AEROVOX BUILT BETTER CONDENSERS AND RESISTORS

The Aerovox Hi-Farad Condenser

Showing mounting ring used to mount a condenser partly above and partly below subpanel.

Universal Mounting Feature

Hi-Farad condensers can be used with perfect safety in any position — UPRIGHT, HORIZONTAL, INVERTED OR AT ANY OTHER ANGLE.

Wet electrolytic condensers can only be used in the position for which they are designed — upright if the condenser was made for upright mounting and inverted if made for mounting in that position. No wet electrolytic condenser can be mounted horizontally since mechanical considerations such as the location of the vent which must be on top, limits its application in this respect.

The mounting rings furnished with Hi-Farad condensers are universal in their application. With them, Hi-Farad condensers can be mounted in upright or inverted positions above or below the subpanel or mounting base to any desired amount as shown in the photographs illustrating the condensers mounted in various positions above and below the phantom view of the subpanel.

Showing inverted mounting with terminals on bottom of subpanel with unit partly above and partly below the subpanel.

How the mounting ring is used to mount a condenser upright above a subpanel.

Type TAR Type TBR Type TCR

Mounting Rings for HI-FARAD Condensers

In this method of inverted mounting, the cover and terminals project through the bottom of the subpanel.

THIS BOOK GIVES THE LATEST AND MOST COMPLETE INFORMATION ON ELECTROLYTIC CONDENSERS

FREE! A copy of this 32-page book, containing a wealth of information on all types of electrolytic condensers will be sent free of charge on request. Just mail the coupon below. The book treats in detail the very important factors that affect the operation and life of electrolytic condensers of various types; the characteristics necessary in filter and bypass condensers to perform their functions satisfactorily and many other subjects of vital importance in the proper use of such condensers.

If you want to know whether leakage is a reliable indicator of filtering efficiency; what electrolyte characteristics are necessary for efficient electrolytic condenser action; how the filtering efficiency of various types of electrolytic condensers compares with paper condensers; in short everything you should know about electrolytic condensers you will find the information in this book. A copy is yours for the asking.

Aerovox Wireless Corporation,
70 Washington Street,
Brooklyn, N. Y.

Please send me, without charge or obligation, a copy of your book, "The Hi-Farad DRY Electrolytic Condenser."

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The Most Complete Line of Condensers and Resistors in the Radio and Electrical Industries

The AEROVOX Research Worker

The Aerovox Research Worker is a monthly house organ of the Aerovox Wireless Corporation. It is published to bring to the Radio Experimenter and Engineer authoritative, first hand information on condensers and resistances for radio work.

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Factors Which Must Be Considered in Using Filter Condensers

By the Engineering Department, Aerovox Wireless Corporation

IN the design of filter systems to use the Aerovox dry electrolytic condensers care must be taken to make absolutely certain that the rated peak voltage of the condenser will never be exceeded in normal operation, by taking peak voltage readings across the circuits in which they are used.

The approximate peak votage across the first condenser of a filter system can be taken as being equal to 1.4 times the r. m. s. value of the a. c. voltage impressed on the rectifier. It should be realized however that the rated voltage of the secondary of a power transformer does not necessarily indicate the voltage actually developed across the winding. A transformer rated at 115 volts primary and 350 volts secondary, each side of the center tap, will not have 350 volts across each side of the secondary UNLESS the line voltage is 115. If the line voltage is lower the secondary voltage will be less than 350 volts, if the line voltage is higher than 115 volts then the secondary voltage will rise above 350 volts. If for example, the line voltage rises to 140 volts (not an uncommon voltage in many parts of the west) then the secondary voltage will be 426 volts. This may produce a peak voltage of approximately 426 times 1.4 or 596 volts across the first filter condenser.

There are three possible solutions to prevent any danger of excessive voltage across the filter system. The first one involves the use of an automatic line voltage regulator which will maintain the proper voltage across the primary of the transformer independent of line voltage. The second condition involves the use of transformers with tapped primaries. With such an arrangement the tap should be adjusted not for an average value, but for the maximum voltage at the light socket to which the receiver is to be connected. If no voltage regulator is used and the transformer primary is not tapped, then the transformer should be so designed that the maximum permissable voltage is produced across the condenser and the tube filament windings when the voltage across the transformer primary is the maximum to which the line voltage may rise.

