The AEROVOX Research Worker

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USEFUL DATA FOR THE PRACTICAL RADIO MAN

PART I

By the Engineering Department

AEROVOX Corporation

In this combined November-December 1938 issue, we reprint, in response to many requests, charts and pertinent information which has been published during the past few years. The second part of the paper will appear in the January-February 1939 issue of the Research Worker.

AEROVOX PRODUCTS ARE BUILT BETTER

Printed in U. S. A.

TO FIND CAPACITY AND POWER FACTOR AT 110V.-60 CYCLES

From Ammeter, Wattmeter Readings

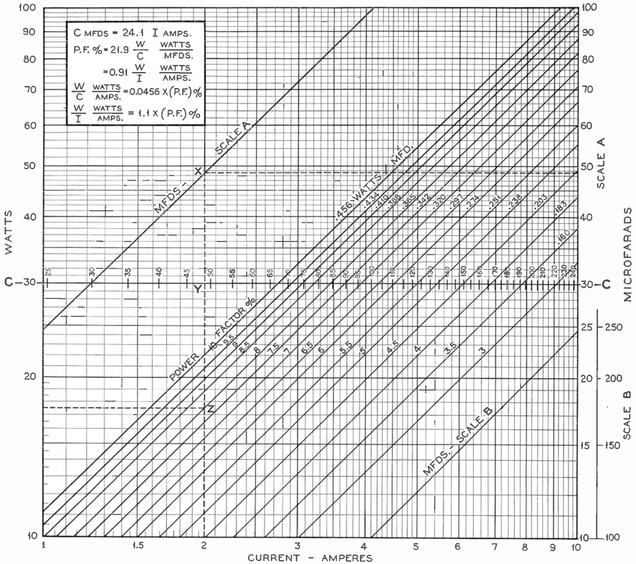

Figure 1

For 110 volt motor-starting condensers the chart of Figure 1 permits the rapid determination of capacitance and power factor when the ammeter, voltmeter, wattmeter readings have been made. It will also show the capacity from voltmeter and ammeter reading alone.

The use of the chart is as follows. It is assumed that all measurements are taken at 110 volts, 60 cycles. Then, reading the current, find the value of the current on the bottom scale, marked "amperes", follow the vertical line upwards until it intersects the line A or B marked "mfds" and follow the horizontal line to the right reading the capacity at the right. The capacity can also be found directly above the corresponding current on the line C-C.

To find the power facter from the wattmeter and ammeter readings, draw a horizontal line from the power scale at the left and vertical line from the ampére scale at the bottom. Read the power factor at the intersection of the two lines. The capacitance is found from the ammeter reading as before.

Example: To find the capacity when the ammeter shows 2 amperes. At 2 on the current scale, follow the vertical line upwards to its intersection "X" with the line marked "mfds scale A", then follow the horizontal line towards the right and read the capacity on the right hand scale—48 mfds. The same can also be found at Y on the C-C scale.

To find the power factor of a condenser which draws 2 amperes and 17.5 watts from the 110 volt line. At 17.5 on the power scale draw a horizontal line. This intersects the vertical line erected at 2 on the current scale at the point Z. This point is situated on the line corresponding to 8 percent power factor.

The same problems can also be worked backwards, that is, when the capacity is given the current can be found from the chart and when the power factor and the capacity are known, both meter readings can be predicted.

Example: Required to find the current drawn by a 200 mfd. condenser from a 110 volt line. Find 200 on the capacity scale B, follow the horizontal line to the left until its intersection with the oblique line marked "mfds. scale B" follow the vertical line down and read 8.2 amperes. Note: the current is 41 ma. per mfd. when a condenser is connected across a 110 volt 60 cycle line.

If the same condenser had a power factor of 3.5 percent, what would be the power indicated by a wattmeter? Follow the vertical line at 8.2 amperes until it crosses the 3.5 percent power factor line, then follow the horizontal line to the left and read 32 watts. The chart can be used for any other voltage, E, if both the power and the current scale are multiplied by the factor E/110.

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CHOKE INPUT FILTER

The study of receiver power supplies consists of two parts—the rectifier and the filter. These two parts must be studied jointly and they are interdependent. The action of the rectifier depends on the load into which it works, while the filter required for any particular application depends on the rectifier used and character of output required. There are four different types of rectifier circuits that may be used for receiver power supplies; the half wave rectifier, full wave rectifier, bridge type rectifier and voltage doubling type rectifier. Each has a definite field of application. Voltage characteristics of each are shown in the table. In the analyses of receiver power supplies, the following features must be taken into account:

