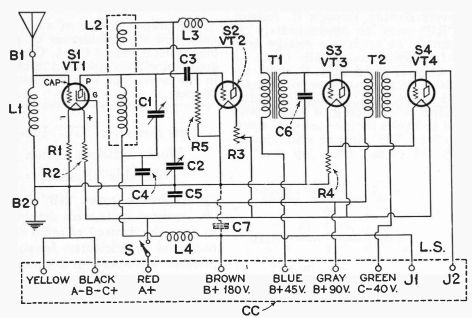
The Aero "International" Short Wave Receiver



List of Parts Required

B1: Eby "ANT" binding post.
B2: Eby "GND" binding post.
C1: Aero, .00014 mfd. special short wave variable condenser.
C2: Aero .00025 mfd. variable condenser.
C3: Aerovox Type 1460, .00015 mfd. moulded mica condenser.
C4, C5: Aerovox Type 1460, .003 mfd. moulded mica condensers.
C6: Aerovox Type 1460, .001 mfd. moulded mica condenser.
C7: Aerovox Type 302, 4 mfd. socket power condenser (optional and used if trouble is encountered due to imperfect filtering by "B" eliminator used with receiver).
CC: Yaxley Type 669 cable connector plug fitted with tip jacks J1 and J2.
L1: Aero No. C-65 R. F. choke.
L2: Aero coil kit, Type LWT-10.
L3, L4: Aero No. C-60 R. F. chokes
R1: Aerovox Type 980, 15-ohm resistor.
R2: Aerovox Type 980, 10-ohm resistor.
R3: Carter M-20-S, 20-ohm rheostat equipped with filament switch, S.
R4: Aero No. 2 ballast resistor.
R5: Aerovox Type 1093, 10-megohm grid leak.
S: See R3.
S1, S2, S3, S4: Tube sockets (provided in foundation unit).
T1, T2: Aero Type AE-770 audio transformers.
VT1: Cunningham CX-322 screen grid radio tube.
VT2, VT3: Cunningham CX-301A radio tubes.
VT4: Cunningham CX-371A radio tube.
1 Aero No. 8 Base Unit, including drilled panel and subpanel and hardware.
1 National Type "E" dial.
3 Kurz Kasch knobs.
1 Carter No. 342 Screen grid connector.
1 Aero bushing for dial shaft.

THE interest in short wave transmission and reception resulting from the reports of almost unbelievable distances which have been covered when using low powered short wave transmitters and simple short wave receivers now bids fair to rival the interest in radio during the early days of broadcasting.

Reception of stations 5SW (Chelmsford, England), PCJJ (Eindhoven, Holland) and 2FC (Sydney, Australia) consistently, even during the daylight hours, has been reported by many users of Aero Short Wave Receivers in various parts of the United States.

The Aero "International" Short Wave Receiver, the circuit of which is shown with this article has proved to be one of the most successful short wave receivers on the market.

This type of receiver accomplishes with four tubes, of which two are the audio amplifier tubes, results which even the ten tube superheterodynes find difficult on the regular broadcast channels.

One of the remarkable features of short wave reception is the almost total absence of static disturbance regardless of the weather conditions which may prevail at the time. Another outstanding feature is the fact that reception during daylight hours is exceptionally good.

In designing an efficient short wave receiver, several factors must be given careful consideration. In the first place, it is essential that none or at most very little of the high frequency oscillations generated locally by the receiver shall reach the antenna.

In the second place, the audio system used in such receivers should be high grade to give uniform amplification of the frequencies in the audible range, with a sharp cutoff at both ends.

In the third place, the oscillation control must be smooth and without extraneous noises.

In the Aero "International," radiation or squealing is limited by the use of a screen grid tube between the antenna circuit and the oscillating tuned circuit of the short wave receiver.

The idea of using a tuned grid circuit with the screen grid tube was abandoned because of the extreme care in shielding which is required to make such use practical and also because of the difficulty which would be experienced in changing the plug-in coils to take in different wavelength ranges if the coils were enclosed in thoroughly shielded compartments.

Considerable care has been exercised to make the operation of the receiver extremely simple.

The wavelength range of the receiver using the three Aero Type LWT-10 plug-in coils is from 17 to 89 meters. By using the No. INT-104 coils, which may be obtained separately, the range can be increased to 205 meters.

