

Sept. 24
1932

ANALYSIS OF DETECTION

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RADIO

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WORLD

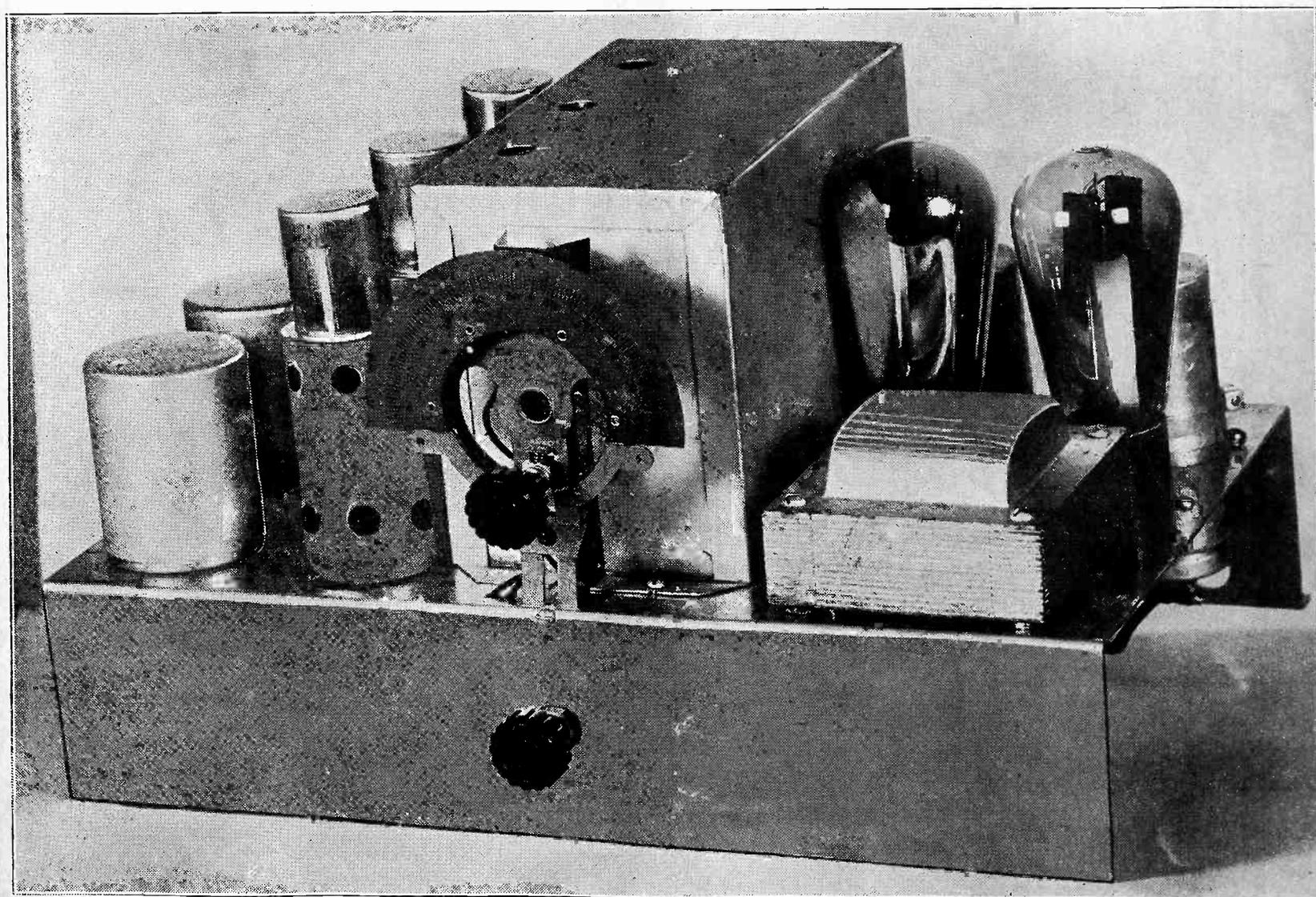
The First and Only National Radio Weekly
Eleventh Year—548th Issue

Voltage, Current,
Resistance Meter

Very Inexpensive
Harmonic Oscillator

Two Wave Traps

5-TUBE A-C DIAMOND



(The Five-Tube 1933 Diamond for A-C Operation. See page 6.)

FOUNDATION UNIT

for 1933 A-C 4-Tube Diamond

Drilled metal plated subpanel.....	\$.85
Two-gang 0.00035 mfd. SFL condenser, brass plates, 2 1/2" long shaft.....	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.....	.19
Cat. DFU at.....	\$5.48

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

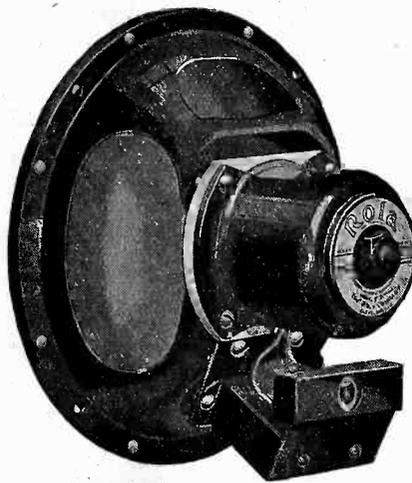
Parts for the 1933 DIAMOND



ONE of the outstanding circuits, the 4-tube 1933 Diamond for a-c operation, 105-120 volts, 50-60 cycles can be constructed most economically. The circuit uses a 58 r.f. amplifier, with special antenna treatment boosting the gain mightily; a 57 power detector, a '47 output tube and an '80 rectifier. You never in your life heard such performance on four tubes!

Herman Bernard, designer of the circuit, used Polymet 8 mfd. wet electrolytic condensers, one with two insulating washers and special lug. These are our Cat. POLY-8, with washers and lug, at only 49c each.

Also, Rola full dynamic (Series F) with 2500-ohm field coil.



Cat. RO-25, Rola full dynamic speaker, with output transformer of '47 matched impedance built in, also 2500-ohm field coil built in (black leads) 8" diameter cone. Series F.\$3.83

Cat. POLY-8, one 8 mfd., wet electrolytic condenser, inverted mounting, with two insulating washers and one special lug, 49c.

TWO-GANG SHIELDED 0.00035 MFD. SFL, \$1.39

De Jur Amsco shielded straight frequency line dual condenser, 0.00035 mfd., brass plates, 1/4" shaft, 2 1/2" long as complete safeguard against body capacity. Cat. DJ-AS	\$1.39
Cat. EQ-100, 20-100 mmfd. Hammarlund equalizer.....	.19
200-turn center-tapped r.f. honeycomb choke coil. Cat. DCH @40
250,000 ohm potentiometer with switch (Cat. P-250-SW).....	.47
100-0 travelling light dial, escutcheon, bulb (Cat. CRD).....	.91

COILS FOR 1933 DIAMOND

Shielded impedance coil for antenna coupler, and shielded interstage transformer (Cat. DP-33), both coils for..... .90

DIRECT RADIO CO.

143 WEST 45th STREET

NEW YORK, N. Y.

PADDING CONDENSERS

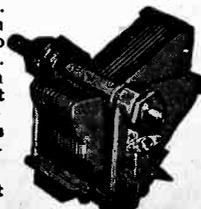


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0.0005 HAMMARLUND S. F. L. at 98c.

A sturdy, precision straight frequency line condenser, with end stops. The removable shaft protrudes front and rear and permits ganging with coupling device, also use of clockwise or anti-clockwise dials, or two either side of drum dial. Front panel and chassis-top mounting facilities. True straight line. This rugged condenser has Hammarlund's high quality workmanship and is suitable for precision work. It is a most excellent condenser for calibrated radio frequency test oscillators, any frequency region, 100 to 60,000 kc., short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction, rigidity; Hammarlund's perfection throughout.

Order Cat. HO5 @98c net



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SPEAKER REPLACEMENT HEADQUARTERS!

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Service men can make the cone and voice coil replacements but any who desire that the installation and adjustment be made for them on precision jigs, in the same manner as in the speaker factories, may send their speakers to us for repair. There is a 25c extra charge for this labor.

The name of the speaker is listed under the caption, "Speaker," the outside diameter in inches of the frame that holds the cone is given under the initials "O.D.," and the price of cone-voice coil combination unit is given next.

Speaker	O.D.	Price	Speaker	O.D.	Price
Atwater Kent	11	\$2.75	Peerless		
Bosch	11	2.75	copper coil	10 3/4	1.95
Bosch	10	1.90	copper coil	12	2.10
Brunswick D.	9 3/4	2.25	copper coil	14 1/2	2.85
Brunswick B.	14 1/2	2.75	Peerless wire-		
Brunswick E.	14 1/2	2.75	wound coil	8 1/2	2.85
Colonial	33	2.25	wound coil	10 3/4	1.65
Decatur	9 1/2	1.90	wound coil	14 1/2	2.75
Eveready	12 1/4	2.25	Philco 65-90..	11	1.50
Eveready	10	1.90	Philco 20		1.50
Earl Inductor	10	.95	RCA 106.....	10 1/4	2.00
Farrand	7	2.25	RCA 105.....	8	2.00
Farrand			RCA 104.....	8	2.00
Inductor	11	1.35	Symington	10	1.90
First Nat'l	10	1.90	Symington	12 1/4	2.25
Freed-Eismann			Sterling	9	2.25
NR 80-87...	10	2.75	Stromberg-		
Majestic G1..	9	1.80	Carlson	12 1/2	2.75
Majestic G2..	9	1.80	Carlson	9	2.25
Majestic G3..	11	1.80	Sparton 737..	9	2.25
Majestic G5..	14	2.75	Steinite	10	1.90
Jensen			Temple	9	2.75
D9, D15	8 1/2	1.50	Temple	11	2.75
D4	9 1/2	2.25	Temple		
D7 Concert.	11 1/4	2.25	Auditorium	14	3.75
Auditorium	13	4.50	Utah	9	1.90
Magnavox	9	2.25	Utah Stadium	12	2.75
Newcomb-			Victor		
Hawley	9	2.25	RE32-45	9	1.35
Oxford	9	1.95	Wright-		
Oxford	8 3/4	2.25	De Costa	10	2.25
Peerless			De Costa	12	2.75
copper coil	8 1/2	1.60	Zenith 52.....	12 1/4	2.25

MAGNETIC SPEAKERS

Ready to Play, but Not Including Cabinet or Baffle
 Farrand 9" O.D., burtex cone.....\$1.50
 Timmons (as used in Philco sets) 9" O.D., burtex cone.....\$1.80
 Auto speaker, 9" O.D., burtex cone.....\$1.50

The magnetic speakers are new speakers, and the prices are for the speakers, not for replacements on such speakers.

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145 WEST 45th ST., NEW YORK, N. Y.

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

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HERMAN BERNARD
Managing Editor

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Vol. XXII

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A Voltage, Current, Resistance SWITCH TYPE METER

A-C Supply of E. M. F. for Resistance Measurements

By Edgar Forbes

IN radio service work and experimenting, what test is made more often than any other test? What test is the next in order of frequency? And so on.

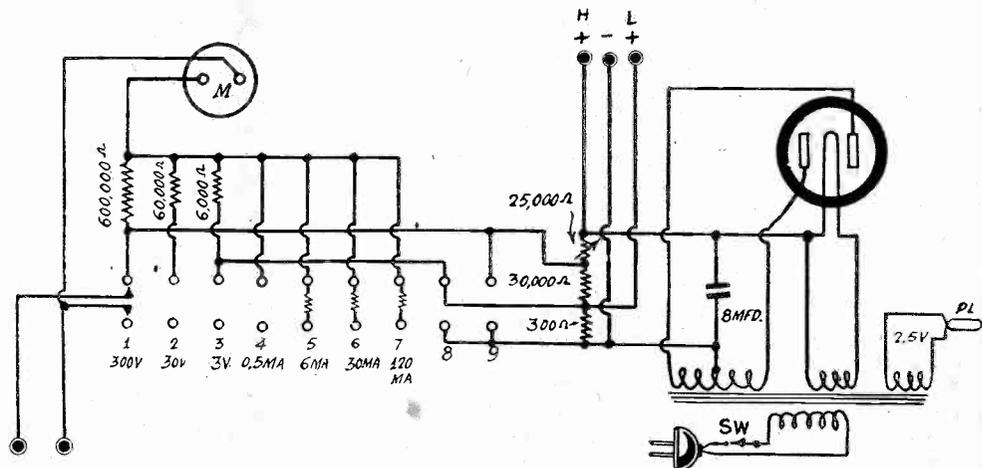
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The switch panel and B supply. The readings are designated, except that (8) is for 100 to 100,000 ohms, (9) for 21,000 to 5,000,000 ohms. If possible use 27,000 ohms instead of 30,000.

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(Continued on next page)

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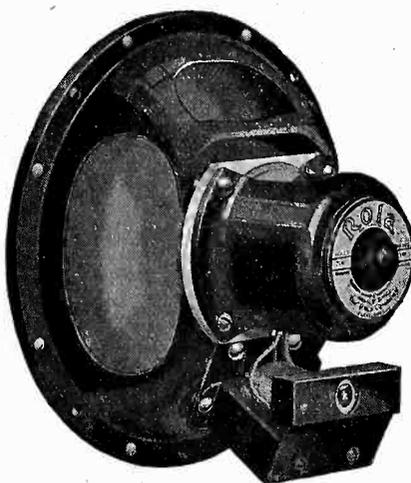


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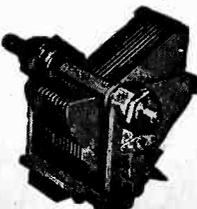
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Majestic G3.. 11	1.80		Carlson 9	2.25	
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Jensen			Steinite 10	1.90	
D9, D15 ... 8½	1.50		Temple 9	2.75	
D4 9½	2.25		Temple 11	2.75	
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Magnavox .. 9	2.25		Utah Stadium 12	2.75	
Newcomb-			Victor		
Hawley 9	2.25		RE32-45 ... 9	1.35	
Oxford 9	1.95		Wright-		
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Peerless			De Costa .. 12	2.75	
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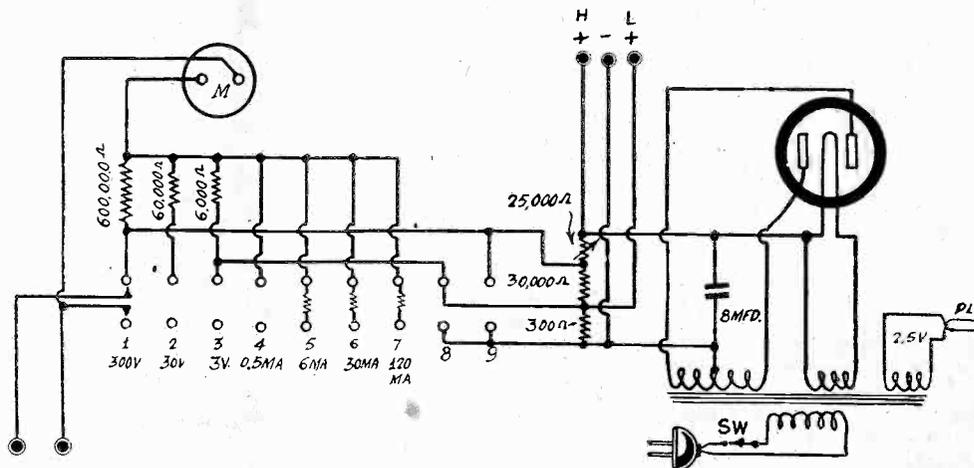
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(Continued on next page)

(Continued from preceding page)

Another thing, we may not even desire to rely on batteries. If we have batteries, for use in our resistance measurements, certainly the battery resistance will change with use and age, therefore we can not well use the same voltage multipliers for resistance work, unless we put across them high resistance rheostats, which must be switched off when voltage and not resistance is to be determined, and also when the battery resistance is practically zero and resistance is to be read.

We can build a B supply into our device for little more than the batteries would cost if we went up to only 90 volts, whereas with the B supply we can have a high voltage, say, 300 volts, and thus measure very high resistance values.

The discussion of the meter requirement is in line with the choice of a meter of 1 ma sensitivity, or better. At 1 ma sensitivity the rating of the voltmeter will be 1,000 ohms per volt. At 0.5 ma sensitivity it will be 2,000 ohms per volt. But the designation of sensitivity by ohms per volt is not an excellent one, although practically standard, for the rating applies to full-scale deflection.

Three Voltages, Four Currents

At full-scale the current of a meter is always maximum, so for a 0-1 ma it is 1 ma, whereas integral voltages actually will be at a higher ohmage per volt. If the scale is 100 volts, then a reading of 10 volts is at 10,000 ohms per volt. However the two ratings are similar in that the stated value is the lowest one, in ohms per volt, and the highest one in current.

So let us consider a voltage-current-resistance meter that affords three voltage scales, four current scales, and two resistance scales. No matter what meter is used, the switching device will be the same, so will the B supply in general, therefore let's consider those first.

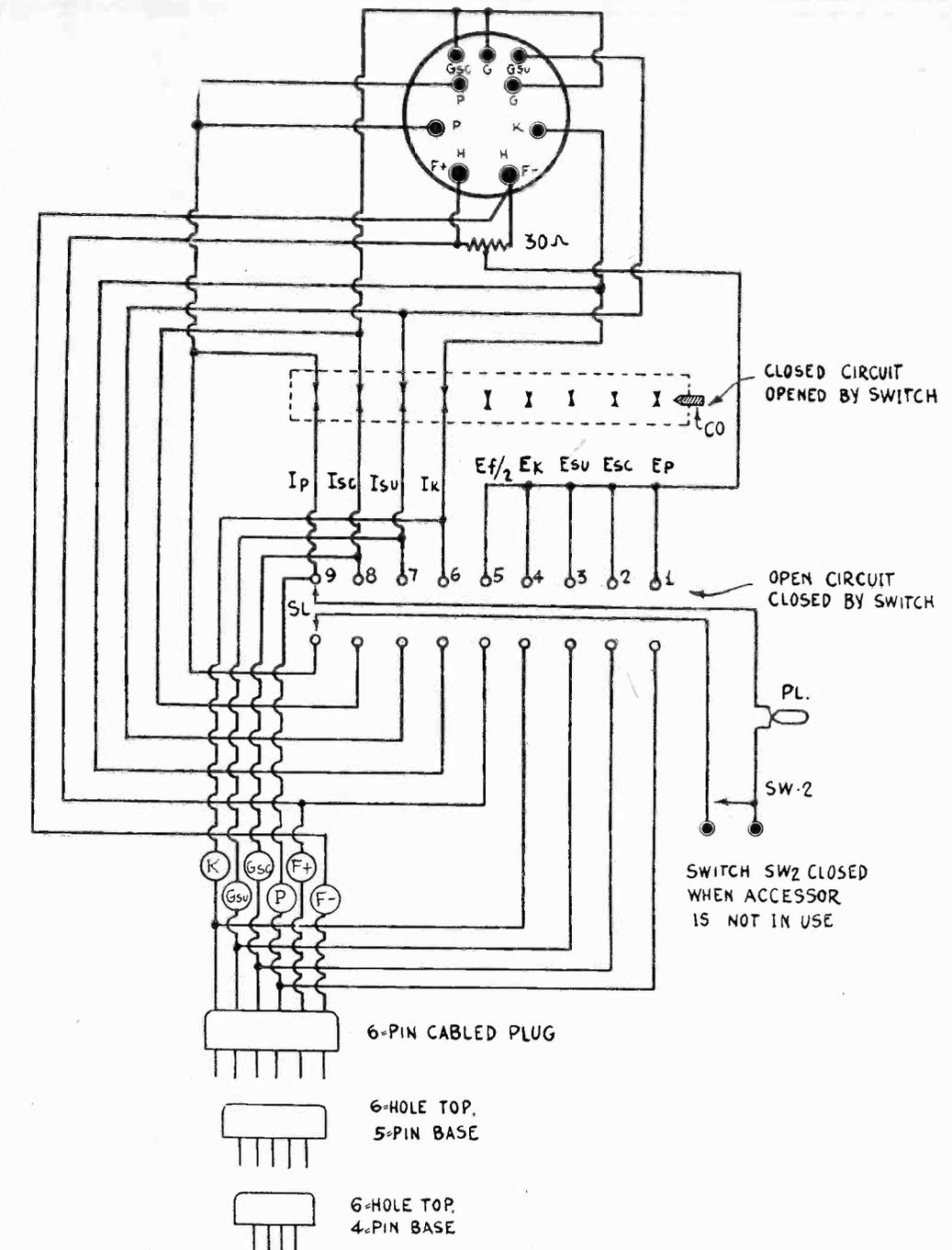
The problem connected with the switch is to render the desired results in the simplest possible manner, that is, fewest switch connections. A double-pole nine-throw switch will do it. At first it seemed that it would not, but a little study of the problem disclosed the way out. That way was to connect one side of the meter permanently to one of the output posts of the device. For all current and voltage readings a common terminal like this applies. And so far as it does apply no other connection is necessary on the switch points otherwise picked up, for this side of the meter. But when resistance is to be measured this side of the meter must pick up one side of the B supply. Let it be the minus side. Two lugs on the switch are used for this.

The other side of the switch picks up respectively the voltage multiplier resistors, a simple matter, as they are in series with the meter. But the current shunts must be in parallel with the meter. Well, we have one side of the meter accessible, and the slider that connects thereto can contact with lugs that pick up one side of a shunt resistor. And the other slider can pick up the other side of the meter and the other side of the shunt. That solves the problem.

B Supply Values

The B supply is very simple. A power transformer is necessary. It is very inexpensive these days—around \$1.25. Two fixed resistors may be used for establishing around 10 ma bleeder, and for apportioning the voltages roughly. Thus values of 30,000 (or preferably 27,000) and 300 ohms may be selected for the 0.5 meter. If a high-resistance potentiometer is put in circuit then fine adjustment of voltage is possible.

The condenser next to the rectifier is put there to hold up the voltage, and to some extent the maximum voltage may be adjusted by selection of the capacity that yields the desired result. The d-c output of the power transformer at 10 ma may be more than 300 volts. If we desire to use smaller



KEY TO ACCESSOR DIAGRAM

K, cathode; Gsu, suppressor grid; Gsc, screen grid; P, plate; F+, positive filament; F-, negative filament; H and H, heater; Ip, plate current (9); Isc, screen current (8); Isu, suppressor current, (7); Ik, cathode current (6); Ef/2, one-half filament voltage (5); Ek, cathode voltage (4); Esu, suppressor voltage (3); Esc, screen voltage (2); Ep, plate voltage (1).

One switch is used for all current and voltage readings. The other switch, SW2, is merely protective.

CO, circuit opener. This insulated device

pries apart the sprung lugs otherwise in closed circuit. SL, slider. This conductive device closes a circuit when CO opens it. Hence in the four current examples (9, 8, 7 and 6) the closer (SL) is in parallel with the opener (CO) to cut the meter in.

The designations are mainly for 57 and 58 tubes. See chart in Sept. 3 issue on all standard tubes at applicable numerical positions. PL is a 6-volt pilot lamp. If it lights on voltage readings or current readings under 25 ma. look for trouble. The Trade Editor will supply parts information.

values of bleeder resistors, of higher wattage rating, we can reduce the voltage that way, or we may use a series resistor between the connection to rectifier filament and the B positive feed to the external circuit, or we may reduce the value of the condenser. Indeed, we might even omit the condenser, as there is no particular need for filtration. However, it is suggested that if a condenser be used it be 1 mfd. or less for the 0.5 meter, and if less, especial pains should be taken to insure that it is of the high voltage type because most condensers of smaller capacity than 1 mfd. are for lower than 350 volts d-c continuous duty rating, and some 1 mfd. are also. If one has a dry electrolytic condenser of 8 mfd., that may be used, the suggestion being made because they stand

up to 500 volts, in some instances, and costs less than a 1 mfd. 400-volt paper condenser.

Reason for Bleeder

Some bleeder is advisable not only to hold the voltage in check but to give the B supply almost perfect regulation, since the drain will not be changed by more than 1 ma.

