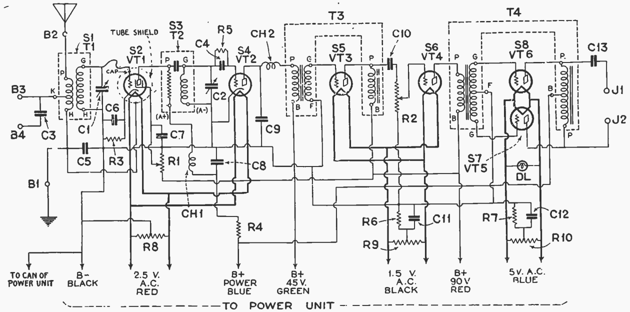
The Songbird All-Electric Screen Grid Receiver



LIST OF PARTS REQUIRED

B1: Eby "GND" binding post.
B2: Eby "SHORT ANT" binding post.
B3: Eby "ANT" binding post.
B4: Eby "LONG ANT" binding post.
C1, C2: Kelford No. 352, .00035 mfd. variable condensers.
C3: Aerovox Type 1450, .00025 mfd. mica condenser.
C4: Aerovox Type 1475, .00025 mfd. mica condenser with grid leak mounting clips.
C5, C6, C7, C8: Aerovox Type 1450, .006 mfd. mica condensers.
C9: Aerovox Type 1450, .002 mfd. mica condensers.
C10, C11, C12: Aerovox Type 250, .5 mfd. bakelite case condenser.
C13: Aerovox Type 250, 1 mfd. bakelite condenser.
CH1, CH2: Twin Coupler, No. 130, Neutrocap 80 millihenry R. F. chokes.
D: No. 1283 Double Drum dial.
DL: Mazda No. 40, 6-8 volt lamp for drum dial.
J1, J2: Kelford No. 285 Tip Jacks.
Power Unit: Kelford No. 360 ABC power unit.
R1, R2: Electrad Type E, 0-500,000 ohm Royalty potentiometer with walnut knobs.
R3: Aerovox Type 1098, 1,000 ohm Lavite.
R4: Aerovox Type 1098, 50,000 ohm Lavite.
R5: Aerovox Type 1092, 2 megohm grid leak.
R6: Aerovox Type 992, 750 ohm Pyrohm resistor.
R7: Aerovox Type 992, 1,000 ohm Pyrohm resistor.
R8, R9: Aerovox Type 985, 10-ohm center tapped resistors.
R10: Aerovox Type 985, 50-ohm center tapped resistor.
S1, S2, S4: Eby UY, Model 8, five-prong sockets.
S3, S5, S6, S7, S8: Eby UX, Model 8, four-prong sockets.
T1: Twin Coupler Type 222-A Shield Grid antenna unit.
T2: Twin Coupler Type 222-C Shield Grid detector unit.
T3: Kelford No. 300 Gain transformer.
T4: Kelford No. 310 Twin Unit Push-Pull transformer.
VT1: Songbird Type 222 A. C. Screen Grid tube.
VT2: Songbird Type 227, A. C. detector tube.
VT3, VT4: Songbird Type 226, A. C. amplifier tubes.
VT5, VT6: Songbird Type X-171A power amplifier tubes.
1 Songbird X-280 Full Wave Rectifier tube.
1 Twin Coupler Type 222-SE Screen Grid tube shield.
2 pairs American Radio Hardware Co. 1928 American subpanel brackets.
1 set American Radio Hardware Co. AKT miscellaneous hardware.
1 Westinghouse-Micarta 7" x 21" x ⅛" Type AKT1 drilled panel.
1 Westinghouse-Micarta 10½" x 20½" x ⅛" Type AKT2 drilled subpanel.
1 package Corwico Braidite hookup wire.
1 package solder.
1 Converse BD cabinet for 7" x 21" panel, 12" deep.
4 Kelford grid leak mounting clips for mounting Aerovox Lavites.

THE CIRCUIT

THE wiring diagram and thumbnail description of the receiver described on this page is the result of several months of experimentation by the engineers of three of the foremost parts manufacturers in the country.

The receiver is exceptionally well adapted for home use. It is very simple to operate, extremely easy to construct and costs less than seventy-five dollars to build, complete with tubes and cabinet.

The receiver is compact and self-contained, including in a single unit both receiver and power pack so that all that is necessary to place it in operation is to plug it into the light socket and connect it to aerial and ground.

It is stable in operation, requires no critical tuning or adjustments and is selective enough to tune from station to station without interference. It is capable of bringing in stations up to 1,000 miles away with more than enough volume to dance to.

In designing the receiver particular stress was laid on the importance of tone quality, without any sacrifice in volume. Careful design of the audio circuit and the use of push-pull amplification leaves nothing to be desired on that score.