Experimenters who are interested in building this receiver may obtain more detailed information on its construction by writing to Mr. B. E. Smith, Aero Products, Inc., 4611 E. Ravenswood Ave., Chicago, Ill.

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The AEROVOX Research Worker

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Principles of Voltage Divider Design

PART 3

(Grid Bias for Battery Sets)

By the Engineering Department, Aerovox Wireless Corp.

ONE of the simplest phases of voltage divider design, yet one which seems to give the most trouble to the average radio experimenter is that which deals with the design of the grid biasing circuits and constants.

This article will therefore concern itself with the fundamental relations which are met with in such circuits to prepare the way for a deeper study on grid biasing to appear in the next issue of "The Research Worker."

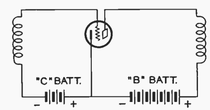


Fig. 10

The matter of providing a suitable grid bias to one or more amplifier tubes resolves itself into two distinct phases. In the first place it is necessary to choose a suitable circuit that fits in with the other characteristics and peculiarities of the receiver and amplifier circuits and in the second place the resistance values of resistors used to provide the necessary grid bias must be chosen with care to give the required results.

The simplest type of amplifier tube circuit, shown in Fig. 10, consists of a grid and plate circuit with batteries provided to furnish the grid bias voltage and the plate voltage. The filament circuit is disregarded, the filament being considered simply as a heated electrode in the tube.

It will be seen readily that the connection shown, provides a circuit in which the plate electrode "P" is positive with respect to the filament electrode due to the connection of the "B" battery in the plate circuit with its negative terminal to the filament and its positive terminal to the plate. In the grid circuit, however, the connection of the "C" battery with its positive terminal towards the filament and its negative terminal towards the grid maintains the grid electrode negative with respect to the filament.

This is the fundamental relationship which holds true in all amplifier circuits regardless of the variations in circuit arrangement which may be used to accomplish the result. A standard variation of the circuit shown in Fig. 10 is given in Fig. 11. This is the standard form used in battery operated circuits in which an "A" battery is used to heat the filament, with a "C" battery in the grid circuit to provide the grid bias voltage and a "B" battery in the plate circuit to provide the plate current.

Before going on with this discussion on the proper way to provide a grid bias voltage it might be worth while to refresh our minds on some simple though sometimes elusive facts regarding the question of positive and negative points in any given circuit and their application to equivalent radio tube circuits.

Let us take the simple circuit shown in Fig. 12 which consists of

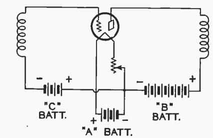


Fig. 11

a 45-volt "B" battery, a fixed resistance "R1" of 9,000 ohms and a fixed resistance "R2" of 1,000 ohms. If we short circuit "R2" so that the actual circuit consists simply of the battery and the load resistance "R1," the applied voltage is 45 volts, the resistance in the circuit is 9,000 ohms and the current flowing in the circuit, according to Ohm's Law I equals E divided by R) is .005 amperes. The negative point of the circuit is at point "a" while the positive point of the circuit is at point "d" as can be determined easily by connecting a voltmeter across those two points.

If we now remove the shortcircuiting connection from "R2" so as to include additional resistance in the circuit, the resistance "R2" and the resistance "R1" act as a voltage divider or potentiometer across the battery. The "most negative" point of the circuit still remains at

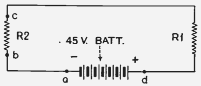


Fig. 12

point "a" while point "c" now becomes positive with respect to point "a."

The current in the circuit is changed to .0045 amperes because of the increased resistance in the circuit. If the current in the circuit is to be kept constant at .005 amperes, the voltage of the battery must be increased to 50 volts. The difference of potential between points "c" and "a" becomes 4.5 volts with point "c" positive with respect to point "a" and negative with respect to point "d." The difference of potential between points "c" and "d" would be 40.5 volts, (45 minus 4.5 drop caused by "R2").

The same effect as that shown in Fig. 12 can be produced by replacing resistance "R2" with a 4.5-volt battery connected as shown in Fig. 13. In this case the 4.5-volt battery is connected in series with the 45-volt battery but with its negative terminal connected with the negative terminal of the 45-volt battery so that the two batteries are bucking each other. The electrical characteristics however of Fig. 13 are identical to those of Fig. 12 insofar as current flow and voltages at the various points are concerned. The total voltage between points "a" and "d" is still 45 volts. The difference in potential between points "a" and "c" is still 4.5 volts. "a" is still negative with respect to both points "c" and "d." "c" is still negative with respect to "d" by 40.5 volts and the current flowing in the circuit is still .0045 amperes, the current being obtained by dividing 40.5 volts (net voltage) by the load resistance "R2" of 9,000 ohms.

