in person were: The Shannon Four, well known recording quartette, consisting of Charles Hart, tenor; Elliott Shaw, baritone; Wilfred Glenn, bass, and Louis James, tenor. Soon thereafter the foremost recording team, Billy Jones, tenor, and Ernest Hare, bass-baritone, entertained the growing invisible audience. Two prominent instrumentalists, Constance Karla, violinist, and Anna Welch, harpist, followed and other artists of note."

Prophetic Situation

Hints of what was to come were plentiful in those days of only a decade ago. Now we find radio sets going full-blast in restaurants and even in some hotel lobbies. Stores are installing them fast, including furriers, butcher shops, delicatessen stores, etc.

Loudspeaker reception was in the low minority then, but a quick-lunch counter called The Dugout, at Ridgefield Park, N. J., contented itself with serving earphones to patrons desiring to do a little noisy listening. This was a great attraction. The Dugout reported, so much so that customers would let their soup get cold while they listened out a song.

The bedspring aerial was honored with a photograph in that issue, the method of using it being plain enough. The counterpane, sheets and blankets were removed, along with the mattress, and a wired clip fastened to the bedspring at any convenient place. Then one listened to one's heart's content. If company arrived unexpectedly of course the house looked a little upset, but a pioneer in a new science must be forgiven for these unsocial aspects of his work.

STATION SPARKS
By Alice Remsen

The Unkept Tryst
FOR DONALD NOVIS

WEAF—Sundays, 7:00 p.m.; Mondays, Wednesday and Saturdays, 6:45 p.m.

A sun-drenched tree is down by the gate;
And I am waiting alone for you.
Watching the road which winds like fate
Always, forever into the blue—
The beautiful blue of the sky that meets
The end of the road down which you'll ride;
The road that often-times defeats
My tired eyes of a sight—denied—
A sight of you—my love, my dear!
Don't you think I ever grow lonely here?

The top of the tree is dusky now,
The gloom of a twilight rests upon
The face of the world; and on my brow
A furrow has come—my smile has gone;
And I am tired, as the autumn chill
Enters my heart; and I feel old.
I feel that you will not come until
My spirit is dead, and my soul is cold.
Do you know how long I have waited here?
Don't you think I ever grow lonely, dear?
—A. R.

AND THE BEAUTIFUL VOICE OF DONALD NOVIS will carry you back to the days of your youth, reminding you of unkept trysts, old sweethearts, and romance in all its aspects. Donald has an appealing voice which will enter your heart and stay there. Don't miss him; he's a treat.

* * *

The Radio Rialto

The best piece of news to come floating down old Radio Rialto today is that Big Time now goes on five times a week, WJZ, 7:45 p.m. The series will be known as "Johnny Hart in Hollywood," a fifteen minute program, and Dr. Royal S. Copeland will give a health talk on each one. . . . Maxwell House has gone "Showboat," and will have many stars on its program in the future, but still retains the sweet voice of Lanny Ross. . . Death Valley Days is back with its dramatic incidents of the time when pioneers plodded through the sands of Death Valley. . . . The life and philosophy of a friend of my youth will be dramatized via the WABC air-waves on October 6th, 9:30-10:00 p.m. That rare old Persian poet, Omar Khayyam, whose philosophical quatrains used to make me ponder, will make his bow at that time. He will be the subject of a musical-dramatic series which promises to be a delightful and colorful broadcast. Sponsored by the California Walnut Growers Association, the program will emanate from Los Angeles over a coast-to-coast network, through Station KHJ, McCann, Erickson placed the account. . . .

Oh, yes, the Radio Rialto is humming with activity, and depression days are over for a great many of us. . . . The H-Bar-O Rangers, is a new thrice-weekly program over the WABC-Columbia network; every Monday, Wednesday and Friday at 5:15 p.m. This series is a script act consisting of cowboy adventure episodes. It is broadcast from Buffalo, N. Y., and is sponsored by the Hecker H-O Company, Inc. . . . Abe Lyman and his Californians have returned to the air in a new tri-weekly series, also over WABC Tuesday, Thursday and Saturday, at 8:15 p.m. sponsored by Sterling Products, manufacturers of Phillips Dental Magnesia. . . . Another good piece of news is that John Finley Williamson, director of the Westminster Choir, brings his internationally known choristers to the air in a series of thirty weekly broadcasts, over WEAF, on Wednesday, October 12th, at 2:30 p.m. . . . Then for a change we have Fred Allen, comedian of musical comedy fame, who will head an array of talent for the new Linit "Bath Club" series over WABC, beginning Sunday, October 23rd, 9:00 p.m. . . . Many other new programs are on the way, if Rialto rumors come true. . . .