In its essentials, the circuit consists of one stage of tuned radio frequency amplification, a detector stage, a stage of transformer-coupled audio amplification, another stage of impedance coupled amplification and a final stage of audio amplification using two power tubes connected in push-pull arrangement.

An A. C. screen grid tube is employed in the radio frequency stage. The use of this tube with a suitable circuit and associated equipment provides greater sensitivity with this single stage than can be obtained by the use of two stages of the usual type of radio frequency amplification using the standard R. F. tubes.

A folder giving complete detailed information, photographs and constructional data is available for free distribution to all who may be interested in further details. A copy will be sent on receipt of the coupon.

AEROVOX WIRELESS CORP.,
70 Washington Street,
Brooklyn, N. Y.

I am interested in the Songbird All-Electric Screen-Grid Receiver and would like to have you send me free the detailed folder on its construction.

Name ....

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The AEROVOX Research Worker

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Principles of Voltage Divider Design

PART 4

By the Engineering Department, Aerovox Wireless Corp.

WITH the fundamental facts discussed in the last issue of the Research Worker as a basis, we can proceed to a further discussion of the correct principles involved in making proper provisions for grid bias in a receiver equipped with A. C. tubes.

A fundamental difference between the A. C. and D. C. tube circuits lies in the fact that the reference point of the filament differs with these two types of tubes. To make this clear we will consider the simple filament circuit of a tube as shown in Fig. 17, which consists simply of a 6-volt battery, a rheostat "R" and a tube filament.

When the rheostat resistance is cut entirely out of the circuit so that point "Z" shifts to point "Y", the filament "WXY" of the tube is connected directly across the 6-volt storage battery. Point "W" is the most positive point of the circuit, being connected to the positive side of the battery, point "Z" is the most negative point of the circuit, being connected to the negative side of the battery while point "X" at the center of the filament is midway between the positive and negative terminals of the battery. In this case point "X" is 3 volts positive with respect to the negative terminal of the battery and 3 volts negative with respect to the positive terminal of the battery. When the rheostat "R" is inserted in the circuit so as to reduce the voltage across the terminals of the filament to 5 volts by causing a 1-volt drop across the resistance of the rheostat, the voltage between points "W" and "Y" of the filament becomes 5 volts and point "X" is then 2.5 volts positive with respect to point "Y", 3.5 volts positive with respect to point "Z" and 2.5 volts negative with respect to point "W".

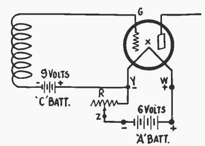

Fig. 17

The condition of any point on the filament varies gradually from negative at point "Y" to positive at point "W" with point "X" which is midway between the two extremes as the average value.

A little study of this condition will explain why the ideal manner of connecting the "C" and "B" batteries is with the positive terminal of the "C" battery connected to the negative terminal of the filament to provide a maximum grid bias within the tube circuit itself, and with the negative terminal of the "B" battery connected with the positive terminal of the filament. When the "C" battery is connected to the negative terminal of the filament advantage is taken of the 2.5-volt drop between the midpoint of the filament, point "X", and point "Y".

With the connection of the positive terminal of the "C" battery to the negative terminal of the filament, the total difference of potential between the centerpoint of the filament, "X", and the grid, "G", is equal to the 2.5 volts that "Y" is negative with respect to point "X" plus the negative 9 volts of the "C" battery making a total difference of potential of minus 11.5 volts.

If the positive terminal of the "C" battery were connected to the positive terminal of the filament, "W", however, which is 2.5 volts positive with respect to point "X", the effect produced would be the same as connecting a 2.5-volt battery in series with the "C" battery with the positive terminals of both batteries connected together so that the two batteries would be bucking each other. As a result of such a connection the total difference of potential between the grid terminal "G" and the midpoint of the filament terminal, "X", would be only 6.5 volts.

Since the connection of the positive terminal of the "C" battery to the negative terminal of the filament serves the double purpose of permitting the use of a lower voltage "C" battery to provide the required difference of potential between the midpoint of the filament and the grid of the tube and since it eliminates the need for an extra terminal brought out from the center point of the filament or the need of using a shunt potentiometer such as is used in A. C. receivers across the filament, that system of connection has been adopted as standard in using a "C" battery in amplifier circuits employing D. C. tubes.

The negative terminal of the filament is therefore taken as the "reference point" in D. C. tube circuits and the recommended "C" bias required for a given value of plate voltage is that required when the positive terminal of the "C" battery is connected to the negative terminal of the tube to take advantage of the difference in potential between that point and the center point of the filament.