The meter at hand happened to be one of the 0-0.5 ma type, a galvanometer, in fact (Weston, series 175), the scale divisions being 30 on either side of the central zero line. The advantage of the galvanometer type of instrument is that there is never any necessity for reversing the meter connections (at the output binding posts) or reversing the lead connections from the meter at the measured points because of

reverse readings. The disadvantage is that the scale is halved, or that you get twice the legibility with the ordinary type of construction.

It is not the intention to stress the selection of any particular meter, except to recommend that it be at least as sensitive as 1 ma, for the unit in the diagram is another of the series devoted to testing outfits for those who already have the meter. Normally a 0-1 ma will have 20 scale divisions, or 50 microamperes per division. Also, straight 0-0.5 ma meters would have the same number of divisions, that is, 25 microamperes per division, whereas the 0-0.5 galvanometer has 16.67 microamperes per division (30 divisions full-scale). The separation per division is smaller on the galvanometer.

Values of Multipliers and Shunts

Assuming the use of a 0-0.5 instrument, the multiplier resistors, on the basis of 2,000 ohm per volt, would be 600,000 for 300 volts, 60,000 for 30 volts and 6,000 for 3 volts. That gives a good distribution of the voltage readings, the advance being by tens. Current readings should be on a smaller advance, say, approximately by fives, so these readings are 1 ma, no shunt; 6 ma, 2.726 ohms shunt; 30 ma, 0.508 ohms shunt, and 120 ma, 0.1255 ohms shunt. The shunt values are on the basis of 30-ohm meter internal resistance.

The selection of both multipliers and shunts is such as to render the readings in currents and voltages coincident to the scale. Thus for the highest voltage scale the readings are 10 volts per division (30 reads 300 volts); for the next voltage scale, 1 volt per division (30 reads 30 volts); for the next voltage scale, 0.1 volt per division (30 reads 3 volts). Then, as to current, the readings are 16.67 mca per division (30 reads 1 ma); 200 ma per division (30 reads 6 ma); 1 ma per division (30 reads 30 ma) and 4 milliampere ma per division (30 reads 120 ma).

Then as to the resistance ranges, 3 volts obtained from the B supply, using also the 6,000-ohm multiplier, will enable resistance readings from 100 to 100,000 ohms. The lower resistance values are hard to read, but it can be done. The accuracy may not be very good, as there will have to be some interpolating or estimating. However, 100,000 ohms does not strictly represent the other limit, even though the readings are crowded here, too. At the reading 1, for instance, the resistance is 174,000 ohms. Resistance values in round numbers nearly always fall on uneven current readings, which applies generally to resistance meters.

The Resistance Jump

For voltages we advanced in steps of tens, for currents approximately in steps of fives, but for resistance reading we shall advance in a step of 50, rated on maximum readings of 100,000 and 5,000,000 ohms. The reason is that we have provided in the first instance extreme readings of 100 to 100,000 ohms and don't want our next step to overlap the other too much. It seems to overlap it considerably, but this is merely theoretical. When one considers that the second starting value is 21,000 ohms, and that the readings are crowded, at either end, we must decide to begin the new scale so that highly legible readings, not merely minimum readings, will be afforded somewhere near where the other left off. Thus we decide on 21,000 to 5,000,000 ohms.

Now, it is a distinct advance to have a resistance meter that will measure high resistance values. More and more high resistors are used in circuits. Ranges of 5,000 and 50,000 ohms serve their purpose, but leave us unequipped to make many desired measurements. It is true that the 5,000-ohm scale will permit better readings of low resistance values, of the order of hundreds of ohms, but it stops at 5,000 ohms, whereas the other stops at 50,000 ohms, and both leave us unable to measure more than 50,000 ohms, although one-third of the resistors

in sets have a higher value than 50,000 ohms, and unless we had the facilities the present device affords we could not test a receiver unless it were in operation. The present method permits of such test without receiver operating, as well as a test in operation if you provide access to the currents, and voltages, which may be done by using an accessor, as will be described.

Voltage Stability

The only subject that may be regarded as doubtful is the resistance measurement's dependence on the voltage of an a-c supply.

I feel there has been a lot of misapprehension on the subject. I have been using an a-c supply for years and have no fault to find with it, although I have checked it hundreds of times against a battery-operated device, with the same meter used.

It is a fact that battery resistance changes, hence voltage differences at the terminals exist when current flows, and to take up this slack voltage a series rheostat is used in conjunction with a limiting resistor less than what would be selected otherwise, or in conjunction with a high resistance rheostat in parallel with a limiting resistor that may be used also as voltage multiplier. But because of these very differences every one who uses a resistance meter, even with batteries, checks the battery voltage at full-scale deflection before taking a reading. Indeed, that is the test made so that compensation can be introduced.

Voltage Accuracy

Now, it is no more arduous to check the voltage from the B supply before making the test. Line voltage may change from time to time, but this change is gradual, and it is far-fetched to assume that any change that is expressible in apparent change of resistance reading will take place between the time of the voltage test and the time of the resistance measurement. Especially in the case of the 3-volt e.m.f. the difference, if any, could not be discerned on the meter, for lack of sufficient sensitivity, since the change is proportional (about 3 per cent.) On the 300-volt side there might be quite a change, but not between the time of the voltage check-up and the resistance measurement, assuming the second follows the first with the usual rapidity. There is no occasion to mangle.

Also, with battery operation it is just possible that the battery resistance also may change with current, whereas the voltage of the B supply will not change with current to any degree readable on the meter in terms of resistance. That is, anywhere from 10 to 10.5 or 11 ma the voltage reading will be the same. No fear need be held, therefore, because of the use of an a-c supply, as the voltage between tests is more constant than the meter is sensitive, to express the situation generally.

The schematic diagram states the values of resistance multipliers and shunts for 0-0.5 ma, but more persons will have a 0-1 ma, so the values are given herewith, with different voltage and current maxima, to facilitate scale readings, since units of tens are assumed, the shunts on the basis

of 27 ohms meter internal resistance:

Voltage Multipliers	Current Multipliers
500 v 500,000 ohms	100 ma 0.2727 ohms
50 v 50,000 ohms	25 ma 1.125 ohms
5 v 5,000 ohms	5 ma 6.75 ohms
	1 ma 0 ohm

Compensation for 0-1 Ma

Since we have other voltages to contend with we shall have to make some changes in constants in the B supply. For to the low value resistance in the bleeder circuit use 500 ohms. The other bleeder resistor should be 39,500 ohms, both bleeders 10 watts. The condenser should be 8 mfd., to make the voltage as high as obtainable, which may be around 425 or 450 volts. With some transformers, because intended for 60 ma, whereas only 10 ma are drawn, the full 500 volts may be obtained.

For the 0.5 ma instrument the resistance scale is given in both instances to coincide with the voltage maxima, for the 1 ma instrument the resistance scale is given coincidentally for 5 volts, but as it is not known whether 500 volts will be reached for the 1 ma instrument, but fairly certain 400 volts will be, so the resistance scale is drawn for 400 volts. The two scales, low and high resistance ranges, may be engraved on the panel of the instrument, or printed scales glued behind glass windows.

The voltages to be checked, previously mentioned several times, of course are checked with the very meter used with the tester. If you have more than merely the meter, that is, multipliers are built in, binding posts for connection of the meter outlets to switch lugs may be put on the panel.

If desired, the voltage points may be brought out to binding posts, consisting of minus (-), high-voltage (H), low voltage (L). Then the B supply may be used in conjunction with many tests requiring independent voltage, such as determination of tube characteristics, with some limitations, of course, because of the a-c component.

Accessor Outlined

To use the present device for testing a receiver in operation, without having to remove chassis from cabinet or do more than plug in, the Accessor may be used. In the July 30th, 1932, issue an Accessor using two switches was described. In the September 3d, 1932, issue an Accessor that rendered the same service was discussed, using only one switch. There was a mistake in the diagram published in the September 3d issue, so the correct one is printed herewith.

The Accessor permits the reading of currents and voltages in a receiver, by rendering the necessary points accessible to a meter or to meters you have, by plugging in and switching. A six-pin plug with cable is connected to a universal tube socket, one that takes UX, UY and six-pin base tubes, so that on the Accessor panel no adapters are necessary for the general run of tubes, although for access to the set, UX and UY base plugs are needed, both with six-hole tops, so that you can get access whether one or another type tube or socket is encountered. For UV-199, WD-11, WD-12 and other special tubes, including the new seven-pin power tube made by some independent manufacturers, special adapters would be needed for use on the Accessor panel as well as another set of adapters for use at the receiver.

On the diagram the readings obtainable with 57 and 58 tubes are given as an illustration. Different type tubes will afford either different readings at the nine different positions, or, mostly, at only some of the different positions, the others giving no readings because no tube element is in circuit then, or duplicated reading. The list of readings obtainable with all the standard receiver tubes was published in the September 3rd issue, and while the list seems imposing, it will be found easily enough committed to memory, once you really know the tube you are testing. With the list at hand, however, you need commit nothing to memory.

(Scales will be printed next week.)

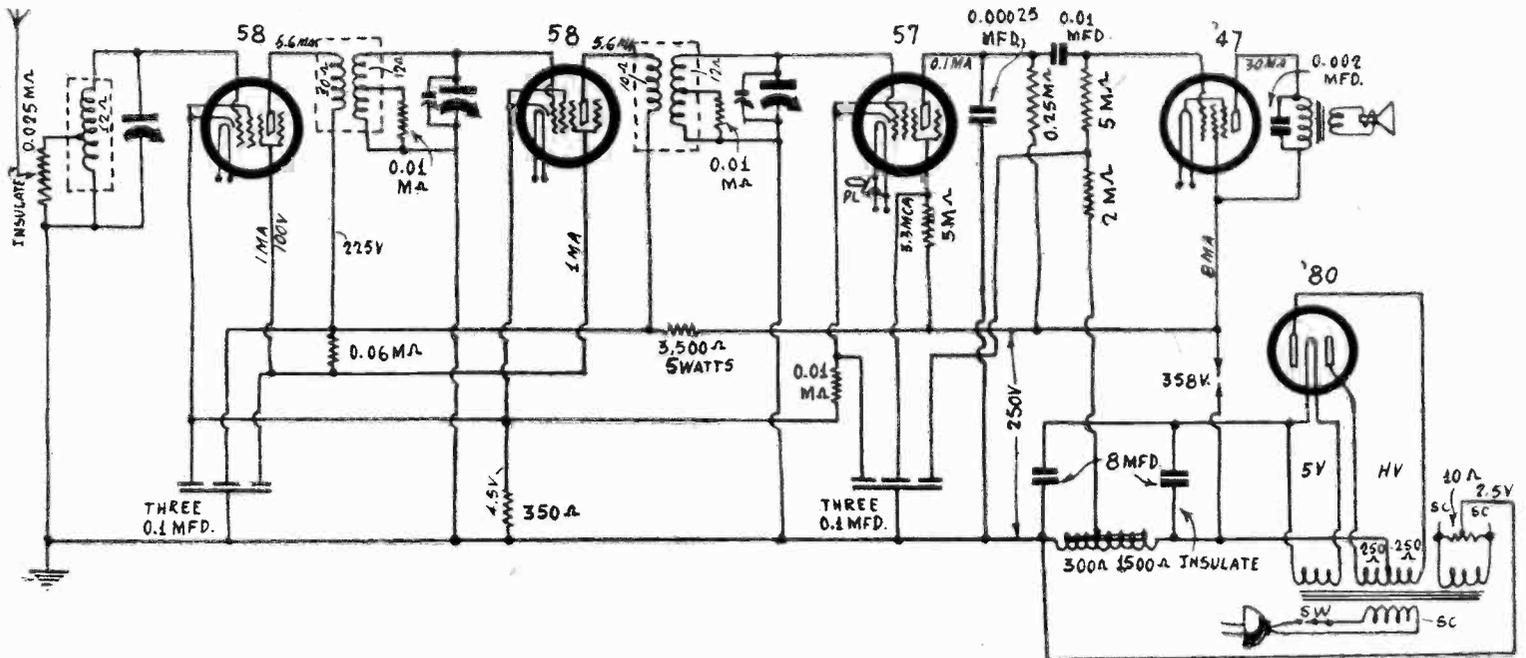
RESISTANCE SCALE 0-1 MA E=400 V. IL=400,000 V. SCALE=0-20

Scale Divisions	Megohms Resistance	Scale Divisions	Megohms Resistance
0	00	8	0.6
1	7.6	8.9	0.5
1.3	5.0	9	0.489
2	3.6	10	0.4
3	2.27	11	0.327
3.5	2.00	11.5	0.3
4	1.6	12	0.266
4.1	1.5	12.5	0.25
5	1.2	13	0.233
5.25	1.0	14	0.1713
6	0.934	14.75	0.15
6.66	0.8	15	0.1333
7	0.743	16	0.1
7.5	0.7		

Sensitivity, Selectivity, Stability in 5-TUBE DIAMOND

Extra T-R-F Stage Main Difference from 4-Tube Model

By Herman Bernard



The circuit of the Five-Tube 1933 Diamond of the Air, for a-c operation. The resistance, voltage and current values are given. SC means that on usual resistance meters the same reading would obtain as on a short circuit.

TESTS made of the Four-Tube A-C Diamond of the Air show that the detector input voltage, with 20-foot aerial, on the Atlantic seaboard, within the New York City limits, were as follows for five stations: WMCA, 0.2 volt; WAAF, 1 volt; WOR, 5 volts; WABC, 4.4 volts; WBBR, 1 volt. As WOR was the strongest station, and as the detector was operated at 6 volts negative bias, plate current adjusted to 0.1 ma., it can be seen that the strongest local did not overload the detector.

Of course, strong locals did produce some distortion if the volume control was full-on, but the adjustment is easily made at the front panel. So in the 4-tube model the location of the volume control after the detector is fully justifiable. The detector with 5-volt input would have to amplify audio frequencies only 3.3 times to load up the output tube, and as the gain was 4, the power tube overloaded before the detector, as it should.

In arranging a five-tube model, with the extra tube a tuned radio frequency amplifier, this safeguarding of the detector is impossible without the volume control located ahead of the detector. Therefore, antenna is brought to the slider of a 25,000-ohm potentiometer and the extremes of the potentiometer connected across a 30-turn winding of the coil between tap and ground.

The Volume Controls Operation

This type of volume control is pretty good, in that though a tuned circuit is affected, the control is across only a part thereof, and the practical detuning effect is very small, especially at d-c voltages are not changed directly. Moreover, the signal alone is attenuated, which is satisfactory in such a receiver, and the signal may be reduced to zero, so that the vol-

ume control resistance does not depend at all on the length of aerial used. The circuit is sensitive enough to work well on very short aeriels, including wire tucks behind moulding.

The two outstanding problems concerning such a receiver are sufficient selectivity and absence of oscillation. The two problems are interrelated, in that the set should be designed so as not to be too far from the point of oscillation, otherwise selectivity and sensitivity will be low. It is the feedback that makes the set sensitive, and this is so obviously true that if you reverse the connections to the primary in the plate circuit of the first or second r-f tube you will be astonished at the deadening effect on the set. The phase has been shifted so that inductive feedback is negative. There should be some positive feedback, just enough for desired results, not enough for oscillation.

Feedback Adjustment

The stabilizing agencies are the resistors connected from tap on secondary of the interstage coils to ground. While values of 10,000 ohms are shown, if there is oscillation these should be made lower, while if it is desired to see how much higher the sensitivity can be developed without squealing, higher values may be tried.

The primaries of the coils may have 30 turns tightly coupled to the secondaries over which they are wound, fine wire being permissible, while the secondaries consist of 127 turns of No. 32 enamel wire, tapped at the 30th turn from the ground end, the diameter being 1 inch. Insulation wrapper separates primary and secondary. The antenna coil has no extra primary. If the same inductance and approximately the same degree of coupling are used the diameters may be different, also the size

of wire. In all instances, however, shielding of the coils is necessary, except that there may be an opening at bottom of the chassis through which the connecting lugs of the coils protrude.

The 58 tubes used were the usual run as obtained in stores and from mail order houses, and therefore the values given for biasing resistors are practical averages. Part of the stabilization consists of working the 58 tubes at a little greater negative bias than 3 volts, the actual voltage having proved to be 4 volts. As WOR delivered 5 volts of radio frequency to the detector in the 4-tube Diamond, of course, it would deliver 5 volts to the second radio frequency amplifier here, which is biased at 4 volts and hence would be overloaded, were not the manual volume control ahead of the second r-f tube to make correction possible.

Detector Sensitivity

Much of the work of attaining adequate sensitivity depends on the detector. A curve was run to the detector. The voltage drop in the biasing resistor from cathodes of the two r-f tubes to ground was measured and an extra resistance inserted between r-f cathodes and detector cathode to make up the voltage difference. Since the intent is to establish the detector plate current at 1 ma. and the screen current of 70 microamperes flows through this resistor, the requirement is 9,000 ohms. Commercial values of 10,000 ohms may be used with perfect safety, although it is good practice to measure the resistance before the unit is inserted. At all hazards use the resistor that drops the plate current to 0.1 ma.

The detector has its screen returned to maximum B plus through a 5 meg. resistor, which actually measured 4,720,000 ohms. Thus, around 80 volts were ef-

LIST OF PARTS

Coils

One tapped impedance coil for antenna stage, for 0.00035 mfd.
Two r-f transformers for interstage coupler, for 0.00035 mfd, secondaries tapped.
One 60 ma. power transformer.

Condensers

One three-gang shielded 0.00035 mfd.
Two shielded blocks, three 0.1 mfd. in each block (black leads are common, go to ground).
One 0.002 mfd. mica fixed condenser.
One 0.01 mfd. mica fixed condenser.
Two 8 mfd. electrolytic condensers, one with two insulating washers and a special connecting lug.

Resistors

One 10-ohm center-tapped.
One 350-ohm pigtail resistor.
Three 0.01 meg. pigtail resistors (10,000 ohms).
One 3,500-ohm 2-watt resistor.
One 0.06-meg. pigtail resistor (60,000 ohms).
One 0.025 meg. potentiometer (25,000 ohms); insulating washers; a-c switch built in.
One 2-meg. pigtail resistor.
One 5-meg. pigtail resistor.

Other Requirements

One chassis, 13 $\frac{3}{4}$ inches wide x 2 $\frac{1}{2}$ inches high x 7 $\frac{3}{4}$ inches front to back.
One vernier dial, travelling light type, with bracket and pilot lamp; dial reads, left to right, 0 to 100.
Four knobs (one for dial, one for volume control-switch, two for manual trimmers.)
One dynamic speaker, 1,800-ohm field coil, tapped at 300 ohms; output transformer built in, has matched impedance for '47 tube.
One shelf 7 $\frac{1}{4}$ x 2 $\frac{1}{2}$ inches, with two brackets.
Three six-spring, two five-spring (UY) and one four-spring (UX) sockets. The extra UY is for speaker plug.
One a-c cable and plug.
Three special aluminum shields for the 57 and 58 tubes.
One rubber grommet for a-c cable exit.
Tubes required: one 57, two 58, one '47 and one '80.

fective on the screen. At the no-signal operating point of 6 volts negative bias, 0.1 ma plate current, at which this screen voltage applies, the plate voltage is about 25 volts less than the applied voltage, or 225 volts.

Fixed or Manual Trimmers

The circuit may be built with fixed trimmers, and if so it is not essential to put any at the antenna stage, because aerial capacity will take care of it. If greater sensitivity is desired, a separate manual trimmer should be put across the next two stages. The front cover illustration shows the set with fixed trimmers, the more popular method with laymen, but those who built their own sets may prefer the greater sensitivity and selectivity arising from the use of manual trimmers. If these manual devices have pointers, then the knobs need not be disturbed at all for local reception, because operation is then on the basis of fixed trimmers, but for distance reception it will be found that the manual trimmers are most helpful, and they are recommended, in the face of popular opposition to them. If what one wants is results, of course, the only choice is to adopt the means that produces them. No gang condensers track sufficiently well to register exact resonance at all points

on the dial, excepting laboratory types costing \$50 to \$100.

The curve taken of the detector enables the readings of radio frequency voltages, and if any one desires to make the same measurements he can accept the curve as printed (page 9, Fig. 3), once the receiver is adjusted to 0.1 ma plate current, with load resistors of 0.25 meg. and 5.0 meg. in the plate and screen circuits, respectively. All that is needed is a 0.1 d-c milliammeter in the plate circuit of the detector, and if permanently located in the set it may be used as a tuning meter. Moreover, voltages, both d-c and a-c (latter peak values) may be read, using the present detector as a vacuum tube voltmeter.

Good Tone

The tonal results are excellent, the sensitivity to weak signals is good, and for weak and medium signal strengths the detection is substantially linear. Somewhat better detection but without linearity takes place at higher signal values, hence not at better quality. This is a handy asset, for the volume control may be adjusted to the linear portion of the curve, to establish memorized volume of sound. This quantity of sound is sufficient to more than annoy neighbors after 11 p. m., for the output of the power tube is 2.5 watts, enough for an auditorium seating 500 persons, too much for the home, hence the volume control should be used considerably. Comfortable room volume is established when the detector input is 1 volt radio frequency.

The volume control and detector conjunctively produce a system that does not destroy tonal values at low volume settings.

Since the total B current will be around 60 ma, the tapped field coil of the dynamic speaker will serve for biasing the pentode, there being 300 ohms between tap and ground and 1,500 ohms between tap and B minus. The two chassis-mounted devices that must be insulated are the 8 mfd. condenser next to the rectifier and the volume control.

Since the pentode output tube is strong in its response to high audio frequencies, 0.00025 mfd. may be put from detector plate to ground (or from plate to cathode, if you prefer), while across the primary of the output transformer is connected a 0.002 mfd. condenser. A large capacity like this is deemed desirable, and when it is that large it may be across the primary of the output transformer.

Sizes of Speaker Cones

Moreover, this condenser helps to correct for squealing, as it removes radio frequencies from the output of the receiver, and thus removes one cause of feedback, especially as the leads from the primary of output transformer and field coil of speaker tend to act as little antennas otherwise. In a less sensitive set this does not matter, nor does it matter in other sets, so long as there is no squealing. But the 0.002 mfd. also corrects for tonal discrepancies, and the net result will be found to be a fairly flat audio curve without the usual pronounced peaks.

Correction in Picture Diagram of 4-Tube Diamond

In the full scale picture diagram of the 1933 Four-Tube A-C Diamond, printed last week, the 2.5-volt power transformer leads should go to the respective heater springs of the '47 socket, and not to the one point only as shown.

The bass response will be particularly good, better with 10 and 12 inch diameter speakers, but quite good even with the more generally used 8-inch diameter speakers.

The chassis is of such size that it fits into a midget cabinet (13 $\frac{3}{4}$ x25 $\frac{7}{8}$ x7 $\frac{3}{4}$ inches), or may be put into a console. Since the kit should cost only around \$15, it is a dandy set to put into an attractive console that may now house a receiver that is somewhat out of date.

It is well worth while to keep pace with the advance in radio, by having an a-c receiver using the 58 and 57 tubes, and for the extreme audio sensitivity attendant upon its use, the established '47 power tube. Everyone reports greater selectivity than with the older type tubes, and accompanied by much greater sensitivity, also, a combination of assets not previously enjoyed, because previously when higher gain tubes were brought out it was ascertained that the greater gain was at the expense of diminished selectivity. And if there is one factor that holds a position of first importance it is that the receiver should be selective enough.

Sensitivity 5 Microvolts

The practical selectivity varies, of course, with the input. When the receiver was worked, using a good ground, and as aerial a piece of wire three feet long, just enough to stretch from the antenna binding post to the floor, the practical selectivity was so good that distant stations 10 kc apart could be separated at the high frequency end of the dial, showing that the oscillation damper was not too great. But at the lower frequency region powerful locals could not be quite tuned out sufficiently to bring in without interference stations 10 kc removed.

The performance just stated was not made using exactly the hookup shown this week, but a design that economizes as a bit more in the number of parts used, and with slightly changed values of some parts to boot. For instance, it is practical to use 6 volts negative bias on the 58 tubes, and thereby the same bias is applicable to the detector, and moreover can be measured directly with ordinary meters. Besides, one fewer bypass condenser is needed, one fewer resistor, too. And instead of 10,000 ohms in the two grid circuit portions for stabilization it is practical to omit the one in the detector stage and use a much smaller value in the second r-f stage, which is the stage that tends to oscillate. Thus another resistor is omitted.