Ran into Ralph Kirberry, the Dream Singer, up at the Famous Music studios. Ralph was trying to decide what song to use for a signature. Asked my opinion, I picked "Broadway Moon," a sweet, if reminiscent, tune. . . . Ralph is still undecided, and after all, a signature song is a very important thing to pick; it must be able to stand the test of time; to be singable by the average voice; must hold appeal for every class and age of listener and, most important of all, must be wedded to the voice of the artist using it. . . . Heard that Mabel Jackson, that nice soprano, is back in town; she will sing on the Maxwell House "Showboat" program. Very glad to hear it. And so should you be, for Mabel is a clever girl and well worth a twist of the dial. . . . Another soprano, who, in my humble opinion is worthy of a radio break, is a cute little youngster from Tennessee named Della Sue Hicks. Della Sue has a voice which might be compared with Virginia Rea's when she first opened on Palm-Olive; it has that same flute-like quality, missing now from Virginia's more mature work. . .

Spent part of the afternoon up at Muriel Pollack's new apartment in East 55th, where another visitor, none other than Bob Keller, almost succeeded in burning Muriel out of house and home by dropping a lighted cigarette between the cushions of a lovely new armchair and leaving a hole smoldering while we rehearsed a harmony number. . . . Muriel, by the way, is doing some very good work with her partner, Vee Lawnhurst, every morning, except Friday and Sunday, over WJZ, at 9:15. The program is known as "The Lady Bugs," and can those two girls play piano, well—just give a listen! . . . Well, from Muriel's house, overtown, where we meet Charlie Kinney, the big overgrown Philadelphia kid, who manages the Pebeco Playboys. He tells me the boys are pulling on an average of five thousand fan letters after each broadcast. That's what you might call pahlenty mail. . . . Next person we run into is Harriet Lee, blonde and beautiful, still going strong with her male trio over the NBC networks. . . . A little farther on we bump into Eddie Wolf; he's feeling pretty good these days; the courts awarded him $35,000 in his suit against Arthur Tracy, the Street Singer; Ed will net about twenty-seven thousand, sixteen thousand of which he received in cash, the rest to come in installments. . . . Eddie has a new radio sensation which he is exploiting, an act called the Three X. Sisters; these girls can imitate anything from a barrel organ to a bassoon, a Dutchman to an Irishman. They recently arrived from London and have already been booked by Eddie on a new sponsored program, the Tidewater Oil broadcast, every Monday, Wednesday and Friday, at 7:30 p.m. over WABC. . . .

Let's hop into a cab and over to WABC. . . As we go in, Charlie Cantor, one of the cleverest radio dialecticians, comes out; we stop to chat and find that Charlie is appearing with Jay C. Flippen in a new series of programs sponsored by the American Oil Company, not heard over WABC locally, but over twelve outside stations. . . . Thursdays at 8:30 p.m. . . . And there's Nat Shilkret, as we get out of the elevator at the twenty-second floor He is busy as usual. Nat has a gargantuan appetite for work and tells us that in the past thirty days he has composed a dozen numbers, the score for a full-length motion picture and incidental music for two screen shorts. Besides this he has worked out eighty pages of symphonic score for recording purposes and has written a two thousand word article; all this aside from preparing and conducting "Music That Satisfies" six times weekly. He also found time to relax by reading several books. Oh, yes, Nat is a fairly busy boy. . . .

Someone asks us how we like the Fu-Manchu mystery program and we say they're all right. By the way; the leading role of Nailand Smith is taken by a noted English actor, Charles Warburton, who established himself as an actor in Sir Frank Benson's celebrated company, and was also with Walter Hampden. . . . Over in the corner we see our old friend, Colonel Lemuel Q. Stoopnagle. He and Budd are making talking shorts from a scenario written by the redoubtable Colonel himself. . . . The fair-haired boy? Oh, that's Mr. Conah, a member of the press department, who informs us that the latest station to join the Columbia chain is that of WICC, Bridgeport, Conn., which is a 500 watt station, established in 1926. This brings 90 stations to the Columbia network. . . .

It seems to me that I've gathered a fair amount of news today, and it's about time I made for home, where Octavia has roast pork stuffed with sage and onion, all ready and waiting for me . . . and so, like Lowell Thomas, I'll also say, "So long."

* * *

Biographical Brevities
ABOUT FLETCHER HENDERSON

In response to numerous requests, I journeyed up to Harlem, met Fletcher Henderson and discovered a gentle-mannered man, with a poetic temperament and music in his soul. . . . He was born in the little town of Cuthbert, Georgia, near Macon. Had no intention of following the profession of music. After receiving his A.B. degree from Atlanta University, came up to New York to study chemistry . . . in order to pay for his tuition he took a job as a pianist and demonstrator with Pace and Handy. . . . This was in 1920. . . .