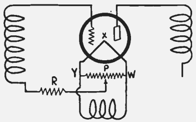

Fig. 18

When a CX-371A is used as an A. C. tube, however, with the filament current being supplied by the winding of a transformer which provides A. C. current for the filament, it is necessary because of the reversals in current flow which makes each filament terminal alternately positive and negative, to take the center point of the filament as a reference point. The means usually adopted to do this is to use either a center tap on the filament winding or to use a center tapped resistor across the filament of the tube. The center tap resistance method is usually used as being the most efficient and simpler method, and is shown in Fig. 18.

It is easily seen that while the points "W" and "Y" of the filament shown in Fig. 18 alternately become positive and negative as the current flow reverses, the average value at "X" lies between the two at any time and provides the best reference point.

In selecting the proper value of grid bias voltage and the proper value of resistance to use to obtain that voltage, the fact that point "X" is positive with respect to the negative terminal of the filament must be taken into consideration. The correct voltage to use in cases where a D. C. tube such as the CX-112A, CX-371A or CX-310 is used as an A. C. tube is equal to the normal grid bias voltage recommended for any given value of plate voltage (with the positive terminal of the "C" battery connected with the negative terminal of the filament for D. C. operation) with an additional grid bias voltage equal to one-half of the rated filament voltage of the tube.

Tube Type	Plate Voltage	Plate Current	D.C. Operation +C connected to −A		A.C. Operation Grid Return to Center Tap	
			Grid Bias Volts	Resistor Required* Ohms	Grid Bias Volts	Resistor Required Ohms
CX-112A	90	5.5	− 4.5	820	− 7.0	1270
	135	7.0	− 9.0	1280	−11.5	1650
	180	10	−13.5	1350	−16.0	1600
CX-371A	90	10.0	−16.5	1650	−19.0	1900
	135	16	−27.0	1700	−29.5	1850
	157	18	−33.0	1830	−35.5	1970
	180	20	−40.5	2000	−43.0	2150
CX-310	250	12.0	−18	1500	−20.5	1700
	350	16.0	−27	1700	−29.5	1850
	425	20.0	−35	1750	−37.5	1900
CX-350	250	28			−45	1600
	350	45			−63	1400
	400	55			−70	1250
	450	55			−84	1500
CX-326	90	3.5			− 6.0	1700
	135	6.0			− 9.0	1500
	180	7.5			−13.5	1800

* With battery operated tubes it is seldom convenient to use a resistor carrying the plate current of one tube to provide "C" bias. The resistor size then depends upon the number of tubes in the set, etc., and in general is lower than the value shown here.

Fig. 19

In the case of the CX-112A and CX-371A, the proper grid bias for A. C. operation is equal to the normal value for D. C. operation plus an additional 2.5 volts. In the case of the CX-310 whose filament is rated at 7.5 volts, the proper grid bias is equal to the normal value for D. C. operation plus an additional 3.75 volts.

In the case of the CX-326, and CX-350, the grid bias values listed in the tables of recommended grid bias are given for A. C. operation because those tubes are specially designed for A. C. use and the values recommended are given for A. C. operation with the center point of the filament taken as the reference point.

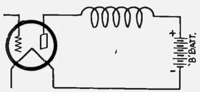

Fig. 20

The table shown in Fig. 19 will prove helpful in eliminating any misunderstanding as to the proper value of grid bias to use when using power tubes either as D. C. tubes or A. C. tubes. In using this table it must be kept in mind that the values of resistors given are those to be used when the resistor is used to supply the grid bias for a single tube. If a single resistor is to be used to supply the grid bias for more than one tube under similar conditions of plate voltage and current, the values of the resistors will be proportionately lower, *i. e.*, one-half the value given for two tubes, one-third for three tubes, etc.

Before proceeding with instructions on the proper method to use in calculating the correct value of resistance required for the grid bias resistor under different conditions of plate voltage and number of tubes used, it will be helpful to correct an erroneous impression regarding the flow of current in the voltage divider of a power supply unit which is furnishing current to the plate circuit of a receiver.

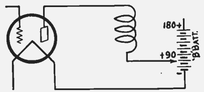

Fig. 21

The simplest type of receiver plate circuit and power supply is that shown in Fig. 20, in which a "B" battery is used as the source of plate current. There is no difficulty in tracing the path of the current in this circuit. The current flows in a complete circuit consisting of the battery, the conducting path between the plate and the filament and whatever coils or other apparatus may be placed in the plate circuit.

If it is necessary to use a voltage lower than the total voltage of the "B" battery as is the case when 90 volts are required for a CX-301A and a 135- or 180-volt "B" battery block is used as the source of current, all that it is necessary to do is to tap off at the 90-volt terminal of the battery as shown in Fig. 21. The current for that particular circuit, then, is furnished by that portion of the battery between the 90-volt terminal and the negative terminal of the battery.