Same Performance

The performance is no different one way or the other, so far as preliminary tests have shown, but the methods are slightly different. The diagram next week will show the circuit and values and the list of parts to conform.

As for the frequency coverage, the receiver, using no trimming or equalizing condensers (and none was used in the model on which the above performance is reported) was from 1520 to 500 kc, better than a three-to-one ratio, and not only covering the broadcast band but bringing in the distress wavelength, 600 meters, also. That is unusual in a tuned radio frequency receiver.

The dial settings for even hundreds of kilocycles were: (2) 1500; (6.5) 1400; (12) 1300; (16.25) 1200; (22) 1100; (29) 1000; (38) 900; (50) 800; (63) 700; (81) 600; (100) 00.

[This concludes the first instalment concerning the Five-Tube A-C 1933 Diamond of the Air. Next week the second instalment will be printed, issue of October 1st, whereas in the October 8th issue the final instalment will be printed, together with a full-page picture diagram of the receiver, if this can be prepared in time. If any changes are made in the circuit they will be reported in these columns and embodied in the picture diagram.—EDITOR.]

AN ANALYSIS OF DETECTION

By J. E. Anderson

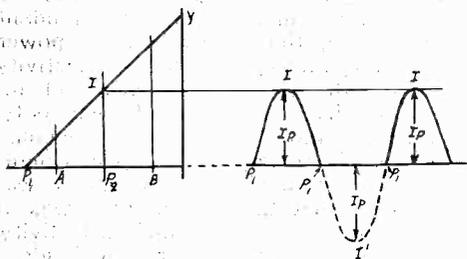


FIG. 1

This shows how a unidirectional conductor operates in a detector. Direct current pulses are produced by the action of a signal voltage.

DETECTION in a radio receiver takes place because there is an unsymmetrical relation between the grid signal voltage and the plate current resulting from it. If the grid voltage, plate current characteristic were a straight line there could be no detection unless the operating point were placed at the cut-off, or so near it that during part of the signal cycle the plate current is cut off.

Let us refer to Fig. 1. Let P_1Y be a straight line representing the relation between the grid voltage and the plate current. If the operating point is at P_2 and the amplitude of the signal voltage is limited to P_2B or P_2A' there would be no detection, but there would be distortionless amplification. But if the operating point is put at A and the amplitude of the signal voltage is the same as before, there would be detection because P_1A is less than the signal amplitude and therefore during a part of the signal cycle the plate current would be cut off. Hence the output wave would be unsymmetrical. There would be no detection, however, if the input amplitude were limited to P_1A , for then the output wave would be symmetrical and we would have distortionless amplification.

True Detection

If the operating point were placed at P_1 there would be detection, regardless of the signal voltage amplitude, for then there would be current only on the positive half of the signal wave. The negative would be entirely suppressed. Since the operating point is now exactly at the cut-off point there would be detection for even the smallest signal voltage amplitudes. Moreover, we would have true linear detection for the output on the active half wave would be directly proportional to the signal voltage amplitude. For any amplitude the output would be a true replica of the input wave on the positive side. If the signal were a true sine wave, the output would consist of a true sine wave in which half is suppressed. That is, only the half wave when the signal voltage is in the positive direction would produce a half sine wave.

The type of output that would be obtained is shown in the right half of Fig. 1. Suppose the operating point is at P_1 and that the signal amplitude is P_1P_2 . As the signal voltage increases the current rises to I . At this point the signal voltage begins to decrease until the signal voltage is again P_1 . The resulting current curve is $P_1I'P_1$, with

amplitude I_p . The signal continues to decrease until the voltage is as much more negative than P_1 as P_2 is more positive than P_1 . But nothing happens because the grid voltage is now beyond the cut-off point. The dotted line $P_1I'P_1$ shows what would happen during this half-cycle if the curve continued straight with the current flowing in the opposite direction. But since current can flow in only one direction and only when the voltage is on the positive side of the cut-off point, the negative side of the current wave is shown in a dotted line to indicate that it is virtual and not real. At the beginning of the second voltage cycle the grid is again at P_1 and the current rises to I as the voltage rises to P_2 . Then it returns and the current decreases to P_1 , or zero. Thus we get the second positive current pulse. For every signal voltage cycle we get one current pulse represented by $P_1I'P_1$ on the right of Fig. 1.

This represents half wave detection. If we had a full wave detector, both tubes operating at P_1 , then the curve $P_1I'P_1$ would be on the positive side, and it would be real, contributing to detection.

Diode Detection

In a half-wave diode detector we have nearly the case in Fig. 1. The operating point is at the cut-off but the characteristic is not straight. The current is proportionately greater for larger voltages. Hence the output current pulses would not be quite like the signal voltage waves but they would be more peaked. This would hold if the tube alone were concerned. But in a diode detector there is always a high resistance in the circuit and it is the voltage drop across this resistor that is the output. If this resistance, which is called the load resistance, is very large compared with the internal resistance of the tube, the output curve is very nearly straight, and we would have a close approximation of the case in Fig. 1.

If we used a duplex diode in full-wave detection we would have the case in Fig. 1 with the dotted wave on the positive side of the current axis. That is, we would have two current pulses for every signal voltage cycle, and every pulse would nearly be a sine half-wave.

Grid bias detection does not differ greatly from diode detection. The principles are the same except that the signal voltage is not used directly to drive the current through the load resistance but is used only to control the current by the valve action. In Fig. 2 we have a typical case of grid bias detection. The curve BOA represents the grid voltage plate current curves of any vacuum tube having three or more electrodes. The operating point O , determined by the fixed bias voltage, should be placed at the point where the output current curve is most unsymmetrical. This happens when the grid bias is slightly less negative than the bias which makes the curvature of the characteristic steepest. The point O in Fig. 2 is approximately the most sensitive detecting point.

A Distorted Wave

If the operating point is at O and the signal voltage wave is sinusoidal with an

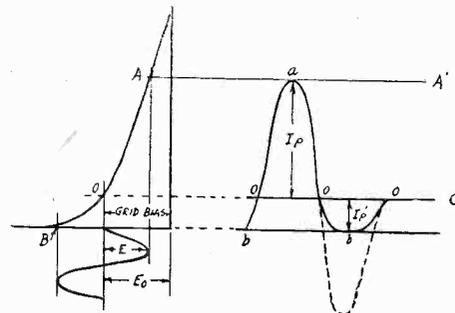


FIG. 2

This shows how a transrectifier operates to produce current pulses in the plate circuit when a signal voltage is applied in the grid circuit.

amplitude E , the grid voltage will vary between $E_0 - E$ and $E_0 + E$, in which E_0 is the fixed grid bias. The plate current will vary between A and B , where B is practically zero in this particular case.

At the beginning of a signal voltage cycle the plate current is determined by the line OC . As the signal voltage increases, that is, moves toward zero bias, the plate current increases. When the voltage has reached $E_0 - E$, the current is up to A . The amplitude of the positive half of the current wave is I_p , measured from OC to AA' . As soon as the signal voltage has reached its maximum it decreases and the current decreases to O . Then the signal voltage changes sign, with respect to the bias, and the current continues to decrease. When the grid voltage has reached $E_0 + E$ the current is down to B . The amplitude of the current in the negative direction is I_p' . It is clear that most of the negative half of the current wave is cut off by the fact that the plate current characteristic rapidly approaches the current axis on the negative side of the operating point. Thus the current output wave is greatly distorted, that is, it is unsymmetrical. The dotted curve in the right part of Fig. 2 shows what has been cut off.

The plate current wave resulting from a sinusoidal grid voltage wave is boabobo. This is pulsating just as the output in Fig. 1 although the duration of zero current is not so long. Detection results just the same, and this is because the curve has been distorted.

Conversion to Audio

So far we have really no detection in either case but a form of distorted amplification of the ratio signal. The current pulses occur at radio frequency. To convert these pulses into audio frequency we have to do something else. We have to put in a radio frequency filter in the output circuit. The simplest filter is a small condenser across the load resistance, whether this resistance is the load resistance in a diode rectifier or the plate coupling resistor in a triode circuit. We may also use a small choke coil to help smooth out the pulses.

In order to explain the conversion of the radio pulses into audio frequency voltages let us draw on the ordinary B battery eliminator for an example. In this case we have either a half-wave or a full-wave diode rec-

tifier. There will be current pulses in the output, but these will all be of the same amplitude. The object of the filter is to remove the pulses so that the output current will be steady and unidirectional, or so that the voltage across the voltage divider will be steady and unidirectional. In this case the voltage divider and the plate resistances of the various circuits connected in parallel with it make up the load resistance.

The filter condensers will smooth out the pulsations and the chokes connected in series with the line aid in this function. If the condensers are large enough and the inductances of the chokes high enough, the output will be quite free of ripple, which means that the pulses have been thoroughly removed.

The r-f Case

When it is a question of detection the radio frequency pulses of the carrier correspond with the current pulses in the B supply. If the carrier amplitude remains steady, that is, unmodulated, we get a steady, unidirectional current in the output, or a steady, unidirectional voltage across the load resistance. If the filtering is good enough there will be no trace of ripple left. That represents complete detection.

But we have not got any audio frequency voltage yet. Again let us refer to the B supply. Suppose the line voltage fluctuated at a regular rate, say one cycle a second. The voltage might be 110 volts ordinarily but it might vary at the rate of one cycle per second between 100 and 120 volts. Then the line voltage would be modulated 9.1 per cent. with a slow frequency of one cycle per second. If the filter is not able to remove this slow variation, then we would have a fluctuation in the output, and this would represent an audio frequency.

Now the r-f signal is ordinarily modulated by various percentages. Let us assume that the percentage is 30 per cent., and the rate at which the carrier fluctuated might be 400 cycles per second. Now if the r-f filter is not good enough to eliminate this fluctuation at 400 cycles per second, the output of the detector, and now the rectifier would be a detector, would contain an audio frequency component of 400 cycles per second.

Rectification and Filtering

Detection, then, consists of complete or partial rectification in addition to partial filtering. It requires both rectification and filtering to constitute detection. The rectification should preferably be complete, but the filtering should not be complete for if it were we would not have any audio frequency in the output.

The necessity for filtering in conjunction with a rectifier is often lost from view because even when no filter has been put in intentionally there is usually sufficient by-pass capacity to effect the partial smoothing out of the current pulses.

If the radio frequency filter is too good, some of the higher audio frequencies will be lost, for they too are smoothed out. An illustration of the need of a partial filter in conjunction with a rectifier is the ordinary diode rectifier-detector. The load resistance might be 500,000 ohms. If there is no condenser across this resistor the detecting efficiency is practically nil. But if we only put a condenser of 50 mmfd. it becomes good, as judged by the audio output. But if we put a condenser of 500 mmfd. across the same load resistance there is a noticeable loss of high audio frequencies. The filtering now has become too thorough at the higher audio frequencies, although it is still all right for the lower audio frequencies, say below 1,000 cycles. The same thing applies to any other form of detector.

An Example

Take, for example, the grid leak detector. In this case the grid is the anode of a diode

Characteristic Curve of 57 Detector, Taken on 4-Tube Diamond

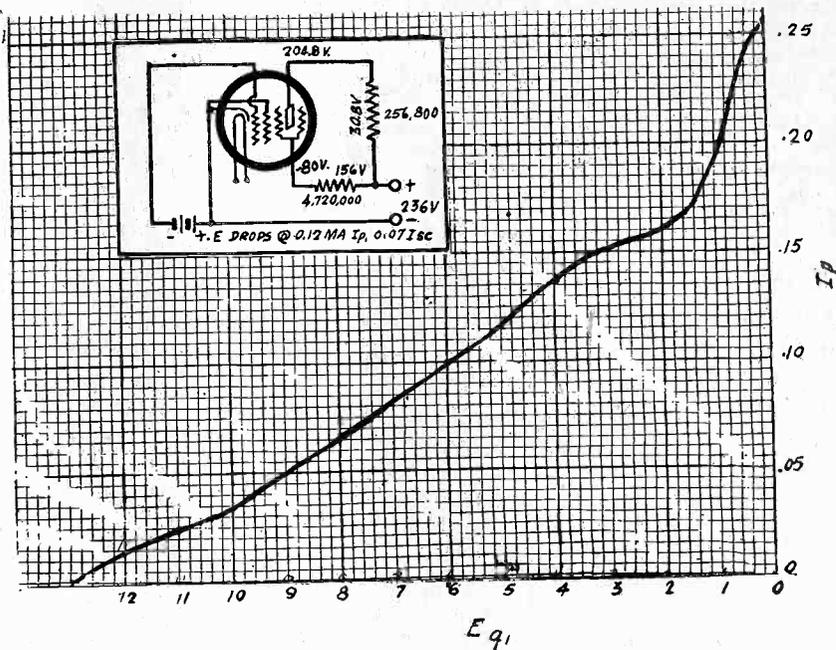


FIG. 3

A static grid voltage plate current curve of a 57 detector tube when working in a circuit shown in the insert. The variation in the screen voltage accounts for the remote cut-off.

rectifier, the grid leak is the load resistance, and the condenser across the grid leak is the r-f filter. It is well known that this type of detector is more effective on low audio frequencies than on high. The reason is that the condenser across the grid leak is too large for the value of the leak. The filtering is too thorough. In a detector of this type the grid also serves as the control grid in an audio frequency amplifier. The tube amplifies the audio frequency voltages developed across the grid leak and the grid condenser. Since the filtering is not complete, it is usually advantageous to put another filter condenser in the plate circuit of the amplifier. When it is said that this condenser is put in the plate circuit of the detector the language is not precise. Rectification and filtering, that is, detection, occurs in the grid circuit. The plate enters only when we consider the tube as an amplifier.

The Plate Circuit By-pass

But the amplifier amplifies both the remnant r-f voltages and the audio voltages. But we don't want the tube to amplify the r-f voltage. Hence we put the condenser across the load so that no radio frequency voltages can build up across the load resistance or impedance. The condenser in the plate circuit of the tube used as grid leak detector is used more to short-circuit the output to r-f than to aid in detection.

When we use a duplex diode triode tube for detection and amplification the two functions are clearly distinguished, unless we use the tube as a diode biased amplifier. In that case the function is the same as when a triode is used as a grid leak detector and amplifier. But in the duplex diode triode with the control grid and the diode plates isolated from each other there is a distinct

separation of the functions. The rectification takes place in the diode circuit, the filtering in the condenser across the load resistance, and detection takes place by combining rectification and filtering. Amplification of the detected voltages take place in the triode. In this case also there may be a certain amount of radio voltage on the control grid because the filtering is not complete. For that reason a by-pass condenser is often placed in the plate circuit of the triode. As in the case of the grid leak detector, this condenser serves to short-circuit the audio frequency load impedance to radio frequencies so that no r-f voltages can build up.

Grid Bias Detection

While the by-pass condenser in the plate circuit of the first a-f amplifier does not take part in detection directly, it does take a part in lowering the detecting efficiency on the high frequencies. Hence it should not be any larger than is necessary. In case a transformer follows the tube there is usually enough distributed capacity in the primary to produce a short for radio frequencies, and no other condenser is needed, but if a resistor follows the tube, a condenser is usually necessary.

Plate Bend Rectification

In the case of grid bias detection, rectification takes place in the plate circuit. Strictly speaking it is not rectification, but merely distortion of the waveform. It has been called transrectification because a signal voltage in the grid circuit produces an unsymmetrical current wave in the plate circuit. The load resistance in this case is the plate coupling resistor and the filter may be put across this resistance. There will be no detection without the filter.

However, this does not mean that an actual condenser must be placed across the resistance to produce detection. Usually, there is enough distributed capacity between the plate and the cathode, or filament, to effect sufficient filtering. However, better detecting efficiency results if a small condenser is put in. Whether or not one is needed depends on the value of the plate coupling resistance. If the resistance is sufficiently high the distributed capacity is large enough.

The efficiency of transrectifiers depends greatly on the operating voltages applied to the tubes and on whether or not these voltages are steady. If the tube is self-biased the operating bias may fluctuate considerably because the varying current through the bias resistance will change the bias. Of course, the variation in the operating bias can be eliminated by means of a large condenser across the bias resistor. A comparatively small condenser will be sufficient to remove the carrier ripple from the bias but it requires a much larger one to remove the audio frequency ripple. If the audio ripple is not removed the effect will be a reduction in the output by virtue of degenerative feed back.

Effect of Screen Voltage

The screen voltage also has a strong effect on the plate current characteristic. However, in a detector tube like the 57, which has a suppressor grid, this is not nearly as great as in a tube like the 224 which has no suppressor grid.

The characteristic also depends on how the screen voltage is obtained. If the screen is returned to the same voltage point as the plate and a high resistor is put in the screen circuit to drop the voltage, the plate current characteristic is entirely different from what it would be if the screen were returned to a lower voltage point with good regulation and without any series resistance. The tube assumes the characteristics of a remote cut-off tube, or at least those of a tube having a much lower amplification factor. The reason for this is clear.

As the grid bias is increased the plate

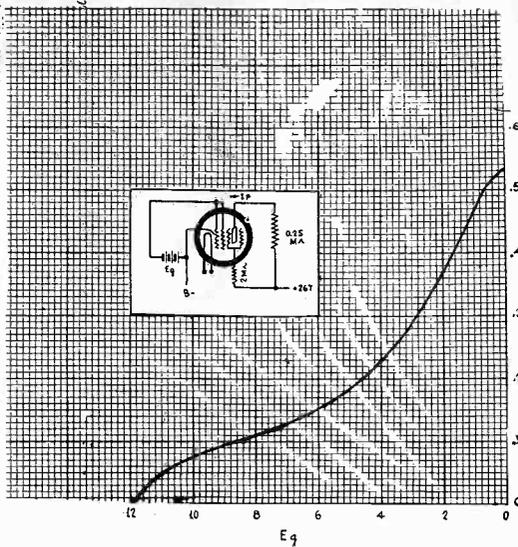


FIG. 4

This curve was taken on the same tube as that in Fig. 3 but with slightly different applied voltages and considerably different screen resistor.

and the screen currents become zero together and therefore the effective voltages become the same as the bias is increased. The curve becomes almost linear up to the cut-off point, which occurs at a much higher bias than the ordinary cut-off bias. This is illustrated in Fig 3, which shows the variation in the plate current with change in bias when the circuit conditions were as in the inserted drawing. The curve was taken with d-c voltages on the control grid and therefore by-pass condensers play no part. Hence they are not shown in the drawing. Under the conditions the tube approaches the characteristics of a triode having an amplification factor of 18 in so far as the cut-off is concerned. When this tube is

operated with a steady screen voltage of 100 volts, without series resistor, and an applied plate voltage of 250 volts, the cut-off point is about 7 volts negative. The curve in Fig. 3 does not cut off until the bias is 13 volts.

Dynamic Characteristics

By looking at the curve one would suspect that under the conditions it would be of little value as a detector, but the suspicion is not founded on fact, for the dynamic characteristics are quite different from the static characteristics. When there is a large condenser from the screen to the cathode, or to ground, the voltage on the screen is relatively constant and is determined, practically, by the screen current flowing at the operating grid bias and by the resistance in series with the screen. The dynamic cut-off, therefore, is more nearly like that which would obtain if the screen grid were returned to say 100 volts without the series resistor. The fact is that the tube is a good detector.

Just why the screen voltage is maintained at a practically constant voltage is not difficult to see. When the current decreases in the screen, the current through the series resistor continues to flow because the condenser discharges through it. Conversely, when the screen current increases, the additional current is not forced through the resistance but flows into the condenser. Hence the grid voltage remains practically constant at a mean value which is nearly the same as the current that flows in the screen circuit at the operating bias. Since the principal current fluctuations in the screen circuit occur at radio frequency, a condenser of the order of 0.1 mfd. is sufficient to maintain the voltage nearly as constant as if it were supplied with a battery.

The condenser across the screen lead resistor is even more effective in holding the screen voltage constant than the condenser across the bias resistor is in holding the operating bias constant. The reason for this is that resistance in the screen circuit is many times greater than the bias resistance would be. In fact, a 0.1 mfd. condenser across a resistance of 5 megohms is effective as a filter down to a frequency as low as 2 cycles per second, whereas the same condenser across a bias resistor of 30,000 ohms would be equally effective down to about 330 cycles per second.

Deceptive Appearances

In Fig. 4 is another static curve taken on the same 57 tube under the conditions shown in the inserted diagram. The principal difference between this circuit and that in Fig. 3 is that the series resistor in the screen circuit is 2 megohms. The applied plate voltage is slightly higher, but this fact does not account for the difference in the characteristic as much as the different value of the screen lead resistor.

If we were to operate at a bias of 6 volts it would seem that the detecting efficiency would be high since the curvature is high. Actually, the detector was not nearly as good with this combination as with the higher screen resistor. There was very little output except on strong signals. It is clear therefore that the static curves are not dependable in judging the performance of a circuit. If static curves are to be used for estimating the performance of a tube, either as an amplifier or as a detector, the grid, screen, and plate voltage should be supplied with batteries, or with voltage sources with so good regulation that the change in current would not change the voltages by an appreciable amount. Moreover, they should be taken with a pure resistance in the plate circuit.

When the detecting efficiency is studied by aural means, that is, by tuning in a station and listening for changes in the output resulting from changes in grid bias, screen voltage, screen resistor, plate resistor, and by-pass condensers across the various resistors, then it is studied under dynamic conditions

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Four Two-Volt Tubes in BATTERY SET

By Conrad J. Emmons

HERE is a small battery operated receiver suitable for use where electric power is not available and when a great deal of volume is not needed. The design is one of utmost simplicity and it should cost very little to build it.

Since the set is to be operated with batteries it becomes necessary to use the smallest tubes available and no more of them than will give satisfactory sensitivity. The supply of the filament current is especially important for this is the most troublesome part of a battery operated receiver, troublesome from the point of view of frequent replacement.

Three of the tubes in the four-tube circuit require a total of 0.180 ampere and the power tube requires 0.26 ampere. Thus the set requires a current of 0.44 ampere. This is too much for a single No. 6 dry cell but not for two of them connected in parallel. Since each cell gives a voltage of 1.5 volts, four cells in series are needed to give the required 6 volts. Therefore the A battery should consist of eight No. 6 dry cells connected two in parallel and four in series.

Provision has been made for 6 volts in order to adapt the circuit for use on a 6 volts storage battery in case one of these is available, as it is on an automobile. The voltage drop in each tube is 2 volts. The drop in the 50 ohm ballast resistors, or in the 12 ohm resistor, is 3 volts. Hence the drop in the filaments and the ballast resistors is 5 volts, and we have to put in a common ballast resistor to drop the remaining 1 volt. Since the current is 0.44 ampere, the required common resistor is 2.25 ohms.

Fixing the Bias

The operating bias on the 234 r-f amplifier is 3 volts, for this is the normal drop in the 50-ohm ballast resistance. The bias on the 232 grid biased detector is usually 6 volts, but in this case it is only 3 volts. This bias puts the operating point at the best detecting voltage provided that we select a low screen voltage. In this case the screen voltage is only three volts, the two volt drop in the filament and the one volt drop in the common ballast resistor. One reason for using a six volt filament source is to make this combination possible, for it makes a sensitive detector. However, the output is not very great, yet it is more than sufficient because there is ample amplification in the two audio stages.

The bias on the first audio tube is also 3 volts, which is enough. It is obtained from the drop in the 50 ohm ballast resistor. This is enough to insure maximum permissible signal on the power tube without overloading the 230 tube.

The power tube bias should be 13.5 volts. This is best provided by a small battery. Since there is a drop of about 3 volts in the 12 ohm ballast resistor only 10.5 volts need be supplied by the grid battery. However, a higher voltage can be used when it is desirable to conserve plate current.

Plate and Screen Voltages

The voltage on the plates of all the tubes is 135 volts, obtained from three 45 volt batteries connected in series. The screen voltage on the first tube is 67.5 volts, but it may be increased to 90 volts if this gives better results.