Now let us see how these principles may be applied in an amplifier circuit. The most common form of amplifier circuit to provide "B" and "C" voltages in a tube circuit is shown in Fig. 11 where separate batteries are used in each circuit.

The same effect can be obtained by using the principle illustrated in Fig. 13 as shown in an equivalent tube circuit, Fig. 14. It will be seen that in this circuit, the connection of the grid return to the negative terminals of both batteries makes the grid negative with respect to the filament just as surely as the connection shown in Fig. 11: At the same time the plate of the tube is obviously positive with respect to the filament as long as the voltage of the "B" battery is greater than the voltage of the "C" battery.

The only difference in the characteristics of the batteries used in the circuit of Fig. 14 and that shown in Fig. 11 is that while the voltage of the "C" battery remains the same, the voltage of the "B" battery must be increased by 4.5 volts if the net voltage is to be kept at a value of 45 volts. This of course is due to the bucking effect of the "C" battery when connected as shown in Fig. 14.

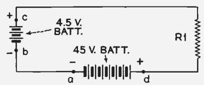


Fig. 13

This scheme of connections of course is not recommended in battery operated sets because of the waste entailed in having two batteries bucking each other but is given to illustrate the application of the principle which is the foundation of the various means of obtaining grid bias voltages in socket power units.

It is only a step from the circuit shown in Fig. 14 to that shown in Fig. 15. It will be noted that Fig. 14 is the equivalent radio circuit to the simple series circuit shown in Fig. 13 with the plate-to-filament resistance of the tube taking the place of "R1." Similarly the radio circuit shown in Fig. 15 is equivalent to the simple series circuit shown in Fig. 12 with the plate-to-filament resistance of the tube taking the place of the load resistance "R1" and the fixed resistance "R2" of Fig. 15 corresponding to the resistance "R2" of Fig. 12.

The circuit shown in Fig. 15 is a very effective means of eliminating the nuisance of extra connections for "C" batteries in a battery operated receiver. The most important feature however of the use of such a resistance method of obtaining the grid bias is the automatic regulation of grid bias to suit "B" battery voltage which it provides.

In the usual battery-operated receiver, when the voltage of the "B" batteries drops through usage, no provision is made to reduce the voltage of the grid bias battery to suit the lowered voltage of the "B" batteries. The result is that while the plate voltage is gradually being reduced to the cut-off point until the battery is no longer worth while using, the grid bias voltage remains constant, thus causing a considerable reduction of the plate current and consequent lowered efficiency of the tube. With the resistance grid bias method shown in Fig. 15, the grid bias voltage is automatically reduced in the proper proportion thus resulting in a proper balance between plate voltage and grid bias voltage which keeps the tube operating at its best throughout the useful life of the batteries. When using this method the voltage of the "B" batteries used should be equal to the usual recommended voltage plus the voltage used for the grid bias. In the case of a CX-371A tube for instance ordinarily operated at at a plate voltage of 180 volts with a grid bias of 40.5 volts, a battery block totalling 220.5 or the nearest standard value of 225 volts should be used.

The resistance "R2" should be properly by-passed, with a bypass condenser of at least one mfd.

The calculation of the resistor for this purpose is a simple matter, it being necessary to know only the current that is flowing in the plate circuit under the recommended conditions of plate and grid voltage. In the case of a CX-371A tube for instance to be operated at 180 volts plate voltage and 40.5 volts grid

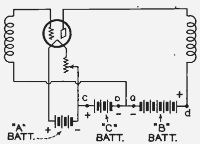


Fig. 14.

bias, drawing 20 milliamperes (.020 amperes) the resistance can be found by dividing the grid bias required in volts, (40.5), by the current drain in amperes, (.02) which equals 2,025 ohms.

When a single resistor is used to supply the grid bias for more than one tube, as for instance in the case

of a push-pull CX-371A stage the additional current drain must be taken into consideration. In that case the current drain is doubled, becoming .04 amperes, the grid bias voltage required remains the same so that the required resistance is 40.5 divided by .04 or 1,012 ohms.