He started to go out nights playing in bands. . . . Found he could make fifteen dollars a night doing this. . . . It started him thinking. . . . Perhaps there was more money in music than chemistry. . . . He certainly liked playing piano better than dabbling with strange chemicals and funny smells . . . and so it started and soon Fletcher Henderson wound up at the head of his own band. . . . That band brought him fame. . . . In 1929 he was featured in Vincent Youman's "Great Day." . . . His was the first colored band to ever play a white hotel . . . the Congress Hotel in Chicago. . . . He has a sweet combination of twelve pieces and can play hot or sweet. . . . Makes his own arrangements and leads from the piano, setting his own tempos . . . His band is heard eight times a week over WMCA, but rumor has it that vaudeville will claim him again, and then a nation-wide network. His band plays real music and is worthy of a spot.

Mr. Henderson is married. . . . His wife is a former professional. . . . Also a musician; trumpet player, internationally known. . . . Played all over Europe, Canada and America with "The Musical Spillers." . . . A quiet, refined couple, with plenty of friends, in and out of the profession.

* * *

(If you care to know something about your favorite radio artists, drop a card to the conductor of this page, address her: Alice Remsen, care Radio World, 145 W. 45th St., New York, N. Y.)

BALLOONED UNIT SENDS REPORTS FOUR MILES UP

Washington.

Radio meteorographs are the newest devices for bringing down to earth information on atmospheric conditions high above the clouds. Several of these instruments have just been calibrated by the United States Weather Bureau and sent to Alaska for use in obtaining facts for the Second International Polar Year, which started August 1st.

A radio meteorograph consists of an automatic temperature and pressure recording device and a compact radio sending apparatus. It is attached to a balloon for release at any desired point.

Signals Transmitted

As the balloon rises the changes in barometric pressure and in temperature cause a metal finger to move across various contact points, thus transmitting radio signals. The observer on the ground below picks up these signals with a receiving set and, from calibrations of the instrument previously made, determines the corresponding temperatures and heights.

In thickly settled areas instruments that automatically record atmospheric changes on tracing paper are often sent up in balloons. Attached to a parachute and bearing a tag asking that they be returned to the nearest Weather Bureau station, they stand a good chance of being recovered.

In the uninhabited polar regions, however, they are not likely to be seen again. The radio meteorograph was, therefore, designed for use there.

Used Up to 4 Miles

Atmospheric records at all levels up to about 4 miles can be obtained by pilots in airplanes. To get records at higher levels, however, balloons are necessary. They go 10 miles or more up into the stratosphere before they burst.

Radio meteorographs are designed to promote that part of the polar year program which calls for a determination of the relationship between weather conditions in the polar regions and those in the lower latitudes. They will also help toward a better understanding of the general circulation of the atmosphere over the earth.

J. D. Rockefeller, Jr., Lauded for Radio City

"The people of the United States are better off than the people of any other country on earth," said M. H. Aylesworth, president of NBC, addressing two electrical associations in New York City. "We will recover from the depression; in fact, we are now on the way out, but I tell you there is nothing in existence as capable as the electrical industry to lead the world back to prosperity.

"Thank God for men like John D. Rockefeller, Jr., who in times of stress and want have the vision and courage to build things like Radio City. He believes this country is not ruined and that this industry is not ruined, so let us all announce to the world we have reached and passed the bottom of the depression and we will accomplish our objective all the sooner."

Patterson is Named NBC Vice-President

The appointment of Richard C. Patterson as executive vice-president of the National Broadcasting Company was announced by M. H. Aylesworth, president, Mr. Patterson resigned as Commissioner of Correction of New York City to accept the new post.

Mr. Aylesworth said:

"I have invited Commissioner Patterson to assume charge of the operation of the company.

"While I shall retain the active presidency my new duties as president of the Radio-Keith-Orpheum Corporation make it necessary for me to divide my time between the two organizations, and I have asked Vice-President McClelland of the National Broadcasting Company to become Assistant to the President of the National Broadcasting Company. Mr. McClelland has accepted his new responsibilities and will immediately assume his duties."

Mr. Patterson was appointed Commissioner of Correction of New York City, August 15th, 1927.

Mr. Patterson was administrative officer of the American Commission to Negotiate Peace at Paris in 1919. He is a Colonel of the Officers Reserve Corps, and has been president of the New York Military Intelligence Reserve Society.

NEW STATION SOON IN MEXICO

Washington.

XENT, Mexico, is about to take the air with 150,000 watts power, on 1,115 kc. It is a new station.

As the time approaches for the station to operate under Norman Baker, who operated KTMT, Muscatine, Iowa, before its removal from the air, broadcasters are hopeful that the impending chaos in the Southwest anticipated because of this high-powered station will be averted through an adjustment at the meeting of delegates at Madrid.

American broadcasters attending the international radio conference at Madrid are hopeful that the difficulties may be ironed out.