While the voltage on the plate of the 230 tube should not be greater than 90 volts,

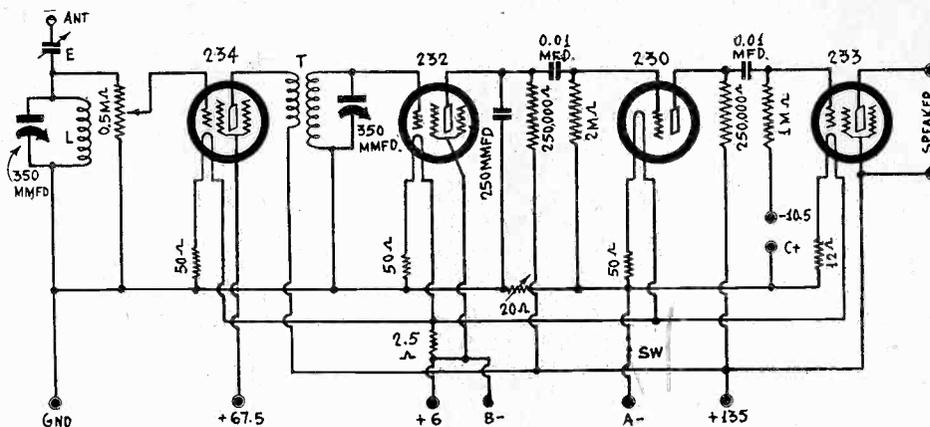


FIG. 1

The diagram of a four-tube battery-operated receiver utilizing small dry cell tubes. It will operate on medium dry cell batteries for long periods due to its wall plate current

this applies to the effective voltage. In this case the plate load resistance is 250,000 ohms and the effective voltage will be very low. The high applied voltage is perfectly safe.

The total plate and screen current in this receiver will be approximately 22 milliamperes. This is so low that a medium size B battery will last many months, assuming that the set is used four hours every day. If it is used much less the batteries will not last much longer because of their limited shelf life. With average use a set

of batteries might give good service for one year.

No by-pass condensers are shown across the B battery and none will be needed as long as the B batteries are in reasonably good condition. In case the receiver should begin to give trouble due to high resistance in the batteries, a 4 mfd. condenser should be connected across the 135 volt supply. The condenser used should not be an electrolytic one because this would exhaust the battery quickly even when the set is not in use, unless the battery is actually disconnected when the set is not in use.

LIST OF PARTS

COILS

- L—One shielded midget coil for 350 mmfd. condenser (disregard primary)
- T—One shielded midget transformer for 350 mmfd. condenser

CONDENSERS

- E—One 20-100 mmfd. equalizer or similar small condenser
- One two-gang 350 mmfd. tuning condenser
- Two 0.01 mfd. mica type condensers
- One 250 mmfd. condenser

RESISTORS

- One 0.5 megohm potentiometer
- Three 50 ohm, wirewound ballast resistors
- One 12 ohm, wirewound ballast resistor
- One 2.5 ohm, wirewound ballast resistor (two 5-ohm resistors in parallel)
- Two 250,000 ohm (0.25 megohm) resistors (Red body, yellow dot, green end)
- One 2 megohm resistor (Red body, green dot, black end)
- One 1 megohm resistor (Brown body, green dot, black end)
- One 20-ohm rheostat

OTHER REQUIREMENTS

- Eleven binding posts
- Three grid clips
- Three UX sockets
- One UY socket
- One filament switch
- One 15 volt grid battery
- One 6 volt dry cell A battery
- Three 45 volt medium B batteries.

Volume Control

The main volume control is a 500,000 ohm potentiometer connected across the first tuned circuit, with the slider connected to the control grid. The reason for using such a high value is that it is desired to shunt the tuned circuit with as high a value as practicable. A lower value would make the circuit less sensitive as well as less selective.

A 20-ohm rheostat placed so as to control the filament current in the first two tubes serves as an additional control. This rheostat does not control the audio tubes because if it did the quality would not be good on strong stations requiring the use of a high resistance setting for the rheostat.

The small adjustable condenser E in the antenna circuit is used to prevent loss in the antenna and thus to make the set more selective and sensitive. The value of the condenser should be about 100 mmfd. A trimmer type condenser having a range from 20 to 100 mmfd. may be used, or any other variable condenser which may be set at about 100 mmfd.

Speaker Required

Since there is no convenient means for obtaining a field current for a dynamic speaker, it is best to use a magnetic speaker or a dynamic speaker with a permanent field magnet. Such a speaker designed for this particular power tube is available. The optimum load impedance for this tube is 7,000 ohms, and this should be the effective impedance of the speaker.

AN HARMONIC 1540-108 kc. in a

By Edu

A MODULATED harmonic oscillator is a handy thing indeed. Whenever one reads about testing and servicing one comes across the advice that an oscillator should be used. Even if you build only an occasional set, t-r-f or super, and particularly a super, you should have an oscillator. No money? Well, that needn't worry you. The oscillator in mind can be built for less than \$5, and you will find it a good one.

There is really next to nothing to it, and one feels half ashamed to have to write up the device. The circuit explains so much. There are a tuning condenser, a coil, a grid condenser and leak, a tube socket, a tube, a filament transformer, an a-c cable and plug, an a-c switch, a panel and a box. The luxury of an output binding post may be added at 10 cents extra, but even this is not necessary, for a wire twisted around the tube once or twice provides sufficient coupling.

Stations as Standards

Admittedly there is little to building this oscillator. The calibration is the thing. The trouble with calibrating, especially on the basis of harmonics, is that one doesn't know which harmonic or fundamental is which. So the device was built and calibrated, and here are the data.

You may use five or six broadcasting stations as the basis, preferably between the middle and low frequency end of the receiver dial. Those used by the author were WMCA, 570 kc; WEAf, 660 kc; WOR, 710 kc; WJZ, 760 kc; WABC, 860 kc.

The tuning condenser is 0.0002 mfd. It is handy to use that capacity, as the frequency ratio need not much exceed 2-to-1, although it certainly must reach 2-to-1. The reason is that when using harmonics there will be gaps between bands unless the ratio is 2-to-1, whereas if it is much more than 2-to-1 there will be too great an overlap.

The coils were as follows: 800-turn honeycomb, 1 inch diameter, between grid and cathode, 300-turn honeycomb, 1 inch diameter, between cathode and return. The total inductance was about 13 millihenries. The coils are mounted one atop the other, adjoining lugs joined for tap.

The tuning range will be from 220 to 108 kc, just outside the 2-to-1 frequency range, as required. If it is a little more in excess, no matter. The dial settings, numerical divisions increasing with decreasing frequency, were as follows for the even tens of the 100 divisions:

- 0, 220 kc; 10, 218 kc; 20, 216 kc; 30, 212 kc; 40, 207 kc; 50, 201 kc; 60, 190 kc; 70, 177 kc; 80, 158 kc; 90, 136 kc; 100, 108 kc.

High Distributed Capacity

It has been stated that restriction of the tuning range is desirable, but effecting at least 2-to-1 frequency ratio is imperative. The condenser was the junior midline, which has a capacity ratio of 6.76, counting the distributed capacity of a standard solenoid, or a frequency ratio of 2.6 to 1. Therefore the honeycomb coils had a high distributed capacity, and the greater part of this distributed capacity arose no doubt from the 300-turn coil. The more turns on a honey-

comb coil, the smaller the distributed capacity.

A somewhat different coil may be used, a single tapped winding, tap about one-quarter the way down, and then the frequency ratio would be lifted a little.

However, taking the stated basis, and the dial settings, one finds that the popular intermediate frequency, 175 kc, comes in at 71 on the dial. This frequency and others in the range can be read if one gets plotting paper, ten squares of tens, and on the bottom puts the dial numbers and on the side the fundamental frequencies, this being made easy by the figures given for the even tens. However, it is not intended that you should actually use that curve as your calibration, but rather that you will use it to find the points in conjunction with any broadcast receiver,

The Individual Calibration

With wire wrapped around the tube for one or two turns, other end similarly wrapped around the aerial that goes to set, work the oscillator in conjunction with the receiver. You will pick up squeals. It is assumed you know the frequencies of the stations tuned in by the receiver. You can get them from a newspaper or from a list of stations, if you don't know the frequencies. There are two indicating possibilities. One is the squeal, the other is the hum. If you tune in broadcast stations as your guide then you hear both hum and squeal. If you have a calibrated receiver you don't need stations but can tune by the hum alone, although stations are better, because their frequency is exact to plus or minus 50 cycles, and besides, the squeal registers a more decisive point than the hum.

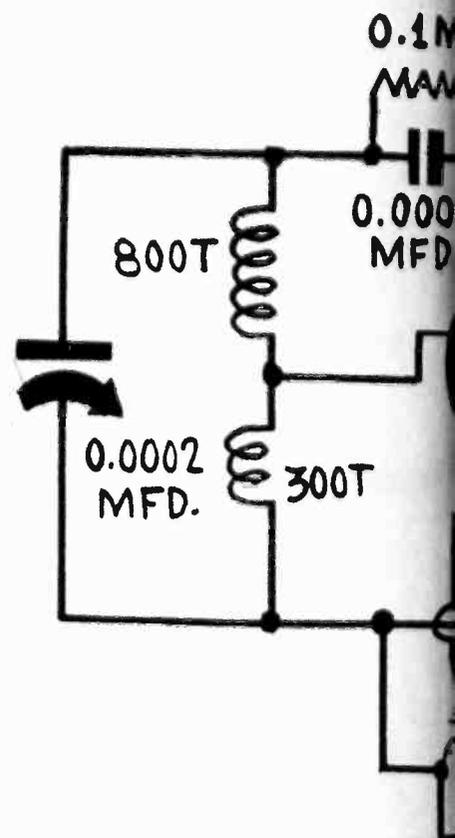
So pick up the squeal, tune to a little to one side and then to the other side, and try to get in the middle where there is no squeal, possibly nothing but hum, or hum plus a low growl. If there is nothing but hum, then you are tuned to zero beat. If there is a low growl, which is usually as well as you can do, then you are so very close to zero beat that you may record this as the frequency. But what frequency?

Well, suppose the station tuned in is WEAf, 660 kc. This must be the third harmonic or 220 kc, at zero setting of the dial.

Check-Up of Curve

Take WMCA, 570 kc. This squeal was heard at 66, or oscillator fundamental of 190 kc, 57 kc being the third harmonic thereof. WEAf, 660 kc, has been discussed. WOR, 710 kc, as a third harmonic is off the fundamental oscillator scale because it is 237 kc, and the scale stops at 220 kc. But a squeal will be heard at 71.5, for the fourth harmonic of 710 is 177.5 kc, which is in the range of the oscillator's fundamentals. WJZ, on 760 kc, is the fourth harmonic of the oscillator's fundamental of 190 kc, and will be found at 60 (see the dial figure 60 in the list above), whereas WABC, 860 kc, is the fourth harmonic of 215 kc, found at 21 on the oscillator dial. Some squeals considerably off the curve will be heard. Ignore these.

Now, the figures you will obtain may not



be the same, but they will be very close and you therefore have a good guide, and

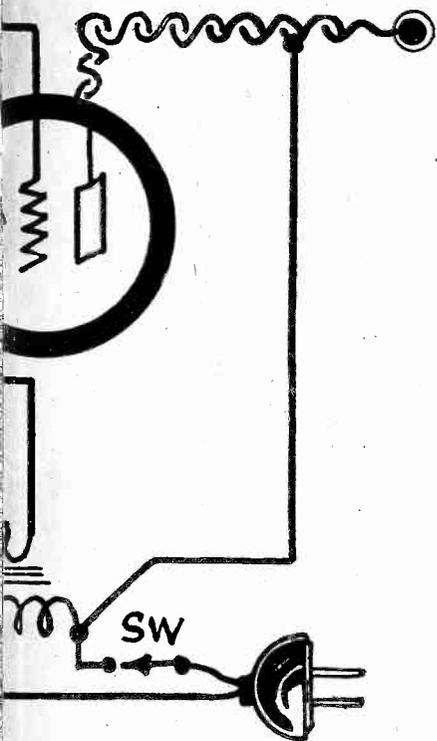
September

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Proceedings

radio amplifier for loss of quality in the selective tuner and in the detector. Many drawings of different circuit arrangements and curves of computed results are given. The importance of this paper lies in its presentation of methods for equalization in the audio amplifier by different devices. Some of the equalization devices are comparatively simple and can be applied by any one.

* * *

Arthur Van Dyck, Radio Corporation of America, New York, has an article entitled, "Dynamic Symmetry in Radio Design," which has nothing to do with the principles of radio but rather of the principles of art. Its connection with radio comes with the design of cabinets, panels, knobs, dials, escutcheons, and other features which appeal to the eye rather than the ear.

The paper reviews some of the principles of dynamic symmetry, the science of vital relations of areas, which was the basis of the ancient Greek art and as rediscovered by Jay Hambidge about fifteen years ago and described by him in his works, "Dynamic Symmetry" and "The Diagonal," published by Yale University Press. A considerable bibliography is appended to the article for those who wish to follow the study of dynamic symmetry further.

using the same piece of plotting paper and have your own careful curve, which you may copy on another similar sheet. This second sheet you may paste on the bottom of the box containing the oscillator.

So far we have calibrated the oscillator for intermediate frequencies from 108 to 220 kc. But what about the other frequencies—higher ones? Use harmonics. Write the harmonic frequencies on the right-hand side of the paper. Thus the total ranges will be:

- 108-220 kc (fundamental)
- 216-440 kc (second harmonic)
- 324-660 kc (third harmonic)
- 432-880 kc (fourth harmonic)
- 540-1100 kc (fifth harmonic)
- 648-1320 kc (sixth harmonic)
- 756-1540 (seventh harmonic)

You can go considerably higher, into short waves, if you like.

Seventh Not Too Weak

All these harmonics can be heard all right, because the oscillator is hooked up as a detector, and scientific systems have been used for frequency calibration, even by the Bureau of Standards, based on standard frequency transmissions from Washington, using up to the fiftieth harmonic.

If the frequency range of the fundamental were wider you would not have to go to the seventh harmonic, but then the overlap would be greater. It is now 4 to 564 kc. For instance, if the fundamental scale were 100 to 250 kc, then the harmonics for these extremes would be 500-200, 300-750, 400-1000, 500-1250, 600-1500. Thus one fewer harmonic, six instead of seven, but with 100 to 550 kc overlap. There is no objection whatever, and a specially made coil, with lower distributed capacity, might yield the result. In one case, better spreadout, seven harmonics; in the other, not quite so good spreadout, six harmonics. You will probably select what the circumstances yield.

Once calibrated for the fundamental, the oscillator is serviceable for the harmonics simply by multiplication, and the extra scales at side will take care of that, so you won't have to do any arithmetic more than once.

May Use 0.00035 Mfd.

The six-harmonic system will work out all right, dial settings somewhat different than those given, but not very far off except at the lower frequency (higher capacity) settings, if the two honeycomb coils are used as stated and the tuning condenser is 0.00035 mfd., instead of 0.0002 mfd.

Looking at the panel top, the dial is mounted at center, the tube socket at right rear, the output binding post at left rear, on a panel 5 inches wide by 6½ inches long. The box need be only large enough to accommodate the panel, and 2½ inches deep. These data are for the small junior condenser (0.0002 mfd.), but if 0.00035 mfd. is to be used the box would have to be larger, and likewise the panel.

WWV Standard

Using the harmonic method of calibration, stations as bases, the accuracy is better the higher the station frequency, because the 50 cycle rule applies regardless of frequency, and at 1500 kc the maximum variation would be 33/1000 of one per cent. That is the standard then. Of course the oscillator, not crystal controlled, will not keep so close, but it will do well. Strike a beat note. You may listen to it for an hour without change of pitch. That's stability.

You may use the WWV standard frequency transmission (accurate to one part in 5,000,000) as your standard by beating your harmonics with its 5,000 kc transmission.

The Bureau of Standards, Department of Commerce, Washington, D. C., sends out the 5,000 kc signal every Tuesday from 2 to 4 p.m. and from 10 p.m. until midnight, Eastern Standard Time. The power is sufficient to make the signal audible clearly in most parts of the United States, but audible in all parts, provided a regenerative receiver is used.

Requirements

Since the signals are continuous waves the receiver must be in an oscillatory condition. This is the oscillator you are building, antenna coupler a few turns around the '27 or 56 tube. The object of the transmission is to provide a readily available standard by which all interested parties may check their own secondary standards, such as master oscillators, crystal oscillators, and wave meters. For radio experimenters the usefulness of the transmission lies in the calibration of oscillators and wavemeters. The choice of the standard frequency is such that it can be used throughout the radio spectrum with comparatively little difficulty.

It is not to be supposed that your oscillator can be calibrated to the same accuracy as the standard because errors amounting to as much as one part in a hundred or so are introduced in reading a dial or a calibration curve, unless special precautions have been taken in these respects. But it is well to have a reliable standard.

40th Harmonic of 125 kc

In making use of the standard frequency it is necessary to have a receiver of the oscillating type. It is also necessary to have another oscillator, and this is the oscillator you are building. The receiver is used for tuning in the standard frequency and the oscillator is tuned as accurately as possible to the standard frequency, using the zero beat method. Then this standard is available at all times, and particularly when the primary standard transmission is not on the air. The fundamental of the oscillator will be 125 kc, the 40th harmonic of which beats with 5,000 kc.

No hesitancy need be felt about that fortieth harmonic. When one gets used to the shape of the curve two-thirds harmonics and other interlopers do not prove confusing.

WAVE TRAPS

Rejector and Acceptor Types for Eliminating Interference

By Charles Enris

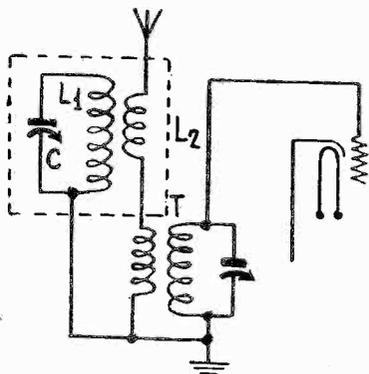


FIG. 1

A simple wave trap of the single frequency rejector type. C, L1, and L2, inclosed in dotted lines, are the elements of the trap.

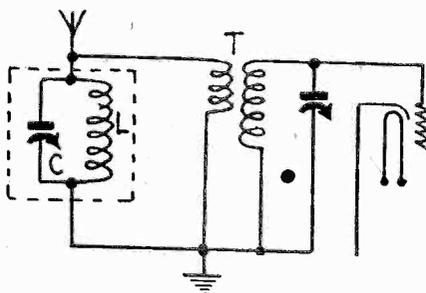


FIG. 2

This wave trap is of the single frequency acceptor type. Only a coil L and a condenser C are needed for the trap.

THE lowly wave trap still has its uses notwithstanding the many super-selective receivers now in use. There are still a few receivers which are not selective enough to separate local stations and many which are not selective enough to suppress local stations when DX is desired. Perhaps the greatest need for wave traps is in the immediate neighborhood of super-power stations. The power from the large stations is so great that in the vicinity no other station can be received even with first rate receivers in point of selectivity. In such cases wave traps are very useful.

Two Types of Trap

There are two types of wave trap. In one type one undesired signal is rejected at a time. When this is used the trap may be tuned permanently to the interfering station and the regular tuner can be adjusted as usual for bringing in the stations desired. The other type of trap rejects all stations but the desired one. It must be tuned every time the rest of the tuner is adjusted, and to the same frequency.

In Fig. 1 is the first type of trap. L1 and C form a highly resonant circuit and L1 is coupled loosely to the antenna by means of a coil L2 of a few turns of wire. This coil, L2, is shown in the antenna lead above the primary of the input transformer T, but it may also be put in the antenna lead on the ground side, but the method shown is preferable.

High Impedance

The signal to which the trap circuit is tuned is caught by the tuned circuit and dissipated so that it will not reach the primary of the input transformer. Another way of looking at it is that by reflection the trap introduces a very high impedance in the antenna circuit to the interfering frequency alone. This impedance is so high that no appreciable interfering signal current can flow in the antenna circuit and none can reach the primary of the input transformer T.

The second type of trap is shown in Fig. 2. Here the tuned circuit LC is put across the primary of the input transformer T.

This trap acts as a shunt to all frequencies except to that to which it is tuned. Currents of higher frequencies than the resonant frequency of LC pass through the condenser C and currents of lower frequencies pass through the coil L. In either case the impedance put across the primary is so low that no appreciable current flows through the primary.

At the resonant frequency of LC, however, the impedance is very high. An extremely small part of the signal current can pass through the tuned circuit and therefore practically all of it is forced through the primary of the input transformer. The disadvantage of the shunt circuit is that it must be retuned every time the receiver is tuned to another frequency.

Conditions of Effectiveness

The trap in Fig. 1 is more suitable for broadcast reception where a single station is causing interference and where the receiver may be tuned to any one of a larger number of different frequencies. The trap in Fig. 2 is more suitable for the reception of a single station where all other signals are to be eliminated.

The effectiveness of a wave trap depends on the selectivity of the trap circuit. The more selective the circuit the more effective it is in excluding those signals not wanted. That applies to both types.

If the coupling between L1 and L2 in Fig. 1 is too close, or if L2 contains too many turns, the trap will not only cut out the undesired station but also others near it. For that reason the coupling should be very loose. And when it is loose, and when the circuit is very selective, the tuning is very critical. C must be adjusted to exactly the right point to cut out the interfering station, but then it will suppress it well and let the other stations near it come through.

Heavy Conductors Used

The second type of trap is most effective if C is large and L small. Traps of this type have been made with a coil consisting of a few turns of copper tubing a quarter of an inch in diameter, the turns

having a diameter of about four inches. Since a trap of this type is used to accept one station and reject all others, it pays to take special care in getting a highly resonant circuit, using a large condenser and a small inductance. The most suitable condensers are fixed mica condensers. Suppose we use one of these having a capacity of 0.01 mfd. If then the tuned circuit is to be tuned to 500 kc, the inductance should be only about 10 microhenries. This inductance will be obtained approximately by winding 6.3 turns of heavy wire on a diameter of 5 inches, with 12 turns to the inch. This could be wound with bare hard drawn copper wire and then stretched so that the length of the coil becomes 0.525 inches long. No. 18 wire could be used. The inductance could be varied by stretching more or less. If much heavier wire is used the coil would have to be longer and more turns would have to be used. Another way of varying the inductance is to slide a contact on the bare turns.

Design of First Type

Suppose we use $\frac{1}{8}$ inch tubing or solid conductor. Let us assume that the diameter of the coil is four inches. In that case about 10 turns would be needed if they are wound 4.86 turns to the inch. The winding would be 2 inches long. This could be stretched or compressed to vary the inductance.

The design of the first type of trap is about the same as that of an ordinary radio frequency transformer. Any r-f coil designed for a 350 mmfd. condenser could be used, but not more than 5 or 10 turns should be used for the L2 winding. A large coil wound with heavy wire is better than a small shielded coil. There are many old type coils wound on 2.5, 3, and 3.5 inch diameters with rather heavy wire which could be used. Coils formerly called "low loss" are just right. As a rule these coils have only a few turns on the primary and these are coupled loosely to the tuned winding. The small primary would be used in the antenna circuit and the tuned winding would be connected across the tuning condenser.

Using Larger Condenser

Coils wound for 500 mmfd. condensers are even better, provided that a condenser of this capacity is used. There are still many of these condensers around, either in the experimenter's junk pile or in radio stores. They can be bought for very little. Coils for this capacity are also available.

If no coils can be obtained for 500 mmfd. (0.0005 mfd.) condensers, they can easily be constructed. The inductance needed to cover the broadcast band is 167 microhenries. If we use No. 18 enameled wire on a 3 inch diameter and wind closely, we require 51 turns. The small winding on this coil should not contain more than 5 turns, wound at one end of the large winding.

If the coil form is 2.5 inches in diameter we should use a smaller size wire so that the coil will not be too long. Let us select No. 22 enameled wire. This combination also requires 51 turns. The small winding may contain five turns in this case also.

The Eclipse's Effect on 8665 Kc. Wave

By E. F. W. Alexanderson

Radio Consulting Engineer, General Electric Company, Schenectady, N. Y.