If, however, no taps are provided on the battery, it is possible to use a voltage divider to provide the necessary 90 volts for that particular circuit. The path of the current in the plate circuit of the tube in such a case is as shown in Fig. 22 by the heavy lines. It is readily seen that the portion "R1" of the voltage divider does not carry any of the current of the plate circuit of the tube but only the "waste current" due to the connection of the total resistance of "R1" and "R2" across the battery. Since "R1" carries only the waste current resulting from the connection of the full resistance of "R1" and "R2" across the battery, while "R2" carries both the waste current mentioned and the plate current, it is readily seen that section "R2" must be designed to carry the heavier load. This load depends on the voltage difference between points "X" and "Y" and is found by subtracting the voltage obtained at that tap as measured by a high resistance voltmeter between the "B—" terminal and the voltage tap, from the total output voltage tap, measured in the same way between the "B—" terminal and the positive terminal of the "B" battery.

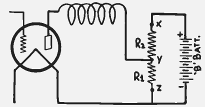

Fig. 22

In this particular instance with a total voltage of 180 volts and the tap at 90 volts, the difference between the 90-volt tap and the highest "B" battery voltage, is 90 volts. However, if the total output voltage of a power supply unit were used having a total output of 500 volts between the output terminals, the difference would be 500 — 90 or 410 volts.

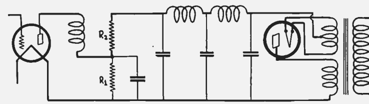

Fig. 23

In figuring the rating of the resistor which would have to be used in that section it would be necessary to multiply the current drain which we will assume is 16 milliamperes for four CX-326 tubes by the voltage difference between the tap and the high point or 410 volts which will give a value of .016 amperes times 410 volts or 6 watts. For safe operation, a resistor should be selected for that section which is conservatively rated at at least twice that value.

The equivalent power supply and plate circuit combination usually used is shown in Fig. 23, with the rectifier and filter circuit substituted in place of the battery.

Here again it will be noticed that the current in the plate circuit flows through the resistor "R2" and not through resistor "R1" which again brings out the fact that it is the upper section of the voltage divider which bears the greatest load and must be designed accordingly to carry it. Many of the voltage divider failures in units which are built up of individual resistor sections are due to the failure of some experimenters to grasp the idea that the upper sections of the voltage divider are the ones which carry the load and also that the voltage which should be used in making the calculations to determine the current carrying capacity of the section should be the difference in voltage between the tap and the high voltage end of the rectifier output.

It must also be kept in mind that in many cases the upper sections also carry the load of the other taps in addition to the load of the high voltage taps. In the case shown in Fig. 24 for instance, section "R1" carries not only the 20 milliamperes that goes to the 180-volt section but also the current which goes to the other taps, so that the total current flowing in that section is 69 milliamperes. The difference in voltage between 250, the high voltage end of the output circuit and the 180-volt tap is 70 volts, so that the current carrying capacity required in resistor "R1" is 4.83 watts. The total current flowing in section "R2" is 49 milliamperes and the difference in voltage between the 90-volt tap and the next tap above it, 180 volts, is 90 volts. The current-carrying capacity of section "R2" should therefore be .049 amperes times 90 volts or 4.41 watts, etc. The current-carrying capacity then of any section of a voltage divider can be found by multiplying the total current in amperes flowing in that particular section, by the voltage drop between the terminals of the section.

While the rating in watts of the section used can be held down to about twice the value thus determined, it is good practice to use a resistor having several times the rating of the calculated figure since the use of a very conservative rating with plenty of safety factor results in a unit which will operate continuously for practically unlimited periods without showing any signs of heating.

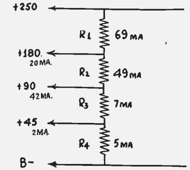

Fig. 24

The various types of circuits used to provide the necessary grid bias in A. C. tube circuits and the calculation of the proper grid bias resistors to use will be discussed in detail in the next issue of the Research Worker.

AEROVOX WINS PATENT SUIT

In an opinion handed down November 5, 1928 by the Honorable Judge John C. Knox of the United States District Court for the Southern District of New York, the patent claims upon which the Dubilier Condenser Corporation based its suit against the Aerovox Wireless Corporation, for alleged infringement of Dubilier patents on mica condensers, were held invalid and a decision was rendered in favor of the Aerovox Wireless Corp.

In reviewing the facts in the case, Judge Knox found that the patent claims contained in the Dubilier patent No. 1,497,095 on which Dubilier brought suit for infringement were not valid and that the patent claims in the Horton patent No. 1,572,604, owned by Dubilier and on which Dubilier also brought suit for infringement were not infringed by the construction of the Aerovox condensers. The opinion goes on to state at length why the patent claims on which Dubilier brought suit represent nothing worthy of monopoly protection.