Agreement Sought

It is hoped that an agreement may be worked out so that stations in Mexico, Cuba and Canada will not interfere with American stations. The United States has no treaty agreement with Mexico to cover the interference expected from this new station which will operate on an unlimited schedule day and night.

The permit for construction was the largest ever issued by the Mexican Government. Built at a cost of $225,000, construction is nearly finished. The 300-foot steel towers will withstand 75,000 pounds pressure.

Between WPG and WRVA

The towers have been completed at a cost of $100,000. Its frequency of 1,115 kilocycles is in between WPG, Atlantic City, N. J., which operates on 1,100 kilocycles, and WRVA, Richmond, Va., on 1,100 kilocycles. It is believed that the broadcasts will interfere with both channels.

WICC JOINS COLUMBIA

WICC, Bridgeport, Conn., is the latest link to be added to the 90-station network of the Columbia Broadcasting System. The Bridgeport outlet, operating on a wavelength of 600 kilocycles, or 499.7 meters, was established in 1926. The station is licensed at 500 watts.

"WIRED RADIO" SEEKING NEW FOOTHOLD NOW

Washington.

Reports that "wired radio" will soon be introduced in America are becoming more persistent. The basic idea of the system was conceived by Major-General George O. Squier while he was chief of the United States Signal Corps, about the time that radio broadcasting was new. However, there has been little progress of the system as a service in this country for various reasons. Lack of capital of the sponsors, lack of interest on the part of the public in the face of space broadcasting, and patent and copyright difficulties, all have had an effect in preventing its commercial development.

In Europe the principle has been applied commercially with more success. About a year ago a British company started a service with an initial list of subscribers of 1,500, each paying 35 cents a week for service in addition to the regular government broadcast receiving fee of $2.50. In Ghent, Belgium, is a system having 3,000 subscribers, and in Switzerland one of 2,000 subscribers.

170,000 in Holland

The largest number of subscribers of "wire radio" is in Holland, with a list containing 170,000 names.

In Europe the public telephone lines are usually employed as the carriers and the systems are frequently tied in with the space broadcasting programs. That is, the "wire radio" stations pick up the broadcast programs and relay them over the wires to the subscribers.

In the United States it is proposed to use the power lines as carriers and the system will be worked in competition with space broadcasters. In order to provide adequate service it is necessary for the sponsoring company first to acquire patent rights for devices used and then to obtain dependable sources of broadcast material. It is reported that Wired Radio, Inc., a subsidiary of the North American Company, has been acquiring patents and copyrights during the past years.

Question of Cost

The claimed advantages for "wired radio" is that it will be free of static and man-made electrical noise, as well as the nuisance of advertising. The handicap, which space radio officials point out, is that most homes now are equipped with radio receivers with which they can receive programs without cost, so that it is not likely that many will pay from $2 to $5 monthly for the new service even if it is free of advertising.

Experiments with "wired radio" over power lines have been conducted quietly in Cleveland since 1929 and already considerable money has been expended in its development.

Inexpensive Set Analyzer

This device, using the Accessor and a meter switch besides, also including oscillator and a-c measurements, will be described next week, issue of October 22d.

SHORT-WAVE CLUB

Wilbert L. Clark, 833 West Greenfield Ave., Milwaukee, Wisc.

Radio Grows Despite Depression, Report Shows

Washington.

Moving steadily toward greater stability, radio is continuing its advancement throughout the world, according to information provided by the Department of Commerce.

Governments, schools, churches, commerce and industry are seeking to establish radio on a stabilized basis because the general public everywhere is interested and affected, it was pointed out.

During the past year several governments have proposed changes in regulatory methods, as attention throughout the world has been focused on the stabilization of broadcasting devices. Stations have continued to increase in number and in power where expansion has added to the service.

Although the field for important improvements is narrowing, invention and research have continued to prove their worth to radio, it was stated. Even atmospheric conditions and climatic limitations have been yielding to engineering; and the number of receiving sets in use is constantly growing.

Thoroughly Established

The following additional information was supplied, according to the "United States Daily":

That radio broadcasting has become a thoroughly established world institution with uniform methods and clearly defined problems is revealed in a study of world radio markets just issued by the Department. Theoretical opinions of earlier days have given way to accurate knowledge and the industry has consequently been placed on a more solid foundation.

Radical changes in financing methods have not ensued with the progress of radio, for it has been shown that both the advertising and license fee systems offer effective means of providing income. The controversy still goes on, however, over which is the better means of supporting radio.

The difficulties arising from any method may be avoided by an alternative, but not without the development of other difficulties of comparable weight. The receiving license fee in a few countries relieves the listener from advertising, but in its place substitutes restricted choice of programs. No method has been devoloped whereby national coverage with several programs can be supported by collectable license fees, even in the most densely populated nations.