WHEN we try to interpret something about which we really know so little as the effect of the sun's eclipse on the propagation of radio waves, the best we can do is to start with such theories as we may have and try to carry these theories somewhat further by establishing new facts.

In equipping an expedition to make radio observations on this eclipse we had in mind particularly to follow out a suggestion made by Dr. Irving Langmuir, who desired to obtain some more data regarding the theory that from the sun there is a corpuscular or electronic emission travelling at a rate of 1,000 miles a second.

For the test we selected a radio frequency of 8,655 kilocycles because we thought that this wave would have a skip distance not much beyond the distance at which observations were made and that the fringe effects of fading at the edge of the skipping distance would be strongly pronounced. These phenomena are especially apparent in television under certain unfavorable conditions where the multiple reflections cause several images, both positive and negative, which rapidly appear and disappear, suggesting a dance of ghosts. We concluded, however, that television would not be the best medium for these observations because what we desired most of all was a permanent record so that the results could be accurately compared with other results at a later date.

Good Use for the Useless

In our test of facsimile transmission between San Francisco and Schenectady some years ago we had found that the ghost images of television can also be observed on the facsimile record. Instead of attempting to transmit facsimile of writing or pictures we selected a type of signal with continuous wave radiation interrupted sixty times per second, each interruption being one-five-hundredth of a second. A facsimile record of this signal gave parallel black lines on a white background if the record was perfect.

The signal from Schenectady which we recorded at Conway, N. H., during normal conditions in the afternoon previous to the eclipse proved, as we expected, that we had to deal with multiple reflections. Though the signal was strong it was of a type with rapid fadings that gives distortions of speech and music. On the record it appears like an irregular mixture of black marks on white background and white marks on black background, alternating with totally black and totally white streaks. This is the kind of signal that is particularly useless for facsimile and television; and was just what we wanted.

The outstanding result of our observations was that this normally strong signal almost totally disappeared during the two hours preceding the optical eclipse of the sun, which in accordance with the calculations of the astronomers would be the time during which the corpuscular or electronic eclipse would take place.

Feels There Was Confirmation

The nearly complete disappearance of the signal was so striking we were worried that something might have gone

wrong with our receiver, but when shortly before the optical eclipse began the signal came back, first in a scattered way, and then strongly and continuously, we felt that we had a complete proof of the correctness of the theory of the electronic eclipse. This record, which was taken during the whole afternoon and evening, will be preserved for those to whom it is of scientific interest.

During this same period observations by earphones were made on other signals. We were particularly interested in a telegraph signal from Germany with approximately the same wavelength as the signal from Schenectady. This signal was heard during the whole afternoon, but during the period when the Schenectady signal was at a minimum the signal from Germany was at its maximum with a very substantial increase.

One fact which is important to keep in mind in attempting to interpret these observations is the calculations of the astronomers that the electronic shadow falls entirely east of the path of the total eclipse where the observations were made. The electronic shadow as shown on published graphs covered a large area nearly bridging the Atlantic Ocean.

A Quandary

It is thus easy to see why the signal from Germany came in stronger during the eclipse, since the electronic shadow produced the effect of night over the Atlantic Ocean and a 30-meter signal is known to be stronger over such a distance at night. It is not so easy, however, to see why the presence or absence of electronic bombardment to the east of the point of observation would have such an effect on a signal from the west.

A clue to this apparent contradiction may be found in the observations of A. Hoyt Taylor, who has made elaborate measurements of the speed of wave propagation. These measurements by Taylor indicate that a short-wave signal received a moderately short distance is delayed in arrival so that it appears as if the signal had travelled something like 2,000 miles further than the direct distance from the transmitting to the receiving station, thus indicating that it does not arrive by the direct path but is reflected from some point 1,000 miles away.

On this basis our observations during the eclipse may be explained. We can assume that the only signal we were able to receive at our point of observation 200 miles from Schenectady arrived at that point not after a direct travel of 200 miles but through one of these Taylor reflections from some point 1,000 miles east. The disappearance of the signal during the electronic eclipse can then be explained if we assume that the reflecting medium had something to do with an electronic bombardment which was absent at that time.

Theory of Double Image

With this assumption we can go further in attempting to explain what has taken place. In examining our graphic record we find that such a record could not have been made by one single ray. If the signal arrives at the receiving station after reflection, we must conclude that there

are at least two such reflections, i. e., two rays arrive simultaneously, one having travelled a distance of several hundred miles more than the other.

This would explain the double image on the record which occasionally gives the appearance of white lines on black background instead of black lines on white background. This theory of reflection may also explain the recent findings of Marconi that even ultra-short waves may at times reach points far beyond the horizon.

If this theory is correct there remains to be explained the nature of the reflecting medium which is produced by the electronic bombardment. Possibly it is one of those phenomena which has become known as the Appleton layer and which must be recognized in addition to the Kennelly Heaviside layer to explain the phenomena of radio.

Almost Complete Suppression

Fortunately we do not need to wait for the next eclipse to investigate this subject further, because the signals that have this peculiar character may be studied any day.

The important fact that we have established is that a signal of a particular wavelength and a particular distance is almost completely suppressed by the electronic eclipse if this eclipse area lies immediately beyond the point of observation as seen from the transmitting station.

Amateurs Believe Eclipse Moved Radio Ceiling

Hartford, Conn. — Approximately one hundred carefully tabulated reports of observations by radio amateurs on the effect on radio signals of the recent solar eclipse have been received by the American Radio Relay League, the national amateur organization. These observations cover all of the high frequency radio spectrum, including the newly developed ultra high frequency region, and were received from strategic points along the entire path of totality.

The basic conclusion arrived at from examining the reports, according to technical experts of the League, is in accordance with the expected phenomena. Conditions during the eclipse, and particularly near the time of totality, resembled those at night, in sharp contrast with the daylight conditions existing before and after the eclipse period.

This lends confirmation to a theory recently advanced which is that it is the sun's ultra-violet or other radiation which creates the ionized layer high in space. This layer, known in radio circles as the Kennelly-Heaviside layer, is in effect the ceiling from which radio waves bounce back to the earth at distant points, and is utilized in nearly all short-wave transmission.

Many amateurs reported hearing foreign and other far-distant stations which had never been heard before at their locations. This seems to confirm the theory of a shower of electrons or charged particles from the sun assisting ionization, and in the case of the eclipse, bringing the "ceiling" into a hitherto unduplicated position with respect to the area of totality.

AN HARMONIC 1540-108 kc. in a

By Edu

A MODULATED harmonic oscillator is a handy thing indeed. Whenever one reads about testing and servicing one comes across the advice that an oscillator should be used. Even if you build only an occasional set, t-r-f or super, and particularly a super, you should have an oscillator. No money? Well, that needn't worry you. The oscillator in mind can be built for less than \$5, and you will find it a good one.

There is really next to nothing to it, and one feels half ashamed to have to write up the device. The circuit explains so much. There are a tuning condenser, a coil, a grid condenser and leak, a tube socket, a tube, a filament transformer, an a-c cable and plug, an a-c switch, a panel and a box. The luxury of an output binding post may be added at 10 cents extra, but even this is not necessary, for a wire twisted around the tube once or twice provides sufficient coupling.

Stations as Standards

Admittedly there is little to building this oscillator. The calibration is the thing. The trouble with calibrating, especially on the basis of harmonics, is that one doesn't know which harmonic or fundamental is which. So the device was built and calibrated, and here are the data.

You may use five or six broadcasting stations as the basis, preferably between the middle and low frequency end of the receiver dial. Those used by the author were WMCA, 570 kc; WEAf, 660 kc; WOR, 710 kc; WJZ, 760 kc; WABC, 860 kc.

The tuning condenser is 0.0002 mfd. It is handy to use that capacity, as the frequency ratio need not much exceed 2-to-1, although it certainly must reach 2-to-1. The reason is that when using harmonics there will be gaps between bands unless the ratio is 2-to-1, whereas if it is much more than 2-to-1 there will be too great an overlap.

The coils were as follows: 800-turn honeycomb, 1 inch diameter, between grid and cathode, 300-turn honeycomb, 1 inch diameter, between cathode and return. The total inductance was about 13 millihenries. The coils are mounted one atop the other, adjoining lugs joined for tap.

The tuning range will be from 220 to 108 kc, just outside the 2-to-1 frequency range, as required. If it is a little more in excess, no matter. The dial settings, numerical divisions increasing with decreasing frequency, were as follows for the even tens of the 100 divisions:

- 0, 220 kc; 10, 218 kc; 20, 216 kc; 30, 212 kc; 40, 207 kc; 50, 201 kc; 60, 190 kc; 70, 177 kc; 80, 158 kc; 90, 136 kc; 100, 108 kc.

High Distributed Capacity

It has been stated that restriction of the tuning range is desirable, but effecting at least 2-to-1 frequency ratio is imperative. The condenser was the junior midline, which has a capacity ratio of 6.76, counting the distributed capacity of a standard solenoid, or a frequency ratio of 2.6 to 1. Therefore the honeycomb coils had a high distributed capacity, and the greater part of this distributed capacity arose no doubt from the 300-turn coil. The more turns on a honey-

comb coil, the smaller the distributed capacity.

A somewhat different coil may be used, a single tapped winding, tap about one-quarter the way down, and then the frequency ratio would be lifted a little.

However, taking the stated basis, and the dial settings, one finds that the popular intermediate frequency, 175 kc, comes in at 71 on the dial. This frequency and others in the range can be read if one gets plotting paper, ten squares of tens, and on the bottom puts the dial numbers and on the side the fundamental frequencies, this being made easy by the figures given for the even tens. However, it is not intended that you should actually use that curve as your calibration, but rather that you will use it to find the points in conjunction with any broadcast receiver.

The Individual Calibration

With wire wrapped around the tube for one or two turns, other end similarly wrapped around the aerial that goes to set, work the oscillator in conjunction with the receiver. You will pick up squeals. It is assumed you know the frequencies of the stations tuned in by the receiver. You can get them from a newspaper or from a list of stations, if you don't know the frequencies. There are two indicating possibilities. One is the squeal, the other is the hum. If you tune in broadcast stations as your guide then you hear both hum and squeal. If you have a calibrated receiver you don't need stations but can tune by the hum alone, although stations are better, because their frequency is exact to plus or minus 50 cycles, and besides, the squeal registers a more decisive point than the hum.

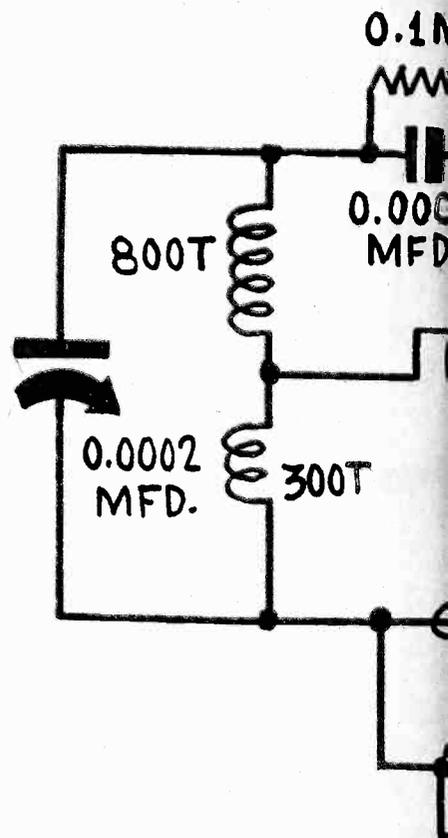
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Take WMCA, 570 kc. This squeal was heard at 66, or oscillator fundamental of 190 kc, 57 kc being the third harmonic thereof. WEAf, 660 kc, has been discussed. WOR, 710 kc, as a third harmonic is off the fundamental oscillator scale because it is 237 kc, and the scale stops at 220 kc. But a squeal will be heard at 71.5, for the fourth harmonic of 710 is 177.5 kc, which is in the range of the oscillator's fundamentals. WJZ, on 760 kc, is the fourth harmonic of the oscillator's fundamental of 190 kc, and will be found at 60 (see the dial figure 60 in the list above), whereas WABC, 860 kc, is the fourth harmonic of 215 kc, found at 21 on the oscillator dial. Some squeals considerably off the curve will be heard. Ignore these.

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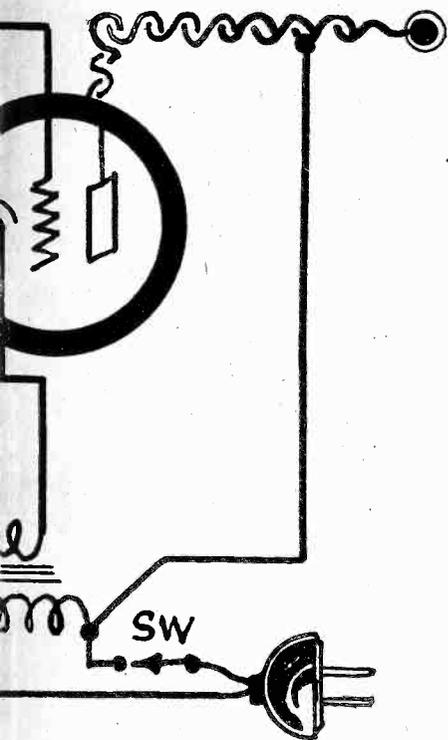
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radio amplifier for loss of quality in the selective tuner and in the detector. Many drawings of different circuit arrangements and curves of computed results are given. The importance of this paper lies in its presentation of methods for equalization in the audio amplifier by different devices. Some of the equalization devices are comparatively simple and can be applied by any one.

* * *

Arthur Van Dyck, Radio Corporation of America, New York, has an article entitled, "Dynamic Symmetry in Radio Design," which has nothing to do with the principles of radio but rather of the principles of art. Its connection with radio comes with the design of cabinets, panels, knobs, dials, escutcheons, and other features which appeal to the eye rather than the ear.

The paper reviews some of the principles of dynamic symmetry, the science of vital relations of areas, which was the basis of the ancient Greek art and as rediscovered by Jay Hambidge about fifteen years ago and described by him in his works, "Dynamic Symmetry" and "The Diagonal," published by Yale University Press. A considerable bibliography is appended to the article for those who wish to follow the study of dynamic symmetry further.

using the same piece of plotting paper and have your own careful curve, which you may copy on another similar sheet. This second sheet you may paste on the bottom of the box containing the oscillator.

So far we have calibrated the oscillator for intermediate frequencies from 108 to 220 kc. But what about the other frequencies—higher ones? Use harmonics. Write the harmonic frequencies on the right-hand side of the paper. Thus the total ranges will be:

- 108-220 kc (fundamental)
- 216-440 kc (second harmonic)
- 324-660 kc (third harmonic)
- 432-880 kc (fourth harmonic)
- 540-1100 kc (fifth harmonic)
- 648-1320 kc (sixth harmonic)
- 756-1540 kc (seventh harmonic)

You can go considerably higher, into short waves, if you like.

Seventh Not Too Weak

All these harmonics can be heard all right, because the oscillator is hooked up as a detector, and scientific systems have been used for frequency calibration, even by the Bureau of Standards, based on standard frequency transmissions from Washington, using up to the fiftieth harmonic.

If the frequency range of the fundamental were wider you would not have to go to the seventh harmonic, but then the overlap would be greater. It is now 4 to 564 kc. For instance, if the fundamental scale were 100 to 250 kc, then the harmonics for these extremes would be 500-200, 300-750, 400-1000, 500-1250, 600-1500. Thus one fewer harmonic, six instead of seven, but with 100 to 550 kc overlap. There is no objection whatever, and a specially made coil, with lower distributed capacity, might yield the result. In one case, better spreadout, seven harmonics; in the other, not quite so good spreadout, six harmonics. You will probably select what the circumstances yield.

Once calibrated for the fundamental, the oscillator is serviceable for the harmonics simply by multiplication, and the extra scales at side will take care of that, so you won't have to do any arithmetic more than once.

May Use 0.00035 Mfd.

The six-harmonic system will work out all right, dial settings somewhat different than those given, but not very far off except at the lower frequency (higher capacity) settings, if the two honeycomb coils are used as stated and the tuning condenser is 0.00035 mfd., instead of 0.0002 mfd.

Looking at the panel top, the dial is mounted at center, the tube socket at right rear, the output binding post at left rear, on a panel 5 inches wide by 6½ inches long. The box need be only large enough to accommodate the panel, and 2½ inches deep. These data are for the small junior condenser (0.0002 mfd.), but if 0.00035 mfd. is to be used the box would have to be larger, and likewise the panel.

WWV Standard

Using the harmonic method of calibration, stations as bases, the accuracy is better the higher the station frequency, because the 50 cycle rule applies regardless of frequency, and at 1500 kc the maximum variation would be 33/1000 of one per cent. That is the standard then. Of course the oscillator, not crystal controlled, will not keep so close, but it will do well. Strike a beat note. You may listen to it for an hour without change of pitch. That's stability.

You may use the WWV standard frequency transmission (accurate to one part in 5,000,000) as your standard by beating your harmonics with its 5,000 kc transmission.

The Bureau of Standards, Department of Commerce, Washington, D. C., sends out the 5,000 kc signal every Tuesday from 2 to 4 p.m. and from 10 p.m. until midnight, Eastern Standard Time. The power is sufficient to make the signal audible clearly in most parts of the United States, but audible in all parts, provided a regenerative receiver is used.

Requirements

Since the signals are continuous waves the receiver must be in an oscillatory condition. This is the oscillator you are building, antenna coupler a few turns around the '27 or 56 tube. The object of the transmission is to provide a readily available standard by which all interested parties may check their own secondary standards, such as master oscillators, crystal oscillators, and wave meters. For radio experimenters the usefulness of the transmission lies in the calibration of oscillators and wavemeters. The choice of the standard frequency is such that it can be used throughout the radio spectrum with comparatively little difficulty.

It is not to be supposed that your oscillator can be calibrated to the same accuracy as the standard because errors amounting to as much as one part in a hundred or so are introduced in reading a dial or a calibration curve, unless special precautions have been taken in these respects. But it is well to have a reliable standard.

40th Harmonic of 125 kc

In making use of the standard frequency it is necessary to have a receiver of the oscillating type. It is also necessary to have another oscillator, and this is the oscillator you are building. The receiver is used for tuning in the standard frequency and the oscillator is tuned as accurately as possible to the standard frequency, using the zero beat method. Then this standard is available at all times, and particularly when the primary standard transmission is not on the air. The fundamental of the oscillator will be 125 kc, the 40th harmonic of which beats with 5,000 kc.

No hesitancy need be felt about that fortieth harmonic. When one gets used to the shape of the curve two-thirds harmonics and other interlopers do not prove confusing.

WAVE TRAPS

Rejector and Acceptor Types for Eliminating Interference

By Charles Enris

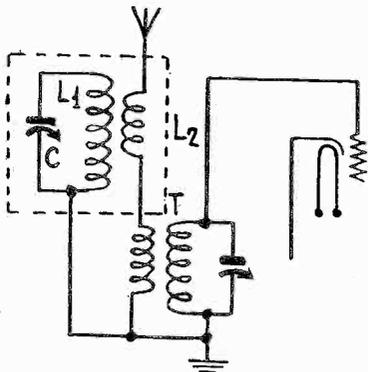


FIG. 1

A simple wave trap of the single frequency rejector type. C, L1, and L2, inclosed in dotted lines, are the elements of the trap.

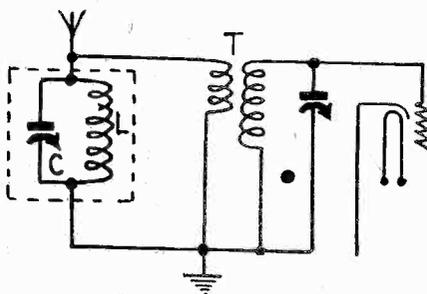


FIG. 2

This wave trap is of the single frequency acceptor type. Only a coil L and a condenser C are needed for the trap.

THE lowly wave trap still has its uses notwithstanding the many super-selective receivers now in use. There are still a few receivers which are not selective enough to separate local stations and many which are not selective enough to suppress local stations when DX is desired. Perhaps the greatest need for wave traps is in the immediate neighborhood of super-power stations. The power from the large stations is so great that in the vicinity no other station can be received even with first rate receivers in point of selectivity. In such cases wave traps are very useful.

Two Types of Trap

There are two types of wave trap. In one type one undesired signal is rejected at a time. When this is used the trap may be tuned permanently to the interfering station and the regular tuner can be adjusted as usual for bringing in the stations desired. The other type of trap rejects all stations but the desired one. It must be tuned every time the rest of the tuner is adjusted, and to the same frequency.

In Fig. 1 is the first type of trap. L1 and C form a highly resonant circuit and L1 is coupled loosely to the antenna by means of a coil L2 of a few turns of wire. This coil, L2, is shown in the antenna lead above the primary of the input transformer T, but it may also be put in the antenna lead on the ground side, but the method shown is preferable.

High Impedance

The signal to which the trap circuit is tuned is caught by the tuned circuit and dissipated so that it will not reach the primary of the input transformer. Another way of looking at it is that by reflection the trap introduces a very high impedance in the antenna circuit to the interfering frequency alone. This impedance is so high that no appreciable interfering signal current can flow in the antenna circuit and none can reach the primary of the input transformer T.

The second type of trap is shown in Fig. 2. Here the tuned circuit LC is put across the primary of the input transformer T.

This trap acts as a shunt to all frequencies except to that to which it is tuned. Currents of higher frequencies than the resonant frequency of LC pass through the condenser C and currents of lower frequencies pass through the coil L. In either case the impedance put across the primary is so low that no appreciable current flows through the primary.

At the resonant frequency of LC, however, the impedance is very high. An extremely small part of the signal current can pass through the tuned circuit and therefore practically all of it is forced through the primary of the input transformer. The disadvantage of the shunt circuit is that it must be retuned every time the receiver is tuned to another frequency.

Conditions of Effectiveness

The trap in Fig. 1 is more suitable for broadcast reception where a single station is causing interference and where the receiver may be tuned to any one of a larger number of different frequencies. The trap in Fig. 2 is more suitable for the reception of a single station where all other signals are to be eliminated.

The effectiveness of a wave trap depends on the selectivity of the trap circuit. The more selective the circuit the more effective it is in excluding those signals not wanted. That applies to both types.

If the coupling between L1 and L2 in Fig. 1 is too close, or if L2 contains too many turns, the trap will not only cut out the undesired station but also others near it. For that reason the coupling should be very loose. And when it is loose, and when the circuit is very selective, the tuning is very critical. C must be adjusted to exactly the right point to cut out the interfering station, but then it will suppress it well and let the other stations near it come through.

Heavy Conductors Used

The second type of trap is most effective if C is large and L small. Traps of this type have been made with a coil consisting of a few turns of copper tubing a quarter of an inch in diameter, the turns

having a diameter of about four inches. Since a trap of this type is used to accept one station and reject all others, it pays to take special care in getting a highly resonant circuit, using a large condenser and a small inductance. The most suitable condensers are fixed mica condensers. Suppose we use one of these having a capacity of 0.01 mfd. If then the tuned circuit is to be tuned to 500 kc, the inductance should be only about 10 microhenries. This inductance will be obtained approximately by winding 6.3 turns of heavy wire on a diameter of 5 inches, with 12 turns to the inch. This could be wound with bare hard drawn copper wire and then stretched so that the length of the coil becomes 0.525 inches long. No. 18 wire could be used. The inductance could be varied by stretching more or less. If much heavier wire is used the coil would have to be longer and more turns would have to be used. Another way of varying the inductance is to slide a contact on the bare turns.

Design of First Type

Suppose we use $\frac{1}{8}$ inch tubing or solid conductor. Let us assume that the diameter of the coil is four inches. In that case about 10 turns would be needed if they are wound 4.86 turns to the inch. The winding would be 2 inches long. This could be stretched or compressed to vary the inductance.

The design of the first type of trap is about the same as that of an ordinary radio frequency transformer. Any r-f coil designed for a 350 mmfd. condenser could be used, but not more than 5 or 10 turns should be used for the L2 winding. A large coil wound with heavy wire is better than a small shielded coil. There are many old type coils wound on 2.5, 3, and 3.5 inch diameters with rather heavy wire which could be used. Coils formerly called "low loss" are just right. As a rule these coils have only a few turns on the primary and these are coupled loosely to the tuned winding. The small primary would be used in the antenna circuit and the tuned winding would be connected across the tuning condenser.

