Aerovox "A" Condenser

Solves Problem of "A" Power Supply

WHILE the A.C. tube was being perfected, work was going on along different lines for dispensing with "A" batteries—namely, the perfection of "A" battery eliminators. Within the last six months, several satisfactory rectifying devices for heavy currents have been placed on the market, together with appropriate filters.

Due to the heavy current output, the electrical dimensions of these filters are very different from those of B-eliminator filters. The chokes are of small inductance, very low resistance, and high current carrying capacity. A typical choke has an inductance of 0.3 henry, a resistance of 0.5 ohm, and a current carrying capacity of two amperes. The condensers are of relatively enormous capacity—1000 to 1500 microfarads. On the other hand, the leakage current of the ordinary "A" condenser is very high—100 to 200 milliamperes at 12 volts. This characteristic is objectionable, as the eliminator then has to supply an extra half-ampere or so to the condensers, which is unavoidable to the load.

Aerovox has recently developed an "A" condenser of unusual excellence. One of these condensers is shown in figure 2. The average capacity of this condenser is 2000 microfarads, and the leakage current at 12 volts is only 50 mils.

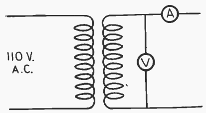

Fig. 1

These condensers differ markedly from paper condensers in their properties. One of these unusual properties is the variation of capacity with voltage. A condenser which measures 2000 microfarads at 6 volts will have a capacity of 1500 microfarads at 12 volts, and only 100 microfarads at 90 volts. A circuit for measuring the capacity of "A" condensers is shown in figure 1. The testing terminals are applied to the condenser, and the readings of the ammeter and voltmeter noted. The capacity of the condenser is then found from the formula

$$C = \frac{I \times 10^6}{2 \pi f E}$$

where C is in microfarads, I in amperes, E in volts, and f is the frequency of the alternating current source.

Fig. 2

Another unusual property of these condensers is the fact that they are polarized. That is, they will behave normally if connected to the output of the rectifier with the proper polarity. If connected reversed, however, the leakage current thru the condenser will be so great that the latter may be destroyed by the excessive current.

The terminals of Aerovox "A" condensers are plainly marked "Positive" and "Negative." The positive lead is red rubber covered wire. Care should be taken to connect the positive terminals of the condensers to the positive terminal of the rectifier.

Two or three of these condensers and two .1 to .5 Henry chokes, connected as in figure 3, will make an excellent filter for heavy currents. A filter of this type will deliver two amperes of direct current from either a half wave or a full wave rectifier without any audible hum whatsoever.

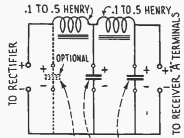

Fig. 3

Under certain conditions where the voltage delivered at the output is low, placing one choke in the negative lead and one in the positive lead instead of both in the positive lead, as shown in the diagram, will increase the output voltage slightly.

Continued from page 3, col. 3

resistor "R1" drops this to 220 volts which provides 180 volts for the plate supply of the power tube and 40 volts grid bias for this tube. The other resistor taps provide the intermediate values of voltage required for the R. F., detector and audio stages. The junction between the bottom tap of resistor "R1" and resistor "R2" provides the "B—" terminal. The junction between resistor "R2" and "R3" provides the negative "4½-volt" terminal for the first A.F. stage while the other end of resistor "R3" provides the "—40-volt" grid bias for the power tube.

This power supply device is highly recommended to anyone who desires a plate supply source which approaches the ideal, at a moderate investment of money, time and skill. It can be used to maximum advantage with any receiver which employs a CX-371A type of tube in the last audio stage. It requires no upkeep attention and has an indefinitely long life.

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The Measurement of the A.C. Component of Composite Voltages

By the Engineering Department, Aerovox Wireless Corp.

THERE are many occasions when it is desirable to measure the ripple voltage superimposed on a steady voltage, such as the output of a direct current dynamo, or a rectifier and filter. For this purpose an instrument is required which will be unaffected by direct current, but readily responsive to alternating currents.