The first condition, involving the use of a good automatic line voltage regulator is the ideal condition of operation because in addition to safeguarding the filter system it eliminates all the troubles such as tube burnouts from excess voltage conditions, poor volume because of lower voltage than that for which the receiver was designed and variation in volume during a program due to fluctuations in line voltage.

While the method of using taps on the transformer makes it possible to adapt the set to the maximum voltage conditions in any particular locality, it does not eliminate the voltage fluctuation conditions arising from a variation of the load imposed on a line.

When neither automatic regulator nor tapped primary are used, the transformer must be designed to furnish the maximum permissable secondary voltages for filter and filament circuits under the highest voltage conditions which may be expected on the line to which the receiver is connected. This means that under low voltage conditions on the line, the filament voltage and current and the plate and grid bias voltages will be lower than required for efficient operation with consequent reduction in receiver efficiency.

The low cost, compactness, excellent filtering action, self-healing characteristics and long life of Aerovox Hi-Farad DRY Electrolytic Condensers makes them ideally suited for all power supply filtering and audio by-passing applications, provided of course that they are used in properly designed circuits which take into account their operating characteristics.

HELPFUL DATA FREQUENTLY USED IN

Ohm's Law

Ohm's Law expresses the relationship which exists between the electromotive force (E) in volts, the current (I) in amperes and the resistance (R) in ohms in any electrical circuit and is the basis of most electrical calculations and relationships.

It may be expressed in various forms, depending on the quantity for which one may be solving the equation. It is most easily remembered as:

$$E = I \times R$$

in which the symbols appear in alphabetical order, (E, I, R,) with the equal sign after the first symbol. The equation may be solved for any of the elements by simple transposition.

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Ohm's Law for A.C. Circuits

For alternating current circuits, Ohm's Law becomes:

$$E = I \times Z$$

where Z is the resultant effect, in ohms, of the ohmic resistance, capacitive reactance and inductive reactance of the circuit.

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Impedance of A.C. Circuits

$$Z = \sqrt{R^2 + (Xl - Xc)^2}$$

—o—

Reactance of a Condenser

$$Xc = \frac{1}{6.28 \times f \times C}$$

A chart showing reactances of condensers of various standard capacities at frequently used frequencies is given on page 32 of the 1931 Aerovox Condenser and Resistor Manual and Catalog.

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Reactance of an Inductance

$$Xl = 6.28 \times f \times L$$

—o—

Resonance in an A.C. Cicuit

In an A.C. circuit, resonance takes place when the capacitive reactance (Xc) equals the inductive reactance (Xl), thereby reducing the total reactance of the circuit to zero.

—o—

Frequency of Resonance

$$f = \frac{1}{6.28\sqrt{L \times C}}$$

—o—

Peak Value A.C. Voltage

The peak or crest value of voltage of an alternating current sine wave is represented approximately by:

$$Ep = 1.4 \times E$$

—o—

Power in a Circuit

$$P = E \times I = I^2 \times R$$

—o—

Resistance in Series

$$Rt = R1 + R2 + R3 \text{ etc.}$$

If the resistances are all of the same value, the total resistance will be equal to the resistance of one multiplied by the number connected in series.

Explanation of Symbols Used in Formulae in This Article

C	—	Capacity in FARADS.
Ct	—	Total or resultant capacity in FARADS of a number of condensers connected in series, parallel or series-parallel.
E	—	Effective voltage in VOLTS.
Ep	—	PEAK VALUES OF VOLTAGE in alternating and fluctuating voltage circuits.
f	—	Frequency in CYCLES PER SECOND.
I	—	Effective current in AMPERES.
L	—	Inductance in HENRIES.
P	—	Power in WATTS.
Q	—	Quantity of electricity in COULOMBS.
R	—	Resistance in OHMS.
Rt	—	Total or resultant resistance in OHMS of a number of resistors connected in series, parallel or series-parallel.
r	—	Shunt or leakage resistance in OHMS of a condenser or of a resistance connected across a condenser.
W	—	Work in JOULES or WATT-SECONDS.
WL	—	Wavelength in METERS.
Xc	—	Capacitive reactance in OHMS.
Xl	—	Inductive reactance in OHMS.
Z	—	Impendance in OHMS.