Using Larger Condenser

Coils wound for 500 mmfd. condensers are even better, provided that a condenser of this capacity is used. There are still many of these condensers around, either in the experimenter's junk pile or in radio stores. They can be bought for very little. Coils for this capacity are also available.

If no coils can be obtained for 500 mmfd. (0.0005 mfd.) condensers, they can easily be constructed. The inductance needed to cover the broadcast band is 167 microhenries. If we use No. 18 enameled wire on a 3 inch diameter and wind closely, we require 51 turns. The small winding on this coil should not contain more than 5 turns, wound at one end of the large winding.

If the coil form is 2.5 inches in diameter we should use a smaller size wire so that the coil will not be too long. Let us select No. 22 enameled wire. This combination also requires 51 turns. The small winding may contain five turns in this case also.

The Eclipse's Effect on 8665 Kc. Wave

By E. F. W. Alexanderson

Radio Consulting Engineer, General Electric Company, Schenectady, N. Y.

WHEN we try to interpret something about which we really know so little as the effect of the sun's eclipse on the propagation of radio waves, the best we can do is to start with such theories as we may have and try to carry these theories somewhat further by establishing new facts.

In equipping an expedition to make radio observations on this eclipse we had in mind particularly to follow out a suggestion made by Dr. Irving Langmuir, who desired to obtain some more data regarding the theory that from the sun there is a corpuscular or electronic emission travelling at a rate of 1,000 miles a second.

For the test we selected a radio frequency of 8,655 kilocycles because we thought that this wave would have a skip distance not much beyond the distance at which observations were made and that the fringe effects of fading at the edge of the skipping distance would be strongly pronounced. These phenomena are especially apparent in television under certain unfavorable conditions where the multiple reflections cause several images, both positive and negative, which rapidly appear and disappear, suggesting a dance of ghosts. We concluded, however, that television would not be the best medium for these observations because what we desired most of all was a permanent record so that the results could be accurately compared with other results at a later date.

Good Use for the Useless

In our test of facsimile transmission between San Francisco and Schenectady some years ago we had found that the ghost images of television can also be observed on the facsimile record. Instead of attempting to transmit facsimile of writing or pictures we selected a type of signal with continuous wave radiation interrupted sixty times per second, each interruption being one-five-hundredth of a second. A facsimile record of this signal gave parallel black lines on a white background if the record was perfect.

The signal from Schenectady which we recorded at Conway, N. H., during normal conditions in the afternoon previous to the eclipse proved, as we expected, that we had to deal with multiple reflections. Though the signal was strong it was of a type with rapid fadings that gives distortions of speech and music. On the record it appears like an irregular mixture of black marks on white background and white marks on black background, alternating with totally black and totally white streaks. This is the kind of signal that is particularly useless for facsimile and television; and was just what we wanted.

The outstanding result of our observations was that this normally strong signal almost totally disappeared during the two hours preceding the optical eclipse of the sun, which in accordance with the calculations of the astronomers would be the time during which the corpuscular or electronic eclipse would take place.

Feels There Was Confirmation

The nearly complete disappearance of the signal was so striking we were worried that something might have gone

wrong with our receiver, but when shortly before the optical eclipse began the signal came back, first in a scattered way, and then strongly and continuously, we felt that we had a complete proof of the correctness of the theory of the electronic eclipse. This record, which was taken during the whole afternoon and evening, will be preserved for those to whom it is of scientific interest.

During this same period observations by earphones were made on other signals. We were particularly interested in a telegraph signal from Germany with approximately the same wavelength as the signal from Schenectady. This signal was heard during the whole afternoon, but during the period when the Schenectady signal was at a minimum the signal from Germany was at its maximum with a very substantial increase.

One fact which is important to keep in mind in attempting to interpret these observations is the calculations of the astronomers that the electronic shadow falls entirely east of the path of the total eclipse where the observations were made. The electronic shadow as shown on published graphs covered a large area nearly bridging the Atlantic Ocean.

A Quandary

It is thus easy to see why the signal from Germany came in stronger during the eclipse, since the electronic shadow produced the effect of night over the Atlantic Ocean and a 30-meter signal is known to be stronger over such a distance at night. It is not so easy, however, to see why the presence or absence of electronic bombardment to the east of the point of observation would have such an effect on a signal from the west.

A clue to this apparent contradiction may be found in the observations of A. Hoyt Taylor, who has made elaborate measurements of the speed of wave propagation. These measurements by Taylor indicate that a short-wave signal received a moderately short distance is delayed in arrival so that it appears as if the signal had travelled something like 2,000 miles further than the direct distance from the transmitting to the receiving station, thus indicating that it does not arrive by the direct path but is reflected from some point 1,000 miles away.

On this basis our observations during the eclipse may be explained. We can assume that the only signal we were able to receive at our point of observation 200 miles from Schenectady arrived at that point not after a direct travel of 200 miles but through one of these Taylor reflections from some point 1,000 miles east. The disappearance of the signal during the electronic eclipse can then be explained if we assume that the reflecting medium had something to do with an electronic bombardment which was absent at that time.

Theory of Double Image

With this assumption we can go further in attempting to explain what has taken place. In examining our graphic record we find that such a record could not have been made by one single ray. If the signal arrives at the receiving station after reflection, we must conclude that there

are at least two such reflections, i. e., two rays arrive simultaneously, one having travelled a distance of several hundred miles more than the other.

This would explain the double image on the record which occasionally gives the appearance of white lines on black background instead of black lines on white background. This theory of reflection may also explain the recent findings of Marconi that even ultra-short waves may at times reach points far beyond the horizon.

If this theory is correct there remains to be explained the nature of the reflecting medium which is produced by the electronic bombardment. Possibly it is one of those phenomena which has become known as the Appleton layer and which must be recognized in addition to the Kennelly Heaviside layer to explain the phenomena of radio.

Almost Complete Suppression

Fortunately we do not need to wait for the next eclipse to investigate this subject further, because the signals that have this peculiar character may be studied any day.

The important fact that we have established is that a signal of a particular wavelength and a particular distance is almost completely suppressed by the electronic eclipse if this eclipse area lies immediately beyond the point of observation as seen from the transmitting station.

Amateurs Believe Eclipse Moved Radio Ceiling

Hartford, Conn. — Approximately one hundred carefully tabulated reports of observations by radio amateurs on the effect on radio signals of the recent solar eclipse have been received by the American Radio Relay League, the national amateur organization. These observations cover all of the high frequency radio spectrum, including the newly developed ultra high frequency region, and were received from strategic points along the entire path of totality.

The basic conclusion arrived at from examining the reports, according to technical experts of the League, is in accordance with the expected phenomena. Conditions during the eclipse, and particularly near the time of totality, resembled those at night, in sharp contrast with the daylight conditions existing before and after the eclipse period.

This lends confirmation to a theory recently advanced which is that it is the sun's ultra-violet or other radiation which creates the ionized layer high in space. This layer, known in radio circles as the Kennelly-Heaviside layer, is in effect the ceiling from which radio waves bounce back to the earth at distant points, and is utilized in nearly all short-wave transmission.

Many amateurs reported hearing foreign and other far-distant stations which had never been heard before at their locations. This seems to confirm the theory of a shower of electrons or charged particles from the sun assisting ionization, and in the case of the eclipse, bringing the "ceiling" into a hitherto unduplicated position with respect to the area of totality.

Radio University

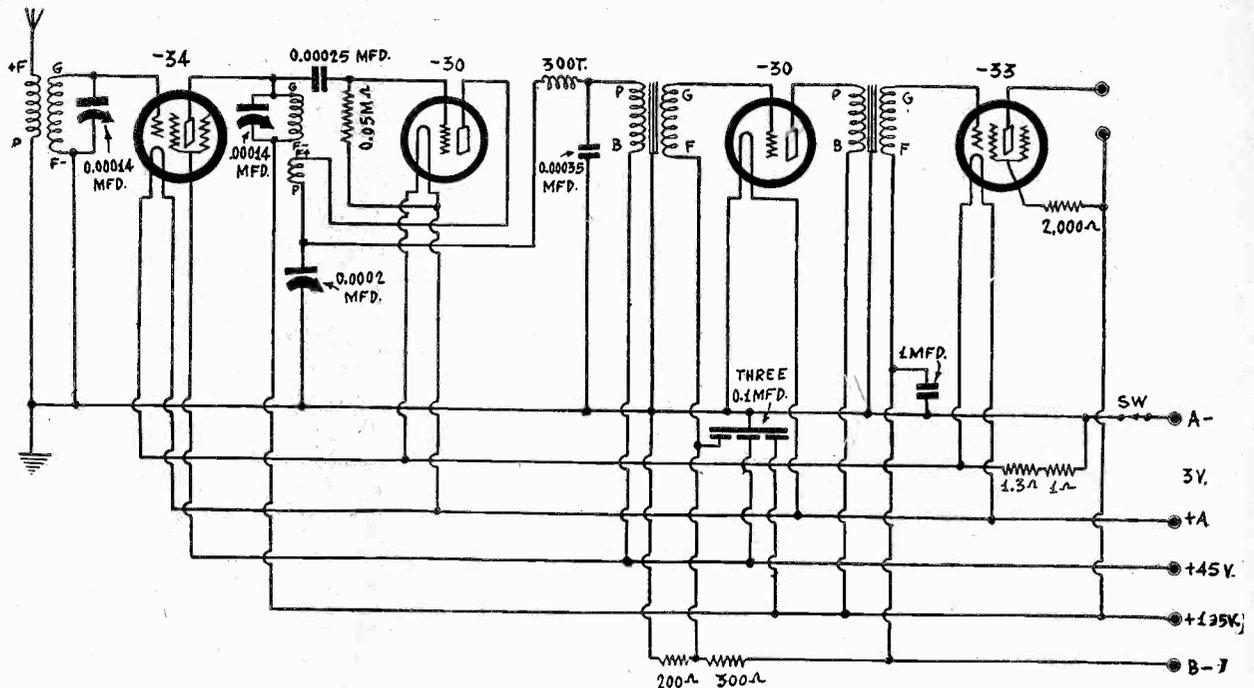
A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at \$6, without any other premium.

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resistance of the plate circuit in a certain manner? If that is done we do not have to have one conception for amplification and another for detection.—A. J. B., Santa Barbara, Calif.

Possibly it would be more logical to regard the functioning of a tube in this manner. Or we might regard the tube from the point of view of the mutual conductance. As far as amplification is concerned the ordinary way of looking at the problem seems to be all right, but it does have drawbacks in respect to detection. It would indeed be desirable to have a relation between the grid voltage and the

FIG. 1029
A four tube regenerative receiver utilizing the small battery tubes throughout.



A Battery Operated Receiver

WILL YOU kindly publish a circuit of a battery-operated receiver using one '34, two '30s, and one '33. I have two audio transformers which I wish to use if possible and two tuning condensers with coils to match. If possible I should like to have regeneration in the detector circuit.—W. H. D., St. Joseph, Mo.

You will find a suitable diagram in Fig. 1029. You will need three variable condensers, two for tuning and one for controlling the regeneration. While the condensers used for tuning are 140 mmfd units for a broadcast set they should be 350 mmfd., or 500 mmfd., if the coils you have are wound for these. The regeneration control condenser should also be larger than the one shown. The circuit remains the same.

* * *

Design of Short-Wave Converters

FOR SOME time I have been experimenting with short-wave converters but so far I have had not had much luck with them. Yet I am convinced that the principle of them is sound for after all they are nothing but short-wave superheterodynes, when taken in conjunction with a good broadcast receiver. If you have any suggestions for making them work satisfactorily I should be pleased to have them. My difficulties are lack of sensitivity, terrible noises at certain settings of the tuning condensers, and trouble with tuning accurately. If there is any preference as to intermediate frequency, what are they?—H. J. S., Newark, N. J.

There is no doubt that the principle of the short-wave converter is sound but the fact remains that they have not been satisfactory. The reason for this seems to be that they are used on so many different sets. There is always trouble in coupling the output of the converter to the broadcast set efficiently. If the proper coupler

is provided one of the main difficulties is cleared up. The lack of sensitivity is largely due to improper coupling. The noises you hear at certain condenser settings are usually due to overloading, which may occur in the converter or in the broadcast set. Very often the overloading occurs in the converter modulator by the oscillator. Sometimes there is blocking of the grid of the oscillator. To prevent blocking the grid leak of the oscillator should not be too high. To prevent overloading of the modulator by the oscillator the coupling between the two should be made loose, yet no looser than necessary to prevent overloading. If the signal voltage overloads the modulator this may be controlled by means of a volume control at the input of the modulator. Oscillator in the modulator circuit should be prevented. There is no particular intermediate frequency that is better than any other, in general. The main thing is to avoid choosing one that is near the frequency of some strong local broadcast station, or any other station that might cause interference. Any frequency to which the broadcast set will tune is all right, provided that there is no interference. The broadcast set may be more sensitive on some frequencies than on others. Naturally, the frequency selected should fall in the range where the receiver is sensitive. The difficulty of accurate tuning is solved by using a slow-motion dial on the oscillator. On the r-f tuner it is not so important. The oscillator selected should also be such that one side of the tuned circuit can be grounded so that there will be no hand capacity.

* * *

Functioning of a Tube

IT IS customary to say that a voltage impressed on the grid of a vacuum tube will introduce a magnified voltage in the plate circuit. Would it not be more logical to say that the grid voltage varies the

effective plate resistance, a known relation that could be dealt with mathematically. We could then without great difficulty predict the performance of a tube both as a detector and as an amplifier. But such a relation is not known any more than is a relation between the plate current and the grid voltage, or the grid voltage and the mutual conductance. Many expressions have been proposed but all suffer from a common defect—they do not fit the case exactly. That is why we always have curves.

* * *

Trapping Out Interference

PLEASE show how interfering local stations can be eliminated by means of wave traps. I understand that a simple trap can be used for suppressing a strong local station.—F. W. R., Albany, N. Y.

You will find a discussion of wave traps elsewhere in this issue. The first type discussed is suitable.

* * *

Selecting Oscillator Coil for Super

HOW is the required inductance determined for a superheterodyne oscillator in which the condensers are ganged and the oscillator is padded, the tuning range and the intermediate frequency being given?—A. C. C., Rochester, N. Y.

Add the intermediate frequency to the highest signal frequency covered by the r-f tuner. Divide the highest frequency by this sum frequency and square the result. Then multiply by the inductance used in the r-f tuners. The result is the inductance required in the oscillator. Since inductance is proportional to the square of the number of turns, for coils of nearly equal size and shape, the turns on the oscillator may be determined by multiplying the turns on the r-f coil by the ratio of the highest frequency to the sum fre-

quency. Let us illustrate. Suppose the i-f is 175 kc and the highest signal frequency is 1,500 kc. Then the sum frequency is 1,675. The ratio is 0.895. If the number of turns on the r-f coil is 127 the oscillator should have 114 turns. If the inductance of the r-f coil is 246 microhenries the inductance in the oscillator coil should be 197 microhenries. It may be that 110 turns would be better because 114 turns would be proportionately more effective than 127 turns in contributing to inductance, because the 114 turn coil would be shorter. Good padding can be obtained by this simple computation.

* * *

Rating Sensitivity of a Receiver

SENSITIVITY of receivers is usually given in terms of microvolts per meter. will you kindly explain what this means? I do not understand what the meter has to do with it.—R. S. W., Omaha, Neb.

FIG. 1030
A push-pull audio amplifier utilizing two 247 type tubes.

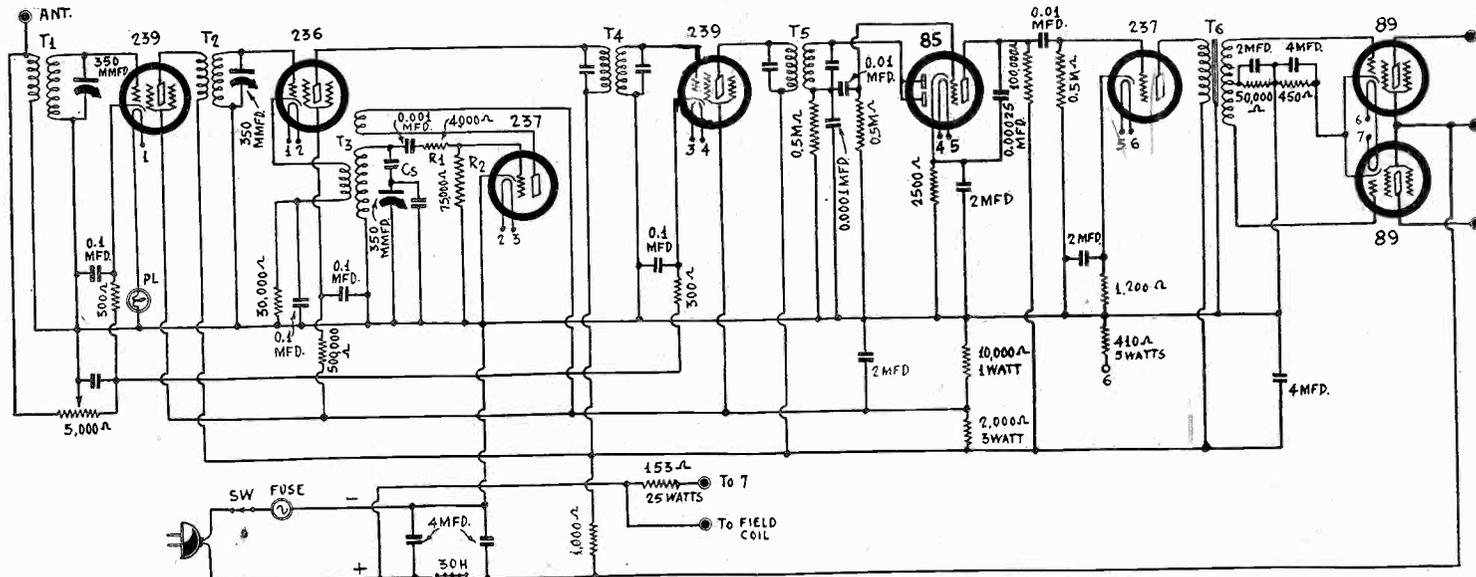
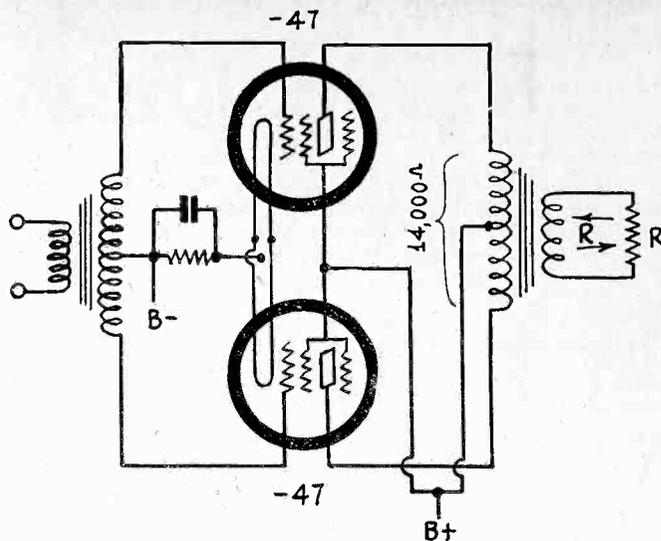


FIG. 1031
The 89 power tube has sufficient output power to make a receiver of this type comparable with one using 247 output.

It does not mean anything and the meter has nothing to do with the sensitivity of a receiver. We might speak of the sensitivity of a set as so many microvolts. In that case it requires that number of microvolts to put out a standard signal, 50 milliwatts in a resistance equal to the optimum load resistance of the power tube, or tubes, the radio signal being modulated 30 per cent. with a tone of 400 cycles per second. The unit microvolt per meter is a unit of field strength in space. It means that if the field is uniform the voltage difference between two points in space one meter apart, and one directly over the other, is one microvolt. If the field is not uniform we have to take a ratio of the voltage between two points very close together to the distance between them. For practical purposes the field from a broadcast station is uniform and we can use the simpler definition of field strength. We erect a vertical antenna effectively one meter high, the number of volts impressed on the circuit served by that antenna is numerically equal to the field strength, provided the field is uniform. But field strength is one thing and voltage is another.

* * *

A Push-Pull Power Stage

IS IT practical to build a high power output stage with two 247 type tubes in push-pull? If so will you kindly publish a circuit and show the values to use, that is, voltages on the elements, grid bias resistor, and the type of speaker?—F. W. C., Rockford, Ill.

In Fig. 1030 is the diagram of a push-

pull stage using two 247 tubes. The voltage applied between B minus and B plus may be as high as 450 volts, but the circuit will work on a lower voltage. The grid bias resistance should be about 200 ohms, or slightly more. The condenser across the bias resistance should be as large as practicable. In view of the low value of the bias resistance, the condenser should be at least 8 mfd. or it will do little good. The input transformer is a regular push-pull audio frequency input transformer. It may be well to connect a resistance of 250,000 ohms across each half

of the secondary of this transformer. The output transformer must be especially designed for the combination of speaker used and these tubes. The impedance of the while primary when connected to a working speaker should be 14,000 ohms. Since the characteristics of the speaker are not known nothing can be said of the ratio of turns except that it should be the square root of the ratio 14,000/R, in which R is the effective resistance of the speaker voice coil. It is best to take the speaker manufacturer's recommendation about the transformer.

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A THOUGHT FOR THE WEEK

FATHER AND MOTHER may go as far as they will in their dislike of "Myrt and Marge," but little Angela and Sue are going to tune in on them no matter how many wry faces their elders make.

Dinner doesn't taste as good as it once did, but the rising generation of gum chewers must have its fill—and what are the grown-ups going to do about it? The answer is .00000.

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Eleventh Year

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POLICE RADIO

IN cities that have police radio, with police automobiles cruising the precincts, in touch with transmissions from headquarters, the catching of a criminal in the act has become so commonplace that it merits only a tiny news item in a newspaper, to fill a hole on the shipping news page. This is indeed a compliment, though preceeding from the left hand. The police radio system works so very well indeed that its state of quasi-perfection is accepted as a matter of blase fact.

The radio is therefore an instrumentality of great importance in catching criminals, especially offenders against the laws prohibiting acts of violence, actual or intended. Hold-up men, robbers, burglars, even hijackers, are trapped in this way, and against them is piled up direct evidence of a most conclusive sort, too convincing to permit jurors to render verdicts of not guilty. There is no defense that even the most astute lawyer can rely on to controvert the testimony of police officers and others who describe how the defendant was caught in the act. The alibi, overworked in the history of American courts, finds itself barren of the very possibility of existence.

It would be interesting to see a record of the disposition of criminal cases in which the defendants were caught by virtue of radioed information. The percentage of convictions, or equivalent pleas of guilty, probably would run much higher than in the general course of criminal events.

During the last quarter of a century the problem of felon-catching has become harder and harder, due to the advent of the automobile. Few are the crimes of violence in which the automobile is not a concomitant instrument of perpetration or escape. While it is true the police have the same access to automotive transportation, the fact is that the criminals have the first selection, and are out of sight before the police arrive. The difficulties presented by the automobile are appreciated by all police officers and commissioners.

But the radio is one-sided, so far, on the side of law enforcement and swift appraisal. Moreover, it would be no advantage to the criminals to have a receiving set in a car to pick up police signals, as the receiver would not prevent the transmissions. What they would need would be a transmitter, and a voice to simulate the impersonal tone from headquarters, to misdirect the police. Yet that, too, would not work where a form of code is used, as is done in some cities, including New York. Numbers are used for identifying the cars addressed and

Ten Years Ago This Week

TEN years ago it was recognized that storage batteries were nuisances and that something had to be done about them. Who cared to recharge, refill, scrape and strain? Not a soul. But the lucky possessors of tube sets had to light, or rather heat, those tubes. And there seemed to be no way out, for connecting a-c to the filament, and doing nothing else about it, produced intolerable hum.