There are several instruments, or combinations of instruments which fulfill this requirement more or less satisfactorily. They may be divided into two general classes: one which measures the A.C. and the D.C. components of the voltage simultaneously, and one which eliminates or nullifies the effect of the D.C. component in some manner and measures the A.C. component only.

The first method is less general in scope and will be described briefly. The D. C. component of the voltage is measured by means of a d'Arsonval meter. The crest value of the voltage is measured at the same time by means of a peak voltmeter. Then the alternating component is equal to half the difference between the peak voltage and the D.C. component of the voltage, assuming a sine wave.

When the alternating component of the voltage is large, this method is convenient and accurate. However, when the alternating component is small, the difference between the readings of the two meters is also small, and the accuracy of the measurement is impaired.

In order to measure small alternating voltages of the order of one volt, it is necessary to nullify the effect of the D.C. component, and use a sensitive vacuum tube voltmeter to measure the alternating component. There are several variations of this method, differing from each other in accuracy and simplicity of connection.

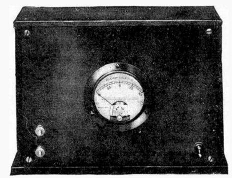


Fig. 1

The first way of eliminating the D.C. component of the voltage (referred to as "E_{dc}") is shown in figure 3. "R" is the load resistance thru which the composite current flows. "E" is a source of counter-e.m.f., preferably a battery, to balance out "E_{dc}", and is adjusted as follows: "E_{dc}" is measured by means of a D.C. voltmeter. The battery "E" is then adjusted by means of the potentiometer "P" so that its voltage is approximately equal to that of "E_{dc}". The switch "S" is then closed, and "P" adjusted until the galvanometer "G" gives no reading. The voltage of "E" is then equal to that of "E_{dc}". Its value is read on the voltmeter "V". These two voltages will cancel each other out, and only the alternating component, "E_{ac}", will be present at the terminals "CD", where it may be measured by a vacuum tube voltmeter.

While this method is effective and accurate, it requires the use of a high voltage battery—up to 700 or 800 volts when testing the output of a pair of CX-381 tubes. This is quite a drawback, especially when a portable instrument is required. However, when a high voltage battery is available, and when portability is not essential, it is an excellent method.

A second method of eliminating the effect of "E_{dc}" is to use a grid stopping condenser type of vacuum tube voltmeter, as shown in figure 4. This type of meter has a condenser in series with the grid, and is therefore unaffected by the existence of a steady potential difference between its terminals. A meter of this type requires no auxiliary apparatus besides "A" and "B" batteries for the vacuum tube, and is hence readily portable. It has a range of 0—7 volts, and can be read to 0.25 volt at the upper end of the scale, and to 0.5 volt at the lower end. It possesses a high degree of accuracy and is unaffected by slight changes of plate or filament voltage. A detailed description of this type of instrument will be given below.

A third method of eliminating "E_{dc}" is to pass the composite current thru a transformer. Since the transformer is affected only by changes of current, "E_{dc}" will not affect the output, which will be determined solely by the alternating component of the input. This is only approximately true, however, for the flux density of the transformer core will vary with the current of direct current flowing thru its windings, and hence the output will be somewhat affected. For any particular direct current, however, the error will be constant, and a correction may easily be applied. The output of this insulating transformer, as it may be called, can then be measured with any type of vacuum tube voltmeter.

It will be seen from figure 4 that the grid stopping condenser

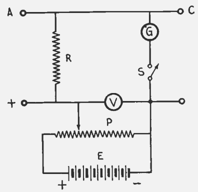


Fig. 3

type of voltmeter is an ordinary vacuum tube detector, and it works in exactly the same way. A special set of operating conditions must be chosen for the tube, for the following reasons: When no alternating e.m.f. is applied to the grid, there is a steady current flowing in the plate circuit, due to the action of the plate battery. When an alternating e.m.f. is applied to the grid, the plate current will decrease. Now, the change in plate current must be comparable to the steady plate current, or it cannot be measured accurately by means of a plate current milliammeter. By suitably proportioning the constants of the circuit, however, the change in plate current due to an alternating e.m.f. of 4 volts applied to the grid may be made equal to half the steady plate current. Under such conditions, the change in plate current may be read directly from the plate milliammeter.