Abuses in Advertising

On the contrary, there is sufficient deprecation of radio advertising to warrant the assumption that it is subject to abuses regardless of restrictions that may be placed upon it.

Attention should be given the coincidence by which those countries which have not put superficial restrictions on advertising have the most prosperous broadcasting systems and the greatest amount of money turnover in advertising. Program quality, in all analyses, can result only from a money turnover, regardless of aesthetic considerations of the primary purposes of those supervising the expenditures.

While there has been little of true novelty introduced in the past year, radio programs have made progress. Talent adapted to radio has been fairly well mobilized and microphone personalities developed along all lines appearing suitable for radio in any given country. International broadcasts have lost their novelty almost everywhere, and the unique in all present programs emphasizes technical radio less and the characteristics of talent and presentation more.

Specialized Programs

There is a developing tendency among stations and systems toward greater individual specialization in programs, but it is impossible to forecast how far this trend may progress. Unless it is halted for reasons not now apparent, its ultimate effect would be specialization on a limited number of program types.

The development of recording with improvement of quality and reduction of cost, has rendered valuable aid to the progress of broadcasting.

Radio has continued to grow in importance as a medium for advertising and most countries now have some advertising on the air, whether or not other means of support are provided for radio.

Chain broadcasting is enjoying growth in most foreign countries where stations are independently operated, but they are evolving slowly in many countries. The rate of growth is dependent upon the provision of interconnection facilities rather than upon any radio condition.

Export Competition

The broadcasting services of the world are rapidly becoming diversified and there are now four classes of stations which cater to the recreational tastes of the public. Sound broadcasting is done on three wave bands, and television stations are increasing in numbers, though they are limited by the small number of people interested in television reception.

Although radio has not suffered in the world markets to the same extent as other commodities as a result of the depression, American exporters in the past two years have had to face a steadily growing competition in many European countries which were formerly substantial markets. The status of radio in Europe is still complicated in so far as it affects United States apparatus, a fact which makes it essential for American exporters to be cognizant of the existing situation in individual markets.

The Commerce Department's bulletin on "Radio Markets of the World, 1932," prepared by Lawrence D. Batson of the electrical equipment division, covers each foreign country as a broadcasting area and as a market for receivers. It may be obtained for 10 cents per copy from the Superintendent of Documents, Washington, D. C.

STATIC PICKUP CUT BY USING A SHIELD LINE

One of the latest devices in radio is the eliminator of man-made static. It takes the nature of a radio-frequency transmission line. Such a line usually consists of two insulated concentric conductors. with definite characteristics. This is a method long established in telephone engineering and was originally developed by the Bell Telephone Laboratories. The two conductors have a definite capacity between them per unit of length, and also a definite inductance per unit of length. Resistance and shunt conductance are usually negligible.

A line of this type conducts radio waves over some distances without appreciable loss, provided that it is terminated properly. Proper terminations are brought about by a step-down transformer at the antenna and a step-up transformer at the receiver end. The outside of the two conductors is usually grounded.

Prevents Certain Strays

The idea of the shielding is to protect the inside wire from man-made static originating between the antenna and the receiver, where most of it does originate. The transmission line therefore carries the signal through the danger zone without any danger of picking up noise.

This device is not supposed to be in any sense a static-eliminator. It does not eliminate anything picked up by the antenna but it merely prevents the pick-up of any noise originating between the antenna and the set.

Two General Types

A transmission line of this nature is a low potential device and for that reason can carry signals over some distances without much loss. The step-down transformer is used at the antenna end because the impedance of the line is much less than that of the antenna, and a step-up transformer is used at the receiver to increase the voltage.

There are two general types of input to receivers, high impedance and low impedance. To adapt the device to one or the other it is only necessary to vary the number of turns on the secondary of the transformer at the receiver.

Construction Work Begun On Panama Radio Station

Washington

Work on the new transmitting and receiving stations near Panama City, the first step in the establishment of a radio telephone service between the United States and Panama, is now under way, according to a report to the Department of Commerce from Assistant Trade Commissioner A. Cyril Crilley, Panama City.

The transmitter and power house are to be located at Lindbergh Field and the receiving station is near Old Panama, about seven miles from Panama City, according to the report. It is expected that the new service will be in operation within the next few months.

Madrid Conference at Odds Over Votes

Madrid.

The International Radio Conference at the beginning of the sixth week had difficulty deciding any of the many questions before it, because the delegates cannot agree on how to apportion votes. Great Britain, France and Holland are demanding one vote each for their many colonies, while the United States and the other nations insist that there should be only one vote for each nation.

One hundred twenty-five nations are represented but the delegates cannot come to any decision on anything until the voting problem has been disposed of, and that seems to be insolvable.