So Charles White reported a development of Dr. P. D. Lowell, of the Bureau of Standards, and before recalling what that was, and lest one spoil your pleasant enjoyment of the depression, let us all bow with reverence to the men who in those days had to have foresight, whereas we today seem to need only hindsight but have plenty of it, thank goodness.

How It Was Done

Well, the learned doctor (not a medical man by the way) had this to suggest: use a stepdown transformer that had a tapped secondary. Connect the primary to the a-c line and take up any small difference between the secondary voltage and the required filament voltage by connecting to the proper secondary tap. That much was easy. But how about the hum? Wait! A little patience please!

Instead of connecting the grid return to one side of the filament, as was done with battery operation, the trick was to return the grid to a point of zero voltage difference between the filament terminals. In other words, our good friend the potentiometer, so much in evidence to-day, although of the fixed-center-tapped resistance type, since we have heater tubes, or power tubes intended for a-c excitation of filament.

Yes, the potentiometer should be 220 ohms, say 100 ohms on each side of a 20-ohm potentiometer. Then the hum may be almost balanced out. The grid return would be to slider and the trick would be to find the point for grid return that did not introduce much of that confounded hum.

Hum "Almost Inaudible"

Mr. White suggested that of course filter circuits could be used, for they were scientifically correct, but rather expensive. Well! Expense entered into it in those days, too!

"Although there is always present a 60-cycle hum," reported Mr. White, "it is possible so to adjust the set that this hum is almost inaudible."

"In conclusion I would like to call attention to the fact that this method of lighting filaments is not only easy to install but exceedingly efficient and economical in operation. There is no heavy, soiled storage

for giving part of the directions. The details are spoken, but often mean little without knowledge of the code, although to the actual perpetrators the gaps conceivably could be filled in from the experience of the moment.

Fingerprints are of vast importance in criminology, although they have what might be termed a belated usefulness, being *ex post facto*, but police radio is part of the *res gestae*, the very body of the crime, and with the use of police radio by more cities, and the enlargement of facilities in cities already so equipped, it is likely that police radio will turn out to be more important

battery to be carried and recharged; there is no charging set to be purchased; and last, but not least, your outfit is ready for operation at any time current supply is in your house. No waiting until the battery is recharged or other delays."

That article was published in the September 23d, 1922, issue of RADIO WORLD.

The Tube Detector Unit

While Dr. Lowell of the Bureau of Standards was busy in that direction, others in the same Bureau, and possibly himself included, turned out an article on how to build "an electron tube detector unit." This was simply a detector tube socket with a rheostat and the inevitable bezel on the front panel, and bus wiring leading to metal binding posts. A baseboard, insulation panel and bayonet type socket were used.

The idea was that here was the detector tube, to replace a crystal. Assumptively you had the tuning device you used formerly with the crystal. If not, no matter, you could build the tuning mechanism. This consisted of tapped secondary and tapped primary, with switch points at front panel for tap positions, but to use a condenser you had to reach over the top of this extra unit, for the condenser was in a circular shield, with knob and pointer at top. One illustration showed the tuning unit, the detector unit, the B battery, the A battery and the phones, and if all these were spread out end to end, etc.

Uncle Sam's Work

Full directions were given for building this, including advice on where to connect and how to solder, and the total cost of parts was estimated at from \$23.25 to \$36.70, depending on the quality of parts used.

There were no factory-made receivers at that time, and the entry of the United States Government into the field of teaching the construction of a one-tube earphone receiver was considered an important step. The importance may be conceded on the basis of the many receivers built after this carefully prepared pattern.

The article was prepared with expected precision and a comforting attention to every last detail. It would serve as an excellent model to any present-day radio technical author.

The light of other days is illuminating indeed, especially as it should remind us of the advantages if not blessings that we enjoy in radio today, with a-c operated receivers selling for from \$10 (less tubes, but including wired chassis, speaker and cabinet) to a few thousand dollars for special installations for the fastidiously wealthy.

than fingerprints, if for no other reason than that the criminals have been caught, and the prints then become merely a matter of case history rather than a clue precedent to a long search.

Just having police radio and leaving all the work to the police is not enough. Police Commissioner Mulrooney of New York City realizes this, and advertises in street cars, asking that persons who see or suspect a crime being committed telephone at once to headquarters. The rest may be left to the police. So in the last analysis the citizenry must co-operate if police radio is to be fully effective.

STATION SPARKS

By Alice Remsen

Transmutation

For "Sweet and Low"

WOR: Mon., Tues., Wed., Fri. 10:00 p.m.
Thurs., 7:45 p.m.

The tired world is resting,
A red glow tints the sky;
The birds for home are queesting,
For eventide draws nigh.

The willow trees are bending,
Down by the silent lake,
They know the day is ending
And so obeisance make.

The darkling night, appalling,
Above the world is spread,
A sable blanket falling
Upon creation's bed.

The crescent moon is pendant
And in her queenly way,
With golden light resplendent,
Will turn night into day.

—A. R.

* * *

And as the moon turns night into day, so will the lovely voices of the "Sweet and Low" girl's trio turn your sorrow into gladness, your tired heart into a haven of peace and content. The voices you hear belong to Verna Osborne, soprano; Annette Simpson, soprano, and Veronica Wiggins, contralto.

* * *

The Radio Rialto

One is almost forced to be a philosopher when in search of news, and say: "Oh, well, if I don't find any today, I shall tomorrow." Yesterday I popped here and there frantically, but not a crumb of information could I find, but ah—today was different, and here I am simply bursting with chatter. . . . Went up to Feist's, and ran into—of all people—May Singhi Breen and Peter de Rose. . . . Of course, you know this ukulele lady and the melody man—they were once radio sweethearts and now are a happy married couple; radio fans know of their charming romance. . . . Peter tells me he has a new song with Joe Morris, and I told him I'd already mentioned it in this column—but I'll do it again—it's "You'll Always be the Same Sweetheart"—nice sentiment—I'm using it next week on a Stanco program. There's the dark-eyed Maria Cardinale; she is due for some commercial programs this Fall—this little lady has a distinct style of her own—one of the few sopranos acceptable over the air. . . . And now off again—walking down Broadway whom should I meet but Nell Burt, a versatile little actress who has been doing a "Ruth Draper" idea over WMCA for Charm Tea for stout ladies. . . . As I stand talking to Nell, Chick Bullock hails me—Chick is the radio crooner who was in a fair way to become a picture star when Fate, in the shape of Kleig lights, ruined his eyes—now the poor lad is forced to wear dark glasses all the time—but it doesn't affect his disposition; he's a cheery chap, always wearing a smile.

Now over to NBC, up to the 12th floor, program department. . . . As I step off the elevator, Hart Giddings, one of the more human NBC executives, bumps into me—tells me a funny story and laughs

himself away. . . . Into the program department, where I find Jessie Deppens, who tells me she has a new song coming out with Chappell—a follow-up for "In the Garden of Tomorrow"—the new one is called "There is a Garden in My Heart," and it's bound to be nice, because Jessie never writes anything mediocre. . . . She also tells me some welcome news: Big Bill Glenn, basso of the Revelers, has a program of his own twice a week, something a little different, Mondays and Thursdays, 10:15 p.m. WJZ. Be sure to listen; Bill's okay. . . . Merry little Marjorie Horton stops at Jessie's desk and gives us all a sunny smile. Marjorie is doing some delightful work on Frank Tours' fine program, "Yesterday and Today"; she is that rare thing, a lyric-coloratura, you must remember her on the old Wrigley program in 1928. . . . Then Joe White, the Silver Masked Tenor, happens along; he is looking positively lean these days; lost twenty pounds since he left St. Vincent's Hospital; he was there to be X-rayed—thought he had 'pendicitis, but it was only the colon—so now he's reducing to a semi-colon—yes, that's my own joke—terrible, sez you; I admit it and promise not to do it again.

The blonde beauty of Harriet Lee lights up the corridor; she is playing the Loew Circuit with her boys. Harriet has a new car—a Plymouth convertible coupe. The car was just a week old when Harriet got a ticket—for parking—someone pushed her in front of a fire-plug; at least, that's her story and she stuck to it, but the hard-hearted judge didn't believe her. . . . Well, in I go to Studio X for my Stanco rehearsal, only to find that some girl friends of mine are to be on the same program—Dorothy Dale, Gertrude McDonald and Florence Shewell—known to radio as The Three Gibson Girls; they've been doing some grand work over WOR—they give a lot of credit to that great little ace, Charles Bates, who is their arranger and accompanist. "Mac" McMann, production pilot for Stanco, verifies the fact that the program will go on the air five times weekly very shortly.

Well, rehearsal's over; downstairs for a cup of coffee with Johnny Hart, "Mac" and Joe Bonime, the orchestra leader—then Johnny drives me over town and drops me off at Jack Robbins, the publisher of Kate Smith's "moon" song. "Goodnight, Sweetheart," and other big hits. Jack is said to have done fifty per cent of the total music business last year; he's a lucky publisher; he and the missus are making another jaunt to England; sail on October 16th. With Jack I find a chap from the corn belt—H. Dean Fitzer, a tall personable fellow; he is manager of Station WDAF in Kansas City and Radio Editor of the Kansas City Star—just in town for a few hours on business. For seven years he has guided the destinies of WDAF, the station which gave Carlton Coon his first start; for fourteen years he has been connected with that very independent daily, the Kansas City Star. . . . After chinning for half-hour or so, must get along, so trot up Seventh Avenue and run into nobody else but Will Osborne; still as slender and debonair as ever; he's doing fine business up at Woodmansten Inn. . . . B-r-r-r—it's getting quite chilly on the corner—think I'll get along home and see if Octavia has some nice onion soup ready for me; gee, but the weather changes quickly in this man's town—if this keeps up I'll have to wear my mittens.

News of the Studios

WABC

Aunt Jemima's back on the air again, sponsored by Jad Salts. The hefty blues-singer may be heard each Tuesday, Wednesday and Thursday at 2:00 p. m., accompanied by Fred Berrens and his orchestra. . . . Christy Walsh, national sports writer, will present an All-American football series every Friday at 9:00 p. m. He will bring to the microphone prominent football coaches of the country for forecasts, sidelights, and chats on strategy and training. An 18-piece band under the baton of Freddie Rich, and a large male chorus, coached by Andre Kostelanetz, will present college and fraternity songs. This series will be sponsored by the General Foods, Inc., in the interests of Postum.

* * *

NBC

Bruce Barton, author and magazine writer, whose articles and books have a wide following throughout the country, has inaugurated a new series of talks on the General Electric Circle program. He may be heard every Tuesday, at 5:45 p. m. over Station WEAJ—and thirty others. Heywood Broun continues on the program as a daily commentator on the news; other guest artists include Albert Payson Terhune on Mondays, Clara Savage Littledale on Wednesdays, John Erskine on Thursdays, and Madame Sylvia on Fridays. . . . Gene and Glenn began their third season of broadcasting recently; during September and October they will be heard three times weekly, Tuesday, Thursday and Saturday. After October 31st, however, they will resume their regular schedule of six days a week, at 8:00 a. m. over WEAJ. They are sponsored, as usual, by the Quaker Oats Company. . . . Ed Wynn, Texaco Fire Chief, says "All the world's a stage and all the women are leading men." . . . "A chain," according to King Kill Kare, "is no stronger than its weakest link, and a laundry is no stronger than its weakest Chink."

* * *

WOR

Glad to hear that Mildren Hunt has started a series of programs over this station; she may be heard every night except Saturday and Sunday at 10:45 o'clock. Known as radio's sweetheart, Mildred has gained quite a following through her work on NBC Columbia chains. . . . Cosmo Hamilton, the distinguished British novelist whose broadcasts are a feature over WOR every Monday night at 10:15 o'clock, has just completed a new play which will be produced in New York this Fall. The title is "Burning Petticoats."

* * *

Biographical Brevities

ABOUT JAY C. FLIPPEN

Jay C. Flippen was born in Little Rock, Arkansas, in March, 1899. Is part Chickasaw Indian. His mother was a talented amateur performer and from her Jay inherits his thespian qualities. He made his professional debut in a local theatre at the age of fourteen. At the age of fifteen he arrived in Chicago and began to batter on the doors of booking agents. It didn't do him much good, so in desperation he worked on the lake boats. He finally got a break when he was nineteen, in a tabloid act, "Vanity Fair," playing one night stands through the Middle West.

Then came burlesque and Al. G. Field's Minstrels. Then he took Bert Williams' place in the road show of "Broadway Brevities" and when it closed was booked for three years in R-K-O vaudeville. Fol-

(Continued on next page)

SALES TALKS ON CBS LIMITED AS PRICES GET O.K.

The Columbia Broadcasting System announced a new tentative policy affecting the length and nature of sponsored programs.

The restriction which heretofore has prevented advertisers from mentioning on the network the prices to be paid for their products is eliminated.

To this end the following schedule has been drawn up:

Not more than two price mentions on a 15-minute program, provided that the total length of all "sales talk" shall not exceed one and a half minutes.

Not more than three price mentions on a 30-minute program, provided that the total length of all "sales talk" shall not exceed three minutes.

Not more than five price mentions on a 60-minute program, provided that the total length of all "sales talk" shall not exceed six minutes.

No Price Competition

Prices mentioned must be of the article or articles advertised and must not be competitive or comparative.

Columbia proposed to its advertisers that every effort be made to prevent a sales talk at the end of one program and another at the beginning of the following one.

Although the first object of the new policy is to reduce the amount of "sales talk" it might also have an effect on economic recovery.

"At the new price levels," said President William S. Paley, "there are many bargains for the public. We in Columbia feel that the mention of these prices should provide an undoubted impetus to buying."

Effectiveness Claimed

"We believe a conviction is current among advertisers that the past twelve months have demonstrated the effectiveness of radio as a direct selling weapon to a degree that was scarcely hoped for in the early days of broadcasting. We offer the foregoing program as a means of increasing still further the effectiveness of radio as a medium by rendering a more complete and satisfactory service to the listening public, clarifying and emphasizing the advertising message, and reducing commensurately the length of the commercial continuity."

No "Certificates" for Cabinets and Chasses

Radio Manufacturers Association, Inc., received the following statement from the Treasury Department relative to a ruling on chassis and cabinets:

"You are advised that under the law and regulations manufacturers of cabinets and chassis for radio receiving sets cannot sell such articles tax free under exemption certificate. However, where a manufacturer of a complete radio receiving set purchases various taxpaid components for use in the manufacture thereof he may sell the complete set at a specified price and will be permitted to pay tax only on the taxable articles manufactured by him, provided, such records are kept that will show specifically the selling price of the articles manufactured by him."

Station Sparks

By Alice Remsen

(Continued from preceding page)

lowed Broadway musical shows. The first was Shubert's "June Days"; others included "Hello, Lola," "Great Temptations," "Artists and Models," "Padlocks of 1926," and the second "Little Show."

His first time on the air came when he served as master of ceremonies at a banquet which was broadcast. He has played every state in the country, and nearly every town of ten thousand or more. Has made records for three leading phonograph companies. Made plenty of movie shorts.

Is crazy about baseball and never misses a game at the Yankee Stadium. Plays occasional golf, and is not very enthusiastic about bridge. Likes to watch prize fights. Is an avid radio fan. Gets his hair trimmed once a month, but never allows a pair of scissors to touch the locks on top. Is a very enthusiastic sort of a chap. Is an only child.

(If you want to know something of your favorite radio artists, send a card to the conductor of this page. Address her: Alice Remsen, care RADIO WORLD, 145 W. 45th Street, New York, N. Y.)

OVERSEA RADIO USES TELETYPE

Application of the teletype machine, such as has been used for printer service over wire lines, to international radio-telegraph circuits has been accomplished by engineers of the Radio Corporation of America and circuits employing this new service have been established by R.C.A. Communications, Inc., between San Francisco and the Hawaiian Islands.

Extension of the service to other circuits will be undertaken in the immediate future. Developmental work in connection with the radio teletype has brought within sight, according to RCA engineers, the possibility of multiple communication on a single radio frequency, so that the same radio channel may be made to carry two or possibly three messages without interference. Research activities are now being directed toward the goal of triplex operation.

Although the teletype has been utilized experimentally in radio for some time, extensive engineering and research were necessary to adapt it to a regular commercial radio service. This has been made possible through the development of a system of vacuum tube impulse relays.

Fu Manchu Thrillers Go On the Air Monday

The Fu Manchu mystery stories by Sax Rohmer, familiar to readers and moviegoers throughout the world, will come to radio Monday, September 26th, from 8:45 to 9:15 P. M., E. S. T., in the first of a weekly series over WABC and the Columbia network.

Rohmer, famous English novelist and creator of "Fu Manchu," will come to the United States to attend the radio premiere in Columbia's Chicago studios. Honoring the first author to cross the ocean for a radio premiere, and to supply an added note of realism, the cast will play the first episode in costume. The radio presentations are under the sponsorship of the Campana Corporation.

BOARD TRYING RED TAPE CUT, \$67,000 SAVING

Washington.

The Federal Radio Commission has created a new section to be known as the "Accounts and Audit Section." This is in addition to the recently created "Division of Field Operations." The new section will handle all matters pertaining to settlement of international accounts, except disbursements; audit travel and expense vouchers; and perform such accounting work as may be assigned. The new sections were created when the Radio Division of the Bureau of Standards was merged with the Federal Radio Commission.

By the merger in Washington, the Commission will save \$34,000, it is estimated, and by the field changes will save \$33,000, according to information made available orally at the Commission.

In reorganizing the field services, it will be necessary to discharge at least 20 employees, it was stated.

Field Duties

The Commission at the same time outlined in detail the duties of the new Division of Field Operations, recently created to perform the function of the Radio Division. These duties will be as follows:

To inspect all transmitting apparatus to ascertain whether in construction and operation it conforms to the requirements of the Radio Law of 1927, as amended, the rules and regulations of the licensing authority, and the license under which it is constructed or operated; to make measurements of frequencies and to make field intensity measurements when required; to maintain records incident to the monitoring of radio stations; to conduct examinations for applicants for operators' licenses; to investigate and report to the Commission facts concerning alleged violations by station operators of such laws, treaties and regulations as might result in the suspension of their licenses; to report to the Commission from time to time any violation of the Radio Act of 1927, the rules and regulations or orders of the Commission, or, of the terms and conditions of any license; and to perform such other duties as may hereinafter be assigned.

Terrell Is Chief

W. D. Terrell, former chief of the Radio Division, will head the Field Operations staff.

The merged agencies are expected to operate more efficiently than when they were separate establishments, Commission officials stated orally. A great deal of "red tape" will be eliminated, they explained.

Germans Exempt Jobless from Paying Tax on Set

Washington.

Unemployed persons in Germany are exempt from paying the monthly radio tax of two marks, according to a report to the Department of Commerce. The blind and war invalids are also exempt from paying the tax.

The total number of German radio subscribers on July 1 of this year was 4,119,531. Ten per cent. of these sets are exempt from the tax.

Lowell Thomas a Champ, But at First He Took It on the Chin "Plenty"

When the movies had begun to take such a hold on the American public that the illustrated travelogue lost its previously wide popularity, a youth not yet of voting age had the temerity to offer a travelogue on Alaska to the reluctant people. Moreover, the first brave stand was made in New York City, the most trying field, for there was the intense competition of the legitimate theatre, vaudeville, musical comedy and even burlesque, not to mention a word about the raging movies. And that stand was made at the Century Theatre, only a few blocks north of Columbus Circle, yet in a zone that theatregoers seemed to shun, for this enormous and elaborate playhouse never was a success. In the face of these difficulties Lowell Thomas, wearing a mustache to make him look older, made his distinguished appearance. I was among the handful that seemed lost in that vast auditorium.

But you might have assumed the house was crowded, if you judged only by the manner and method of young Thomas. His resonant voice carried the story of his Alaskan trip to the gilded filigree of the theatre's dome ceiling, he interested his meagre audience mightily, and he finished his run at this theatre just as determined as he had been at the start. The experience was enough to take the steam out of most men. If one has to talk to the walls for a couple of weeks one finally feels harrowed. Not so of Thomas. He had what is called at an afternoon tea intestinal fortitude, and at a prize fight guts.

He Meets Secretary Lane

Outside of New York Thomas fared better, and probably he had no more interested and packed audience than in Washington, D. C., due in part to the interest of Government officials in Alaska.

Thomas took pains to invite the Secretary of the Interior to attend the travelogue. That official was Franklin K. Lane. The vast territory where flowers bloom and wheat grows, yet where ice stills the rivers and frozen wastes call huskies to their sleds and overland tasks, where the tallest mountain on the western hemisphere lifts its peak, and in the bosom of the domain reposes enough coal to last the world at the present rate for 500,000,000 years, was under the jurisdiction of Secretary Lane.

The mere youth on the platform won the admiration of Secretary Lane, and a friendship started that lasted until the Secretary's death, some years after he had gone out of public office.

When Thomas decided that he would make a personal study of the operations at all the Allied fronts during the World War, shortly after the United States entered it, he had to be duly accredited as a correspondent, and Secretary Lane, who had been impressed with the personality and pluck of this young man, made it possible for Thomas to get every credential he needed.

Generals to the Side

Having read the credentials, I assumed that if during an attack Thomas desired to penetrate the Allied lines to the very front for a better and closer view, all general officers were to put at his disposal their personal automobiles and chauffeurs.

Thomas "did" the war on a grand scale, making a minute study of not only operations, but personalities as well, and including in the scope of his clinical endeavors the Eastern front, where a spectacular and inspiring campaign wrested the Holy Land from the yoke of the infidel.

Thus Thomas met General Allenby, and the General was won by the young man's personality, charm and determination quite as much as other leaders had been, and still other leaders were to be in years to come. "With Allenby in Palestine," on Thomas' return to the United States, became his most popular travelogue, and movies or no movies, great metropolitan distractions or none, people flocked to hear Thomas tell of the restoration of the sacred soil of the poetical homeland. For two months Boston flocked to hear him. Success attended Thomas in other cities. He had "arrived."

Being interested in personalities, it was only to be expected that Thomas would seek out Col. E. T. Lawrence, dashing soldier of imperishable memory, even though Lawrence is now in the British Army by insistent choice as simply Private Shaw, rather than as General Lawrence.

The War's Most Romantic Figure

It will be recalled that the motley tribes of the Arabian deserts were doctored with revolt. If they could not revolt against a British domain they would revolt against other tribes, or individual against individual. That was their creed. And then Lawrence, the man whom they trusted as they trusted no one else, and who united all the tribes, and executed such amazing military exploits that he won distinction as a military strategist, was commissioned a Colonel, and routed the Turks. Any one who has not read Col. Lawrence's own book, "The Revolt in the Desert," should do so, for he is also a singularly gifted observer and writer.

Thomas on his return to this country also wrote biographical books about romantic and adventurous figures, including of course Col. Lawrence. Thomas is daring himself, and he writes and talks of those who dare.

Travelogues, books and magazine articles made it possible now for Thomas to obtain a substantial income, and meanwhile his reputation was growing. So when Floyd Gibbons' contract with "The Literary Digest" expired, Thomas became "the voice of the Literary Digest." Six nights a week his fine speaking voice was heard on the air, bringing the news of the world, enriched by comments and relation of personal experiences, for he had done his large share of knocking about the globe.

When the "Digest" was to go off the air for a spell there were many bids for Thomas' services, and Sunoco won out, so that now Thomas is sponsored on the air by that oil company.

Thomas as Teacher and Reporter

I first met Thomas when I was attending St. Lawrence University Law School, at Brooklyn, N. Y., when he was teacher and I one of the pupils, although he was a year

younger than I. He wasn't teaching law, although he had studied it in Chicago. He had just come from Princeton University, where he conducted a public speaking department. As lawyers have to be speakers of sorts, he fancied a law school would offer a good opportunity to branch out.

Due to my selection of topics I was to discuss, it became evident that I had something to do with the newspaper business. I told Thomas I was a reporter at the New York City Hall at the time. He had been a reporter in Chicago, and a most persistent one.