Metric Prefixes Commonly Used with Electrical Quantities

Meg-or Mega-	= 1,000,000	$= 10^6$
Myria-	= 10,000	$= 10^4$
Kilo-	= 1,000	$= 10^3$
Hecto-	= 100	$= 10^2$
Deka-	= 10	$= 10^1$
Deci-	= .1	$= 10^{-1}$
Centi-	= .01	$= 10^{-2}$
Milli-	= .001	$= 10^{-3}$
Micro-	= .000,001	$= 10^{-6}$
Milli-micro-	= .000,000,001	$= 10^{-9}$
Micro-micro	= .000,000,000,001	$= 10^{-12}$

The prefix "pico" is sometimes used in place of "micro-micro-".

—o—

Resistance Conversion Factors

To change ohms to megohms, divide ohms by 1,000,000.

Example: 25,000 ohms = .025 megohms.

To change megohms to ohms, multiply megohms by 1,000,000.

Example: .025 megohms = 25,000 ohms.

—o—

Frequency-Wavelength Conversion

$$WL = \frac{300,000,000}{f}$$

Resistance in Parallel

$$Rt = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} \text{ etc.}}$$

If the resistances are all of the same value, the total resistance will be equal to the resistance of one divided by the number connected in parallel.

The total resistance of resistors connected in series parallel is found by separating them into groups, finding the resultant resistance of each group and reducing the network into a series of resultant resistances, after which the total resistance of the network can be determined.

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Total Watts Rating of Resistors of Equal Resistance and Rating

The total watts rating of resistors of equal resistance and watts rating connected in series or parallel is equal to the watt rating of one multiplied by the number connected in series or parallel.

—o—

Resistance Required to Produce a Desired Voltage Drop

The resistance required to produce a voltage drop sufficient to reduce an available voltage to a desired voltage, when the current taken by the device at its rated voltage is known, may be found by using the equation for Ohm's Law when solving for resistance:

$$R = \frac{E}{I}$$

in which E is the voltage drop required and I is the current taken by the device at its rated voltage. This form is used when it is desired to reduce the line voltage from 110 to 6 volts for instance (in which case the voltage drop is 110—6=104); when it is desired to reduce the voltage of a battery to that required by the filament of a vacuum tube, etc.

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Specific Inductive Capacity

The specific inductive capacity or dielectric constant (k) of any dielectric is the ratio of the capacity of a condenser using that dielectric to that of an identical condenser (same plates and separation) using air as the dielectric.

—o—

Charge on a Condenser

$$Q = C \times E$$

—o—

Current Through and A.C. Voltage Across a Condenser

$$I = 6.28 \times f \times E \times C$$

—o—

Potential Energy Stored in a Condenser

$$W = \frac{C \times E^2}{2} = \frac{E \times Q}{2} = \frac{Q^2}{2C}$$

The above data is representative of the valuable information contained in the NEW 1931 Aerovox Condenser and Resistor Manual and Catalog. A copy will be sent to you free on request.

AEROVOX BUILT BETTER CONDENSERS AND RESISTORS

SOLVING CONDENSER & RESISTOR PROBLEMS

Capacity of Condensers in Parallel

$$Ct = C1 + C2 + C3 + C4 \text{ etc.}$$

When the capacities of the condensers are equal, the total capacity is equal to the capacity of one condenser multiplied by the number of condensers connected in parallel.

—o—

Capacity of Condensers in Series

$$Ct = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{C4} \text{ etc.}}$$

The total capacity of a number of condensers of equal capacities when connected in series is equal to the capacity of one condenser divided by the number of condensers connected in series.

The total capacity of a series combination of any number of condensers is always less than the capacity of the lowest capacity condenser of the combination.