Employes Organized As a Selling Unit

A sales plan which capitalizes on sales campaigns conducted by its employes during May and June has been announced by the Westinghouse Electric and Manufacturing Company.

The plan enlists the permanent co-operation of every Westinghouse employe in promoting sale of the household electrical products manufactured by the company. The employe finds and interests the prospective buyer. The actual sale is made by a regular dealer.

"Westinghouse, as well as other large companies, has learned the value of having every employe in its organization co-operate in promoting sales of the company's products," said H. C. Thomas. "Such an arrangement does not replace or in any way affect the regular system of distribution—that of sales through a dealer organization—but supplements it by enlisting an army of salesmen, each of whom have many contacts with the buying public."

During the two months the company's 35,000 employes referred the dealer organization to 68,260 prospective buyers, resulting in 58,045 sales aggregating nearly $3,000,000.

CAMPAIGN AIDS SALES

Dealers report increased business, starting with the World Series, and stimulated further as the campaign for the presidency grew hotter. This began early in the month when President Hoover took the stump and discussed, among other things, charges made against his administration by his opponent, Governor Roosevelt. The speeches were broadcast by chains.

Literature Wanted

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

W. T. Miller, Box 184, Cass, West Virginia.
W. G. Hughes, 1024 Dartmouth St., Chattanooga, Tenn.
R. Simmons, 5937 So. Spaulding Ave., Chicago, Ill.
Lester Bodwell, 90 Cherry St., Rahway, N. J.
Eugene D. Vernon, 1628 Washington, San Francisco, Calif.
Felix J. Adamson, 1129 East 77th St., Cleveland, Ohio.
Leon Sanderson, 506 N. 7th Ave., Hopewell, Virginia.
Ed Erb, 212 Fourth St., Elyria, Ohio.
Rosenberg Electric Co., (Radio Circuits), 471 William St., Buffalo, N. Y.
A. F. Baca, A. F. Baca Radio Service, Taos, New Mexico.
T. R. Morris, Radiotrician, c/o Jones Russell & Co., Colorado, Texas.
L. F. Glenn, Rt. 1, DeSoto, Kans.
Joe Malyseak, Radio Serviceman, 526 Brighton St., La Porte, Ind.
J. Cabito, 472 Edinburgh St., San Francisco, Calif.
Albert Sanders, 3306 McElderry St., Baltimore, Md.
J. Dean, 420 Mifflin Way, Wilkinsburg, Pa.
J. W. Thomas, 291 Jones St., Mt. Clemens, Mich.
Radio Engineering, F. A. Sweezey, 25 Cedar St., Sudbury, Ont., Canada.
Eugene Hisel, 401 S. Main St., Brookfield, Mo.
W. L. Patrick, Patrick's Radio Service, Box 1131, Laurel, Miss.
A. J. Slameka, 1135 Ry. Exch. Bldg., 80 E. Jackson Blvd., Chicago, Ill.

Subscribers! Important!

Note subscription expiration date on wrapper containing your copy of RADIO WORLD. If nearing expiration date, please send in renewal so that you will not miss any copies. Subscription Dept., RADIO WORLD, 145 W. 45th St., New York City.

Tradiograms

By J. Murray Barron

There is within about 50 miles of New York City practically 10 per cent. of the total population of the United States, or approximately 12,000,000 persons. That is indeed something to take into consideration when marketing radio merchandise, either receivers or parts, especially as the purchasing power is higher than that of any European country. All this gigantic territory has Parcels Post delivery, railroad and practically all motor truck delivery.

Here we find a region that possibly has been hit less by business conditions than the average and is in much better financial condition than the majority of districts in any part of the country. Within this territory there are eight cities of more than 100,000 population and more than seventy towns of greater than 10,000. There is no section of the country more in line for business or in better condition to buy. There is possibly less unemployment in proportion than in any given population elsewhere, and surely this vast territory can be reached more quickly and less expensively than any other territory of like population. Much of this population makes frequent trips to New York City and others have contact through neighbors. Anyone really interested in this live territory can easily get all the population figures in any public library and with a good map, using New York City as centre point, draw a 50-mile circle which would run approximately from Trenton, N. J. to near Bridgeport, Conn., passing through upper Orange County (N. Y.) and Suffolk County on Long Island, at about Sayville.

* * *

Lester D. Smith, engineer for the Weston Electrical Instrument Corporation of Newark, N. J., delivered a talk on test equipment before the Rochester, N. Y., Section of the Institute of Radio Servicemen at its regular meeting. Meetings are held the first Monday of each month and usually at the Seneca Hotel, Rochester, N. Y. Claude Drake, serviceman for Hickson Electric Supply Co., is secretary of the local group.

* * *

Radio Chassis, Inc., 110 West 18th Street, New York City, announces the conclusion of arrangements with Frank Squire to be chief engineer for the company. Mr. Squire has been associated with such organizations as A. H. Grebe Co., De Forest, The Kolster Radio Co. and Fada Co.