As an example of his fortitude, he set out alone to find a criminal whom the police the country over could not catch. The only data at hand were details of the crime, a scant description of the culprit (no photograph or fingerprints), an estimate of his age and the remark chanced by some witness that the fugitive had been reading up on college curricula. So what did Thomas do but write a letter to the president of every college in the United States—typed every letter himself, for reporters do not rate stenographers—describing the fugitive and soliciting a report as to whether any one of that description had enrolled in the college. And what do you suppose? Yes, one president wrote back that a youth who might fit the description, was one of the new students. Thomas took a witness with him, the student was identified and taken back to Chicago by Thomas, the boy reporter with the mustache.

* * *

Code of Success

Absentee audiences at the start of his travelogue career of course do not sum up all that he had to face early in life. He worked as printer's devil in the mid-West, he sold newspapers on the street, he got into tight jams such as beset a reporter without fault of his own, and he snatched an education from the lion's teeth of adversity.

Thomas has not uttered any credo of success, for he is too modest, but surveying his forty years for half their span I can see his code just as clearly as if he had embodied it in a personal statute. It is this:

- (1)—Aim high.
- (2)—Never say die.
- (3)—Interest yourself in the ambitions and problems of your friends, and encourage them constantly.
- (4)—Feel important enough to deserve to be important.

That last may seem inconsistent with modesty, but isn't, for the unquenchable fire of zeal is kindled only by flaming importance. Inconsequence of thought and deed quenches every activity in the end.

* * *

The Winning Way

Much about a man can be determined by hearing him talk. Voice and expression reveal personality quite as much as the twinkle of an eye or the vigor of a handshake. And so throughout the land—and overseas due to short waves—the friendly voice of Lowell Thomas is welcomed into millions of homes. And it is the kind of voice, illuminating a prince of men and a sparkling personality, that carries an abundance of good-will.

—HERMAN BERNARD.

Tube List Prices

Type	List Price	Type	List Price	Type	List Price	Type	List Price
11	\$3.00	'38	2.80	'24-A	1.65	'80	1.05
12	3.00	'39	2.80	'26	.85	'81	5.20
112-A	1.55	'40	3.00	'27	1.05	82	1.30
'20	3.00	'45	1.15	'30	1.65	'74	4.90
'71-A	.95	46	1.55	'31	1.65	'76	6.70
UV-'99	2.75	47	1.60	'32	2.35	'41	10.40
UX-'99	2.55	'50	6.20	'33	2.80	'68	7.50
'100-A	4.00	55	1.60	'34	2.80	'64	2.10
'01-A	.80	56	1.30	'35	1.65	'52	28.00
'10	7.25	57	1.65	'36	2.80	'65	15.00
'22	3.15	58	1.65	'37	1.80	'66	10.50

ONE-THIRD OF HOMES HAVE NO ELECTRIC LINE

The United States Department of Commerce has issued some interesting figures, based on the latest census, which indicate the extensive market existing for battery operated radio receivers.

One in every three homes in the country, the announcement states, is unwired and therefore must use a battery powered set or do without radio.

In these homes are a total of 9,800,000 families who must depend on battery powered sets if they are to enjoy radio at all.

A surprising thing brought out by the census is that many of these unwired homes are within the corporate limits of cities, indicating a market for air cell sets in urban centers as well as in rural sections.

Arranged by states, the figures for the total number of homes, and the number without electricity, are as follows:

State	Number of Homes	Number of Homes Without Electricity
Alabama	592,530	442,676
Arizona	106,630	52,361
Arkansas	439,408	342,453
California	1,618,533	45,221
Colorado	268,531	98,622
Connecticut	389,596	13,217
Delaware	59,295	21,128
Dist. of Columbia	126,014	21,860
Florida	377,823	194,719
Georgia	654,009	490,642
Idaho	108,515	42,034
Illinois	1,934,445	333,666
Indiana	844,463	254,762
Iowa	636,905	238,774
Kansas	488,055	201,906
Kentucky	610,288	368,747
Louisiana	486,424	319,622
Maine	198,372	44,367
Maryland	386,087	110,151
Massachusetts	1,024,527	59,382
Michigan	1,183,157	250,175
Minnesota	608,398	234,728
Mississippi	472,354	399,382
Missouri	941,821	389,918
Montana	137,010	70,412
Nebraska	343,781	145,732
New Hampshire	119,660	21,845
New Mexico	98,820	69,383
New Jersey	987,616	71,427
New York	3,162,118	162,334
Nevada	25,730	12,466
North Carolina	645,245	431,525
North Dakota	145,382	97,187
Ohio	1,700,877	390,143
Oklahoma	565,348	342,611
Oregon	267,690	*64,100
Pennsylvania	2,239,179	506,336
Rhode Island	165,811	3,022
South Carolina	366,265	281,501
South Dakota	161,332	98,220
Tennessee	601,578	396,895
Texas	1,383,280	837,380
Utah	116,254	21,794
Vermont	89,439	23,975
Virginia	530,092	311,370
Washington	426,019	85,036
West Virginia	374,646	225,002
Wisconsin	713,576	191,345
Wyoming	57,218	31,083
Totals	29,980,146	9,862,657

*Estimated.

Tradiograms

By J. Murray Barron

While a large number of servicemen in some of the smaller communities find a ready market for custom-built receivers, there being a dozen or more excellent standard kits on the market, yet there are many others whose neighbors and customers prefer to see a complete receiver in the cabinet. In this field there are a great number and variety of receivers of excellent and attractive design. The choice is wide, hence the customers can get from four tubes to any number that will appeal to his pocketbook or idea of performance or possession.

Some manufacturers will include a personal nameplate to lend local color, at only a small cost. In this way the serviceman builds up his own business with no need for manufacturing facilities. His only care being to represent a reliable manufacturer. The number of manufacturers who are not tied up in local territories runs into dozens. This is in addition to the receivers offered by the numerous mail order houses who cater to the serviceman and local dealers. Possibly these manufacturers are unknown to the greater numbers of servicemen and dealers, as they do very little advertising and solicit much of their business by personal contact. Of course, this necessarily confines them to a restricted territory, which is not to their best advantage for it not only is the cause often of needless competition, but leaves unsolicited a vast territory that needs the contact equally as much as the servicemen and dealers need the business.

Harry Goodman, director of the radio show to be held at Hotel Edison, 228 West Forty-seventh Street, New York City, September 19th to 25th, reports excellent co-operation from the manufacturers. Dealers, jobbers and distributors from all sections of the country are expected to attend. Practically all of the booths of the grand ball room have been taken, and more than sixty manufacturers are expected to exhibit.

National Union Radio Corporation, 400 Madison Ave., N. Y. City, reports that Dr. E. A. Lederer, research and development engineer, is spending several months of intensive study on radio tube and cathode ray tube development in principal European countries. He is expected back the latter part of this month with a wealth of data for application to experiments in the National Union Laboratories.

H. Curtis Abbott, vice-president in charge of sales of the Columbia Phonograph Company, announces the appointment as metropolitan distributors the Okeh Radio and Record Co. It will be operated by Maurice Despres and Julian Jacobs at 25 Warren Street, N. Y. City. Their territory will include Greater New York, Long Island, Westchester County and parts of New Jersey. Sales of records will continue to be handled by the Empire Radio & Phonograph Co., of 41 West 14th Street. At Chicago Phillip Crowen-Snyder, Inc., has taken over the Columbia branch at 111 North Canal Street. This branch has been a landmark for more than thirty years. Both radio and record will be handled by Crowen-Snyder.

PHONE SERVICE TO EGYPT

Radiotelephone service between North America and Egypt has been opened to the public via London. The service at the Egyptian end embraces Cairo and Alexandria, the former having 17,500 telephone instruments and the latter 11,600. The distance between New York and Cairo, via London, is 6,000 miles.

SOUND TRAVELS BEST WHEN DAY IS COOL, DAMP

After a two-year study of sound absorption in air, the Bureau of Standards has discovered that sounds can be heard farther on cool, damp days than on hot, dry days, and that the absorption in hot, dry air is greater for sounds of high pitch than for those of low pitch.

The Bureau also found that the "rate of decay of sound in a room does not follow exactly the uniform law that has hitherto been assumed, but is influenced by the area of absorbing material present and its distribution."

These factors affect the design of radio broadcasting studios, because broadcasters endeavor to keep the sound absorption constant in the studios. The rate of decay must neither be too rapid nor too slow.

New Incorporations

- Broadcast Radio and Television Co., Inc., Bayonne, N. J., deal in radio and television equipment.—Atty., Benjamin Nessenbaum, Bayonne, N. J.
- Dreyer Furniture and Radio Co., New York City.—Atty., Hyman & Hyman, 103 East 125th Street, New York City.
- Mason-Dixon Radio Group, Inc., Wilmington, Del., radio and television broadcasting.—Atty., H. Albert Young, Wilmington, Del.
- Noel Lamp Works, New York City, electrical appliances.—Atty., L. H. Robinson, 475 Fifth Ave., New York City.
- Johnston & Davies, Inc., Wilmington, Del., telephone and radio equipment.—Atty., Corporation Trust Co., Dover, Del.
- Home Radio and Washing Machine Co., Atlantic City, N. J., radio and electric appliances.—Atty., H. Walter Gill, Atlantic City, N. J.
- Simpson Speed Unit Corp., Detroit, Mich., electrical and mechanical engineers.—Atty., Colonial Charler Co., Dover, Del.

CORPORATE CHANGES

Adelberg Refrigerator & Fixture Corp., Brooklyn, N. Y., to Ace Refrigerator & Fixture Corp.

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.

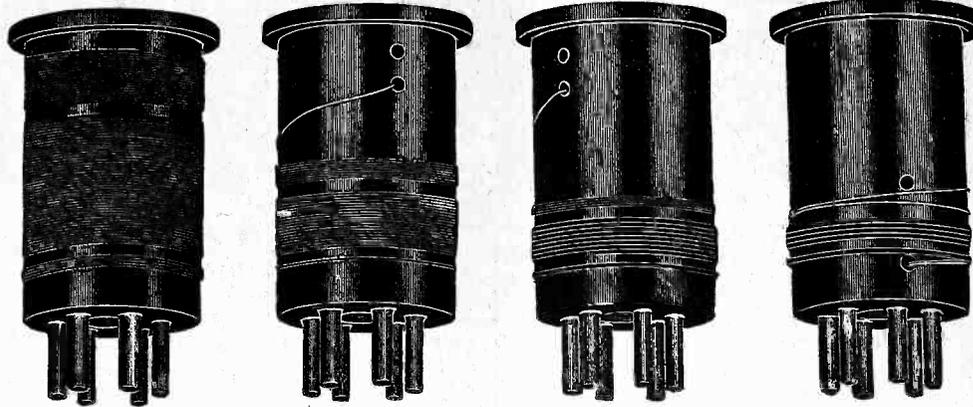
- David Salzman, Union Radio Service Lab., 580 Howard Ave., Brooklyn, N. Y.
- C. W. Hancuff, c/o Hancuff & Dell Laboratories, 5105 Broad Avenue, Altoona, Penna.
- Wallace Radio Company, H. R. Wallace, Prop., Frontenac, Kansas.
- P. E. Thompson, 65 Huron St., Brooklyn, N. Y.
- John F. Shea, 149 Third St., Mohawk Heights, Cohoes, N. Y.
- King Ramsey, Box 247, Conroe, Texas.
- Ralph Cates, Box 187, Haw River, N. C.
- J. W. Desserich, 2931 Corman Ave., Cincinnati, Ohio.
- F. W. Gross, Radio Service, 109 Orange Street, Mansfield, Ohio.
- Frank Braitner, 823 Lexington Ave., Brooklyn, N. Y.
- Harry H. Simonin, "Exclusive Auto Radio Service," (on automobile radios, their parts and accessories), 525 W. 142nd St., New York City.
- George Fagg, 68 Congress St., New Rochelle, N. Y.
- Gilbert's Radio Service, 2224 L Street, San Diego, Calif.
- R. H. Draper, S.O.S. Radio Service, 901 E. Adams St., Taylorville, Ill.
- Wilbur Anderson, Mt. View Hotel, St. Mories, Idaho.
- Offenbach Electric Co., 1427 Market St., San Francisco, Calif.

SHORT-WAVE CLUB

- G. C. Hairston, Jr., Post-Office Dept., Mobile, Ala.
- J. A. Nye, Jr., 600 Moorehead St., Ida Grove, Iowa.
- Charles Pugh, 1387 Masonic Ave., San Francisco, Calif.

6-Pin Plug-In Coils 200 to 15 Meters with 0.00014 mfd.

SHORT - WAVE plug-in coils with three separate windings for detector circuit produce best results as they avoid the broadness of plate-circuit tuning or the losses of r-f choke load on plate circuit due to damping. The lower winding is for r-f plate circuit, if t-r-f is used, or for aerial otherwise, the center winding is the tuned secondary, while the top winding is for feedback. The coils are accurately wound on 1.25 inch diameter Bakelite and have a 1/2 inch flange for gripping. Thus the actual winding need never be touched when you're handling the coils, and they are suitable for calibration.



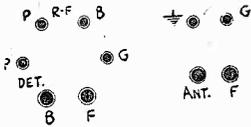
- Cat. SWB—Four plug-in coils, 6-pin base; primary, secondary, fixed tickler.....\$1.70
- Cat. SZ—Six-spring wafer socket for use as coil receptacle for six-pin coils.....1.10
- Cat. SWA—Four plug-in coils, UX base, primary and secondary; primary may be used for feedback if condenser connects serial to grid.....\$1.35
- Cat. SX—Four-spring (UX) wafer socket for use as coil receptacle for four-pin coils.....1.00
- Cat. H-14—Hammarlund junior midline 0.00014 mfd. condenser with Isolantite insulation.....\$1.20
- Cat. H-20—Hammarlund junior midline 0.0002 mfd. condenser with Isolantite insulation. Used as feedback control.....\$1.35

THE secondary is to be tuned with 0.00014 mfd. capacity. Using four coils, there will be sufficient overlapping of bands, also assured coverage to above 200 and below 15 meters. Also, 0.00015 mfd. may be used instead for tuning, with slightly greater overlap. Regeneration may be controlled by a 0.0002 mfd. variable condenser from detector plate to ground, or by a plate voltage rheostat or other means. The standard six-pin tube socket may be used for coil receptacle.

For antenna stage tuning only two windings are needed, where no stage of t-r-f is included, when use SWA.

HOW TO USE THE COILS FOR HIGHEST EFFICIENCY AND SMOOTHEST OPERATION

In building short-wave receivers using our plug-in coils be careful to locate the coils so that the centers of their cores are at least 6 inches apart, otherwise in sets with t-r-f the r-f tube may oscillate. Even if a volume control in the r-f stage controls any oscillation present the recommended separation should be maintained, otherwise a critical circuit results.



The connections to make are diagrammed herewith. Bottom views of sockets are shown. For the 6-pin coil P-B RF goes to aerial and ground if there is no r-f. Standard UX and 6-pin sockets serve as coil receptacles.

HIGH-GAIN SHIELDED-COILS FOR T-R-F

DIRECTIONS FOR BEST RESULTS

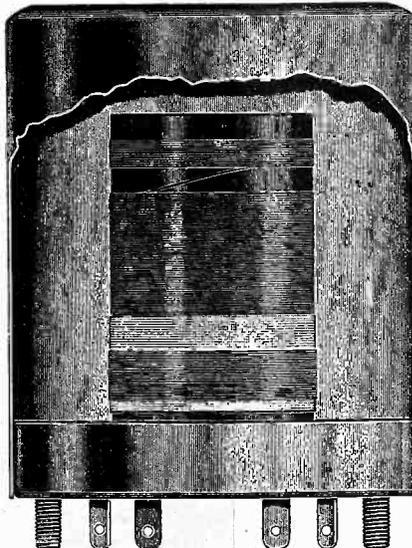
THE shielded coils for tuned radio frequency sets are supplied in matched sets of three or four, with secondary inductance equalized (plus or minus 0.6 microhenry). Thus any lack of sensitivity due to mismatched secondaries is avoided. As inductive discrepancies could not be compensated for by parallel capacity trimming, this high degree of inductive accuracy is important. Complete coverage of the wave band with the specified capacity condensers is absolutely guaranteed.

The coils may be used (set of three) for t-r-f, and with minimum value of negative bias for r-f tubes may oscillate a little at the very highest frequencies, say 1500 to 1580 kc, as they will be tuned below the broadcast band about that much. The negative bias should be increased until oscillation completely stops. Thus also selectivity is improved by heightened permanent or limiting bias.

In using four coils (three stages of t-r-f and tuned detector) each screen and plate lead should be carefully filtered, using 300-turn honeycomb coils and 0.002 mfd. or higher capacity in the filter, and the coil centers placed at least 4 inches apart.

The diameter of the form is 1 inch, the aluminum shield 2 1/2 inch diameter, 2 1/2 inches high. The shield has a small protected opening at top so the lead for the grid cap may be brought through. The opening is bevelled. This constitutes the protection against fraying the insulation of leadout wire to grid cap.

In the four-coil system, reversing connections to primary of second coil often stops oscillation in poorly filtered sets.



- Cat. No. 1—Three t-r-f coils for 0.00035 mfd., 80-meter tap.....\$1.35
- Cat. No. 1-F—Four coils, 0.00035 mfd.....\$1.80
- Cat. No. 3—Three t-r-f coils for 0.0005 mfd., 80-meter tap.....\$1.35
- Cat. No. 3-F—Four coils, 0.00035 mfd.....\$1.80
- Cat. DGH—Diode r-f choke, center-tapped.....\$1.40
- Cat. 3DS—Three-deck long switch for above coils, to utilize 80-meter tap.....\$2.50

80-METER TAP PROVIDED

EACH coil for the t-r-f sets has secondary tapped, so that if desired a long switch may be used to shift the tuning condenser stators to extreme of winding (200-555 meters) or to tap (80-200 meters). The tap is represented by a ground symbol stamped on the shield base. Please note ground is not to be connected to ground symbol. Grid return is the side lug inside the shield. P, B represent primary, G and side lug secondary.

The 80-meter tap does not have to be used, but is advantageous to those desiring to tune in television, amateurs, police calls, some relay broadcasting and other interesting transmissions in a band of frequencies replete with novelties for the usual broadcast listener.

High impedance primaries are used, the number of turns chosen so that the same coils may be used for antenna coupler and interstage couplers.

For diode t-r-f circuits, either full-wave or half-wave detector, a diode choke may be inserted inside the detector form. This choke has three terminals, with outleads: two extremes and center. For full-wave use two extremes to anodes of 55 or 85, center to cathode resistor. For half-wave use two extremes and ignore center tap.

Except in rare hookups the diode circuit requires an input free from grounding, and as the tuning condenser rotor and frame are grounded the choke pickup affords any potential output.

T-R-F sets using the 55 or 85 should have three stages of resistance audio, e.g., first stage the triode unit of the 55 or 85, second stage screen grid audio, third stage power tube or tubes (output).

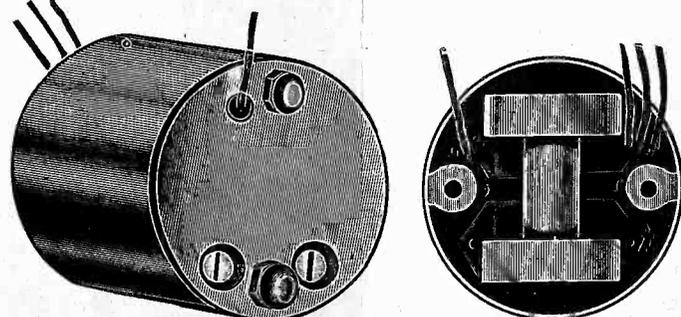
MIXER AND INTERMEDIATE TRANSFORMERS

PADDED SETS

For circuits using 175 kc. or 400 kc. intermediate frequency we have two coils for a stage of t-r-f and first detector, and accurately chosen inductance for the padded oscillator for these intermediate frequencies. There is no 80-meter tap provided on these mixer coils.

The coils are of the same type of mechanical construction as the t-r-f coils. Since there is no secondary tap, the code for connecting the t-r-f coils of the superheterodyne combination is different: P and B, primary; G and ground symbol, secondary. P would go to plate or antenna, G to grid cap, while B and ground symbol are the returns.

The oscillator has a smaller inductance secondary, for padding, and moreover is a three-winding coil. The three windings are: pickup, secondary and tickler. The pickup winding consists of 10 turns, and is brought out to two side lugs. The polarity of its connections unusually is of no importance. The secondary is represented by G and ground symbol, G going to grid and ground symbol to grid return, usually ground. The tickler connections for oscillation usually require that the lug at B be connected not to B plus but to plate, hence the P lug goes to B plus. In any case, if no oscillation results, reverse the tickler connections.



- Cat. No. 4—Three mixer coils, for 0.00035 mfd. Intermediate frequency in-tended, 175 kc. Price includes padding condenser, 700-1000 mfd.....\$1.80
- Cat. No. 5—The mixer coils for 0.0005 mfd., 175 kc., 700-1000 padder.....\$1.80
- Cat. No. 7—Three mixer coils, for 400 kc; padding condenser included is 350-450 mfd.....\$1.80

INTERMEDIATE TRANSFORMERS

The intermediate transformers consist of two honeycomb coils, wound with low resistance wire, coils spaced 1 inch apart, and thus affording loose coupling, stability and high selectivity. Primary and secondary tuned.

- Cat. FF-175—Shielded intermediate frequency transformer, 175 kc.....\$1.10
- Cat. FF-175CT—Same as above, center-tapped secondary, for full-wave diode detector.....\$1.25
- Cat. FF-450—Shielded intermediate frequency transformer, affording choice by condenser adjustment of frequencies from 380 to 480 kc.....\$1.30
- Cat. FF-450CT—Same as above, center-tapped secondary.....\$1.45

Padding Condensers @ 45c Each

- Cat. PC-710—For 175 kc intermediate. Put in series with oscillating tuning condenser. Capacity 700-1000 mmfd. Hammarlund. Isolantite base.
- Cat. PC-3545—Same as above, except 350-450 mmfd. for 380-480 kc intermediate.

- Cat. CH-300—A 300-turn r-f choke, inductance 1.3 millihenries.....\$0.30
- Cat. CH-800—An 800-turn r-f choke, inductance 10 millihenries.....\$0.35

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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. Price25c

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.

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

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"A B C OF TELEVISION" by Yates—A comprehensive book on the subject that is attracting attention of radioists and scientists all over the world. \$3.00, postpaid. Radio World, 145 West 45th St., N. Y. City.

THE FIVE NEW TUBES, 46, 56, 57, 58 and 82, characteristics, installation data, uses, fully described and illustrated in the April 30th issue (7 pages) and in the May 7th issue. Send 30c for these two copies. Radio World 145 West 45th Street. New York, N. Y.

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To do your radio work properly you need meters. Here is your opportunity to get them at no extra cost. See the list of nine meters below. Heretofore we have offered the choice of any one of these meters free with an 8-weeks' subscription for RADIO WORLD, at \$1, the regular price for such subscription. Now we extend this offer. For the first time you are permitted to obtain any one or more or all of these meters free, by sending in \$1 for 8-weeks' subscription, entitling you to one meter; \$2 for 16 weeks, entitling you to two meters; \$3 for 26 weeks, \$6 for 52 weeks, entitling you to six meters. Return coupon with remittance, and check off desired meters in squares below.

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One 300-turn honeycomb coil..... .30

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Two 0.00014 mfd. junior midline tuning condensers (both)..... 2.40
One 0.0002 mfd. junior midline tuning condenser.... 1.35
Two 0.00035 mfd. fixed condensers (both)..... .30
One shielded block containing three 0.1 mfd. condensers (black, common, to a minus; reds interchangeable)..... .57

RESISTORS
One 0.05 meg. pigtail resistor (50,000 ohms)..... .15
Two 4-ohm filament resistors in series, to constitute 8 ohms (both)..... .20

OTHER REQUIREMENTS
One 9 x 7 1/2 inch wooden baseboard..... .25
Four UX sockets (two for tubes, two for coil receptacles)..... .40
One 7 x 10 inch bakelite drilled front panel..... 1.25
Two knobs, one for r-f condenser, other for feedback condenser (both)..... .10
One vernier dial..... .50
One push-pull A battery switch..... .20
One binding post strip with eight posts on it..... .25
One 34 tube and one 30 tube (both)..... 2.61
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Blueprint 633-34, this circuit, 25c.

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