—o—

Voltage Ratings of Condensers in Parallel

With condensers connected in parallel, the voltage rating of the combination is limited by the voltage rating of the lowest voltage condenser, and the voltage applied across the combination should never exceed that of the condenser having the lowest voltage rating.

—o—

Voltage Ratings of Condensers in Series

The calculation of the resultant voltage rating of condensers connected in series is rather complicated unless the condensers connected in series are of the same capacity, voltage rating and power factor.

When condensers of equal capacity are connected in series, any voltage applied across the combination will distribute itself equally across each condenser and the voltage across each condenser will be equal to the voltage across the combination divided by the number of condensers connected in series, provided the insulation resistances or power factors of the condensers are equal. When the insulation resistances are not the same for each condenser, the voltage distribution across the condenser will be affected to a greater or lesser extent depending on the waveform of the applied voltage. The effect of unequal voltage distribution can be minimized by the use of resistor balances (high value resistors across the condensers).

The voltage distribution among several condensers connected in series, for condensers of fairly low power factor, will be proportional to the product of capacity by power factor.

—o—

Equivalent Series Resistance of Shunt Resistance Across a Condenser

The effect of a high value of resistance connected across a condenser may be resolved into the effect of a resistance connected in series with the condenser by means of the following equation in which "r" is the shunt resistance and "R" is the equivalent series resistance. The equation holds true only for condensers of very low power factor.

$$R = \frac{1}{(6.28f)^2 \times C^2 \times r}$$

Frequently Used Electrical Units

VOLT	—	The unit of elecromotive force, is the force required to send one ampere of current through one ohm of resistance.
AMPERE	—	The unit of current, is the current flow which one volt will send through a resistance of one ohm.
OHM	—	The unit of resistance, is the resistance offered to the passage of one ampere when impelled by one volt.
COULOMB	—	The unit of quantity, is the quantity of current which passes through one ohm in one second when impelled by one volt, or the flow of one ampere through one ohm for one second.
WATT	—	The unit of power, is the power to do work represented by the flow of one ampere through a resistance of one ohm under a pressure of one volt.
JOULE	—	The unit of work, is the work done by one watt in one second (watt-second) or the energy expended by one ampere flowing through one ohm under a pressure of one volt for one second
FARAD	—	The unit of capacity is the capacity of a condenser which is charged to a potential of one volt by one coulomb or which takes a charge of one coulomb under a pressure of one volt.

Capacity Conversion Factors

To change farads to microfarads, multiply farads by 1,000,000.

To change farads to micro-micro-farads multiply farads by 1,000,000,000,000.

To change microfarads to micro-micro-farads, multiply microfarads by 1,000,000.

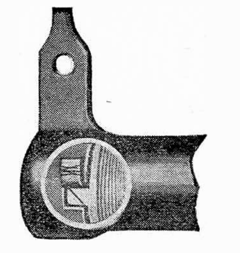
To change micro-microfarads to micro-farads, divide micro-microfarads by 1,000,000.

Caution in Measuring Capacity

The capacity reading of a condenser will vary somewhat when measured with different types of measuring instruments, and under different voltages, frequency and waveform conditions.

BRAZED TERMINALS PREVENT OPENS AND RESISTANCE CHANGES

ONE of the most important features of Aerovox Pyrohm Resistors is the method used to obtain positive contact between the ends of the wire of the resistance element and the terminals of the units.



In the Aerovox Pyrohm resistors, a few turns of the end of the resistance wire are wound around a lip raised from the terminal. The lip is then turned back as shown in the cutout view.

But while other resistor manufacturers merely coat this junction with a cement which protects the joint from the entry of enamel when the unit is fired, Aerovox goes one important step forward by using a special hard soldering process which joins the resistance wire and terminal electrically, and effectively prevents the entry of the enamel or the formation of any oxide films which would tend to reduce the electrical efficiency of the joint.

By making the most perfect electrical and mechanical joint possible, troublesome changes in resistance values and costly rejections are eliminated.

If you use condensers and resistors in your work, you should have a copy of the NEW 1931 Aerovox Condenser and Resistor Manual and Catalog. A copy will be sent to you free on request.