* * *

James R. Fouch, president of the Universal Microphone Co., Ltd., Inglewood, Cal., announces, that hereafter complete factory stocks will be carried at various branches throughout the country. This move is to offset delay in getting radio merchandise from the Pacific Coast.

* * *

The merging of the Davega and City Radio stores gives the new company a new name, Davega-City Radio. There are thirty-eight stores.

* * *

P. C. Ripley, recently appointed general sales manager of the Kester Solder Company, Chicago, Ill., has been associated with the company for a number of years and is a recognized authority on solder.

* * *

Harvey's Radio Shop, in West Forty-third Street, New York City, reports increased interest in photo cells, especially for the performance of tasks about the house, such as opening doors. Harvey Sampson, proprietor, advises dealers to display photo cells and diagrams of uses.

100,000 Service Men; 20,000 "Would Suffice"

Chicago.

The merchandising of radio tubes was the main feature at a meeting held jointly by the RCA-Radiotron Company Inc., and the Chicago Section of the Institute of Radio Service Men at the Hotel Sherman in Chicago. More than 700 service men and dealers attended.

Preliminary talks were given by E. W. Butler, commercial engineer for RCA-Radiotron Company, and Harold L. Oleson, sales engineer for Weston Electrical Instrument Corporation, on the technical aspects of new tubes and test apparatus for merchandising not only the new tubes but those in sets of past seasons.

T. F. Joyce, sales promotion manager of the RCA-Radiotron Company, spoke for more than an hour. He outlined the important position which the service profession holds in the industry and in the tube merchandising programs, because of the direct contact with the users of radio devices.

The necessity for developing the radio service profession was emphasized and especial stress was laid upon the importance of reducing the number of men engaged in radio servicing. It is significant that Mr. Joyce should lay emphasis upon one of the principal points in the program of the Institute of Radio Service Men, and that he should show graphically that there is no place in the radio business for the 100,000 or more persons who now classify themselves as radio service men. Whereas the Institute has contended that not more than 30,000 men are required to satisfy the need, the speaker placed the number at 20,000 for the entire United States.

HILL GAINS FOLLOWING

A large following is being gained by Edwin C. Hill, news reporter, heard over the Columbia System. Hill's style is unlike any other on the air.

New Incorporations

Whitaker-Upp Co., Wilmington, Del., radios, sound producing machines, refrigerators—Attys., Corporation Trust Co., Dover, Del.

Dawson's, Inc., Trenton, N. J., radios—Attys., Backes & Backes, Trenton, N. J.

Majestic Artist Bureau, New York City, broadcasting programs—Attys., MacNeil & Mitchell, 36 West 44th St., New York City.

Associated Battery Co., Inc., Wilmington, Del., Attys., Corp. Fiscal Co., Dover, Del.

Cobina Wright's Orchestras, New York City—Attys., A. F. de Kreiges, 49 Wall Street, New York City.

Ferris Instrument Corp., Boonton, N. J., electrical instruments—Atty., Malcolm J. Ferris, Boonton, N. J.

Approved Products Corp., New York City, electrical appliances—Atty., B. Kantor, 130 West 42nd St., New York City.

Hush Publications of Delaware, Inc., Bronx, N. Y., operate telegraph, cable, telephone, teletype, radio, wireless—Attys., Corporation Trust Co., Dover, Del.

Hexacon Electric Appliance Corp., Roselle Park, N. J.—Atty., Walter H. Flaherty, Elizabeth, N. J.

CORPORATE CHANGES

Capital Increases

Radio Exchange, Manhattan, New York City, 6,000 shares to $500,000.

Precision Instrument Co., Inc., Washington, D. C., $100,000 to $200,000.

Name Change

Consolidated Orchestras Booking Exchange, New York City, to Radio Theater.

BANKRUPTCY

Petition Field Against

B. P. N. Auto and Radio Supply Stores, Inc., auto supplies, radio and sporting goods dealers, 108 Canal Street, Stapleton, S. I., N. Y., and 243 Richmond Ave., Port Richmond, Staten Island, N. Y., by Wilson Western Sporting Goods Co., Inc., for $217; Peerless Sporting Goods Co., $119; Charles Weiland, Inc., $103, and Westwood Sales Co., $120.

FISCAL REPORT

World Radio Corporation—Year ended July 31: Net income, $5,979, or $2.74 a share on preferred stock and 22 cents a share on common, compared with $54,529, or $25.01 a share on preferred and $1.35 a share on common in preceding year.