The instrument described in this paper and shown in figures 1 and 2 employs a CX-301-A vacuum tube as the detector. The schematic diagram is shown in figure 4. It was found by experiment that a grid condenser of 0.02 mfd. and a grid leak of 6 megohms gave a maximum

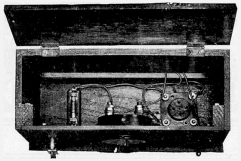


Fig. 2

change in plate current for a given applied e.m.f. A smaller condenser gave less sensitivity, and a larger condenser gave no increase in sensitivity. At the same time, it rendered the response of the instrument so sluggish that a quick reading was impossible. The value of the grid leak affected the sensitivity in much the same way as the grid condenser did.

The plate voltage affects the sensitivity of the meter to a marked degree. It was found that a maximum change in plate current occurred when the plate voltage was in the neighborhood of 90 volts. The steady plate current was then 8.3 mils.

In order to assure a stable calibration, the filament is burned at 4 volts. This eliminates the effect of "ageing" with its accompanying changes in tube characteristics, and insures an indefinitely long life to the tube.

Calibration of Vacuum Tube Voltmeter

Volts A.C.	Plate Current
0	8.3 mils
0.7	7.7
1.4	6.7
2.1	5.8
2.8	5.0
3.5	4.25
4.2	3.70
4.9	3.20
5.6	2.95
6.3	2.70
7.0	2.50

Fig. 5

Because of differences in tube characteristics, it is necessary to calibrate the meter separately for every different tube used in it.

When all connections to the meter have been made, the filament switch is turned on. The plate current milliammeter will then read a maximum. This maximum reading is the "operating zero" of the voltmeter, and should be marked with a red line. The voltmeter is then calibrated with known A.C. voltages ranging from 0.5 to 7 or 8 volts. These voltages are most easily obtained by the use of a step-down transformer and a slide-wire potentiometer. The plate current will decrease upon the application of these alternating voltages to the grid, in successively smaller steps as the applied voltage is increased. A calibration table for one particular tube is given in the table shown in figure 5. It will be seen that the cale is quite crowded at the upper end. This is to be expected in view of the quadratic characteristic upon which the tube is operating.

To measure ripple voltages, the output of the generator, or rectifier

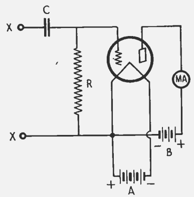


Fig. 4

and filter, is applied to the terminals of the voltmeter, whereupon the reading of the plate milliammeter will decrease. The ripple voltage is then read off in terms of the plate current, from the calibration table.

The simplicity of the meter is readily evident from the front end and assembly views shown in figures 1 and 2 and the wiring diagram, figure 4. A list of parts for the construction of this meter is as follows:

1 Cunningham CX-301-A Vacuum Tube.
1 Weston Model 301, 0—10 D.C. Milliammeter.
1 Benjamin No. 9040 Tube Socket.
1 Aerovox Type 1450 .02 mfd. Mica Condenser.
1 Aerovox Type 1092 6 Megohm Grid Leak.
1 Aerovox Type 1049 Grid Leak Mounting.
1 Westinghouse Micarta Panel.
1 Specially Built Cabinet.

An Ideal Power Supply Unit

for the Average Radio Receiver

THE question of the relative advantages of "B" batteries and power supply devices is one that is always sure to arouse considerable discussion. Without the necessity of bringing up any controversial aspects of the subject, it might be well to state that the greatest advantage of a suitable power unit for any type of receiver is that it provides a practically unvarying voltage of the proper value to keep the tubes operating at their best efficiency. It also provides a means of supply a negative grid bias to the tubes that is always in the proper proportion to the plate voltages applied to the tubes.