When the grid bias for other tubes such as the first audio stage and the R. F. stages are to be supplied in the same way, by means of the drop across a resistor, the same principle can be employed to calculate the resistor required.

It is necessary to know of course the total plate current drain of the receiver and the plate current drain of each group of tubes. If we take for instance a receiver using two CX-322 tubes in the R. F. stages, a CX-301A tube as a detector, a CX-301A tube in the first A. F. stage and two CX-371A tubes in a push-pull stage the scheme of connections will be as shown in Fig. 16.

In this particular case, the two CX-322 tubes should be operated at 1.5 volts negative bias, 135 volts in

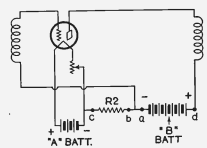


Fig. 15

the plate circuit and at these values the current drain will be 1.5 milliampere apiece or a total of 3 milliamperes. The CX-301A tube as detector at 45 volts plate will draw 1.5 milliamperes. The CX-301A tube in the first A. F. stage at 90 volts plate and 4.5 volts grid bias will draw 2.5 milliamperes and the two CX-371A tubes at 180 volts plate and 40.5 volts grid bias will draw 40 milliamperes. The total current flowing through the grid bias resistor connected in the "B—" lead will therefore be of the order of 47 milliamperes or .047 amperes.

The resistor may be either a tapped resistor or a number of individual resistors connected in series. Point "a" of the resistor unit is the most positive point and is connected to the filament circuit. The grid return of the detector tube is connected back to the positive "A" battery lead and has no bearing on the resistor values. To produce a voltage drop of 1.5 volts (the value required by the R. F. stages) with a current of .047 amperes flowing through it, resistor "R1" must be approximately 30 ohms. To produce a voltage drop of an additional 3 volts (total 4.5 volts) for the first A. F. stage, resistor "R2" must be approximately 65 ohms. To produce an additional 36-volt drop to give a total of 40.5 volts for the push-pull stage, resistor "R3" must be approximately 785 ohms. Each tap must of

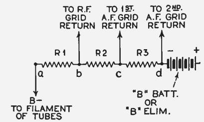


Fig. 16

course be properly bypassed to the filament by 1 mfd. condensers to prevent coupling.

This method can be used effectively with old type "B" eliminators which have no provisions for grid bias voltages, provided the eliminator is capable of supplying about 220 volts. All that is necessary is to substitute the "B" eliminator in place of the battery shown in Fig. 16. The "B—" terminal of the eliminator should be connected with the "d" terminal of the resistor. The "a" terminal of the resistor is connected to the "B—" terminal of the receiver and the taps of the resistor are connected to the proper grid bias terminals of the receiver.

If a CX-112A tube is used in the last stage, with a plate voltage of 135 volts, the total voltage drop across the resistor should be 9 volts and the resistor figured accordingly.

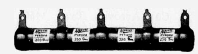
In using this method of supplying the grid bias it must be kept in mind that the voltage of the total grid bias is deducted from the taps of the eliminator so that the voltage at each tap of the eliminator should be checked up and readjusted for the changed conditions brought about by the addition of the grid bias unit.

If these facts regarding the method of providing grid bias voltages in battery operated receivers are carefully digested and kept in mind, no difficulty will be experienced in grasping the essential facts regarding the proper circuits and constants to use for grid biasing in A. C. sets.

The proper design of such circuits and the calculation of grid bias resistor values for A. C. operated sets will be discussed in detail in the next issue of the Research Worker.

New Aerovox "GB" Units More Efficient Than "Variable" Resistors

THE new Aerovox "GB" tapped resistor units were developed to meet the demand of radio engineers and experimenters for an adjustable resistance unit to eliminate the necessity of keeping either a large assortment of fixed resistors on hand or to use such makeshifts as "variable" resistors consisting of several resistance units connected in series and provided with taps connecting to the points of a multicontact switch.



The Aerovox "GB" units consist of tapped resistors with resistance sections so selected as to permit series, parallel or series parallel connection of the sections so as to give gradual changes in resistance with variations of less than 100 ohms from step to step.

This type of resistor will permit of a much closer adjustment of resistance than the multi-contact switch or the wiping contact arm adjustment type of "variable" resistors whose resistance change per step ranges from 300 to 2,000 ohms per step change in switch adjustment.

Complete details regarding these units, which have the added advantage of being much lower in cost than "variable" resistors are contained on page 16 of the latest Aerovox catalog. A copy may be had free on request.

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