BLUEPRINTS OF STAR CIRCUITS

8-TUBE AUTO SET

Sensitivity of 10 microvolts per meter characterizes the 8-tube auto receiver designed by J. E. Anderson, technical editor of Radio World, and therefore stations come in with only six feet of wire for aerial, and without ground. Most cars will afford greater aerial pickup, and besides the car chassis will be used as ground, so with this receiver you will get *results*. The blueprint for construction of this set covers all details, including directions for cars with negative A or positive A grounded. The circuit features are: (1) high sensitivity; (2), tunes through powerful locals and gets DX stations, 10 kc either side; (3), latest tubes, two 239 pentode r-f, two 236 screen grid, two 237 and two 238; push-pull pentodes, all of 6-volt automotive series; (4), remote tuning and volume control on steering post, plus automatic volume control due to low screen voltage on first detector; (5), running board aerial. The best car set we've published. This circuit was selected as the most highly prized after tests made on several and is an outstanding design by a recognized authority. Send for Blueprint 631, @ 50c

SHORT-WAVE CONVERTER

If you want to build a short-wave converter that costs only a very few dollars, yet gives good results, furnishing all its own power from 110 volts a-c, and uses no plug-in coils, you can do so from Blueprint 630. Price.........25c

5-TUBE AC, T-R-F

Five-tube a-c receivers, using variable mu r-f, power detector, pentode output and 280 rectifier, are not all alike by any means. Forty circuits were carefully tested and one selected as far superior to the others. This prized circuit was the 627, and if you built it, you will always be glad you followed our authentic Blueprint, No. 627. This is the best 5-tube a-c t-r-f broadcast circuit we have ever published. Price 25c

A-C ALL-WAVE SET

An all-wave set is admittedly what many persons want, and we have a circuit that gives excellent broadcast results, and is pretty good (not great) on short waves. No plug-in coils used. Cost of parts is low. Send for Blueprint, No. 628-B, @..........25c.

In preparation, an 8-tube broadcast superheterodyne for 110v d-c. Write for particulars.

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FULL SCALE PICTURE DIAGRAM OF 4-TUBE DIAMOND

This full scale diagram, together with an accompanying article on wiring, adjusting and operating the Four-Tube Diamond, appeared in Radio World dated Sept. 17. Sent for 15c a copy. First and Second installments of article on the 4-Tube Diamond appeared in issues of RADIO WORLD, dated Sept. 3 and 10. The three copies sent for 45c. Or send $1.50 for a three months' subscription and receive these three numbers free.

Also full scale picture diagram of the 5-tube Diamond. This appeared in Radio World of Oct. 8, 15c a copy. Other issues containing information about the 5-tube Diamond are dated Sept. 24 and Oct. 1. These 3 copies, including full scale picture diagrams, mailed on receipt of 45c, or sent free with a $1.50 subscription for three months.

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THE FORD MODEL—"A" Car and Model "AA" Truck—Construction, Operation and Repair—Revised New Edition. Ford Car authority. Victor W. Page. 708 pages, 318 illustrations. Price $2.50. Radio World, 145 W. 45th St., New York.

"THE CHEVROLET SIX CAR AND TRUCK" (Construction—Operation—Repair) by Victor W. Pagé, author of "Modern Gasoline Automobile," "Ford Model A Car and AA Truck," etc., etc. 450 pages, price $2.00. Radio World, 145 W. 45th St., N. Y. City.

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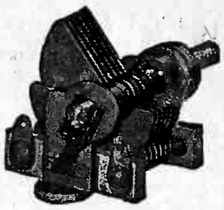

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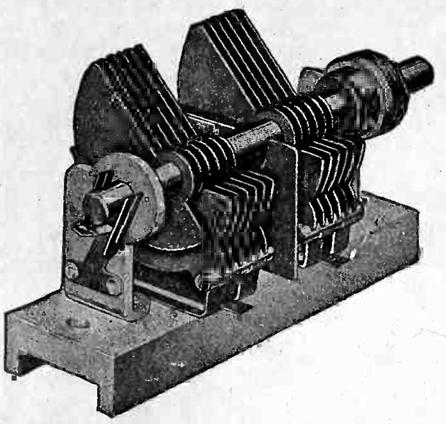

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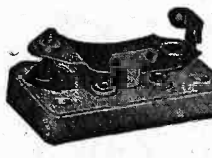

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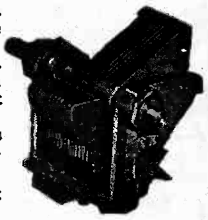

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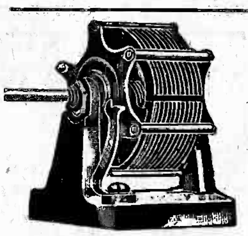

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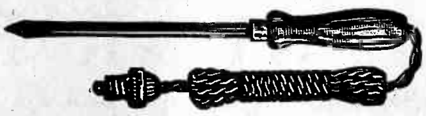

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