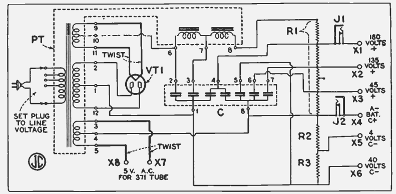
When using "B" batteries, it is necessary as the "B" voltages are reduced as the batteries run down, to constantly change the voltages applied to the grids of the tubes so as to keep a proper balance between the plate and grid bias voltages. In the great majority of cases this is impractical because the grid voltages cannot be adjusted gradually but only in steps depending on the taps provided in the "C" batteries. At best this constant adjusting of the "C" battery voltage as the "B" batteries run down is a nuisance.

In the case of a properly designed power supply unit, however, a proper relation between plate and grid voltages under all conditions of operation, can be maintained automatically.

The eliminator described in this article can be used to advantage with any type of receiver employing one or two CX-371A power tubes in the last audio stage.

A power pack made up in accordance with the wiring diagram given herewith is small in size, consists of few parts, is easy to wire and is economical both in first cost and maintenance. Even with the use of the high quality parts recommended, the first cost is only slightly higher than the cost of the "B" batteries that would be required to operate an average receiver for a single year.

The transformer required for the unit should provide secondary voltages of approximately 300 volts for each side of the full wave rectifier circuit; a five-volt, center-tapped winding for the filament supply for the CX-380 full wave rectifier tube; and another five-volt, center tapped winding for operation of a single CX-371A power tube in the last stage or for two CX-371A tubes connected in push-pull.



List of Parts Required

C: Aerovox No. BC-280 condenser filter block
J1, J2: Carter No. 2A single, closed circuit Short Jacks.
PT: Samson No. 713 Power Block
R1: Aerovox No. 996-171 tapped Pyrohm resistor.
R2: Aerovox Type 992, 100-ohm Pyrohm resistor.
R3: Aerovox Type 992, 1000-ohm Pyrohm resistor.
VT1: Benjamin No. 9040 vacuum tube socket.
XI to X8 incl.: Eby engraved binding posts.
One Cunningham CX-380, full wave rectifier tube in socket VT1.
One 10" x 4" x 3/16" Westinghouse Micarta binding post panel.
One 10" x 11½" x ¾" baseboard.

A unique feature of the Samson transformer employed in this unit is the primary plug connection by means of which the transformer primary is matched up with the prevailing local line voltage by the position of the plug.

The filter and by-pass condensers are all contained in the Aerovox BC-280 filter block, thus eliminating the trouble usually resulting from the necessity of mounting individual condenser units. The condensers contained in the block have an ample factor of safety thus eliminating any possible chance of breakdown and trouble.

An Aerovox No. 996-171 tapped Pyrohm resistor is used as the voltage divider to provide accurate, permanent values of voltages at the receiver terminals.

Binding posts are provided for each required output voltage and jacks are included on the terminal panel so that a milliammeter with a scale range of zero to 50 milliamperes may be plugged in by means of an ordinary phone plug to obtain current readings on the plate supply to the power amplifier tube in the receiver and also on the total current drain of the receiver.

The transformer and associated apparatus have been carefully selected to give the best possible regulation to avoid any excessive variation of voltage at the terminals even under very heavy current drains. Under ordinary operating conditions, the voltage variation at the terminals is so small as to be negligible.

The comparatively low output resistance of the voltage divider used has the advantage that with the receiver disconnected from the eliminator, in other words with no load, the voltage increase at the filter is so small as to eliminate surges and strains that would otherwise endanger filter condensers and rectifier tube.

The total available voltage at the output of the eliminator is 300 volts at a drain of 40 milliamperes. The voltage drop in the first section of

Continued on page 4, col. 3