	HALF WAVE Fig. 12	FULL WAVE Fig. 11	BRIDGE CIRCUIT Fig. 14	VOLTAGE DOUBLING Fig. 15
E_{dc} (av)	$0.458E_{ac}$	0.458_{ac}	$0.909E_{ac}$	———
I_{dc}	$0.318I_{m}$	1.41_{ac}	I_{ac}	———
E_{dc} (max.)	$1.41E_{ac}$	$0.707E_{ac}$	$1.41E_{ac}$	$2.83E_{ac}$
E_{ac} per plate	E_{ac}	$0.5E_{ac}$	$0.5E_{ac}$	E_{ac}
E inverse max.	$2.83E_{ac}$	$1.41E_{ac}$	$1.41E_{ac}$	$2.83E_{ac}$
I_{av} per tube	I_{dc}	$0.707I_{dc}$	$0.707I_{dc}$	I_{dc}
I max. per tube	I_{dc}	I_{dc}	I_{dc}	———
Sec. kva.	$1.57E_{dc}\ I_{dc}$	$1.57E_{dc}\ I_{dc}$	$1.11E_{dc}\ I_{dc}$	———
Pri. kva.	$1.57E_{dc}\ I_{dc}$	$1.1E_{dc}\ I_{dc}$	$1.11E_{dc}\ I_{dc}$	———
Ripple freq.	f.	2f.	2f.	2f.
Ripple voltage rms.	———	$0.847E_{dc}$	$0.471E_{dc}$	———

E_{ac}=Transformer Secondary Voltage.

1. Output voltage required 2. Allowable ripple voltage 3. Static and dynamic regulation of the supply 4. Peak voltages across the condensers of the system

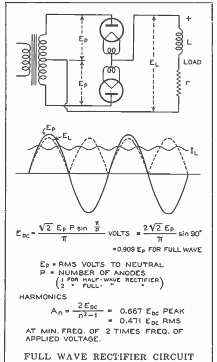

Figure 11

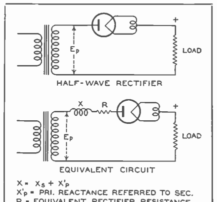

Figure 12

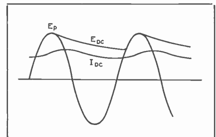

Figure 13

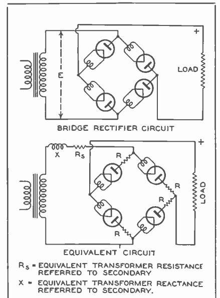

Figure 14

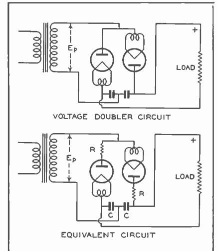

Figure 15

These various features depend on the type of circuit used and the constants of the circuit.

The curves of Figures 7, 9 and 10 are plotted for a DC voltage output of 100 volts with current as abcissa and the peak AC voltage as ordinates. The curves of Figure 7 are plotted for zero tube drop and must be corrected for the tube used and the tube current to obtain the AC voltage required to deliver 100 volts DC. The correction is made by finding the DC voltage drop, in the tube used, from the curves of Figure 5 multiplying by 1.5708, the ratio of the peak value to the average value of a half sine-wave, and adding this voltage drop to the ordinate of curve 7. This value, when divided by 1.41 gives the RMS plate voltage to deliver 100 volts DC into the filter. To obtain any other DC voltage, the AC voltage must be multiplied by the ratio of the desired DC voltage to 100 volts.

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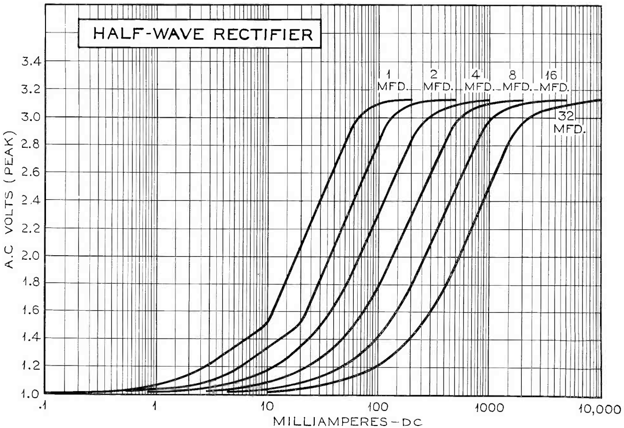

Figure 9

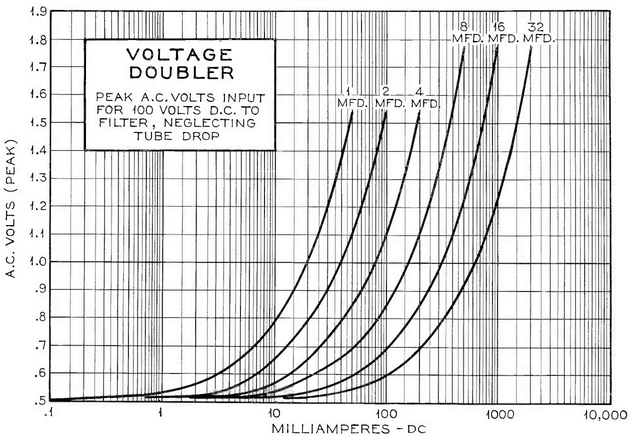

Figure 10

TIME CONSTANTS OF RESISTANCE-CAPACITANCE CIRCUITS

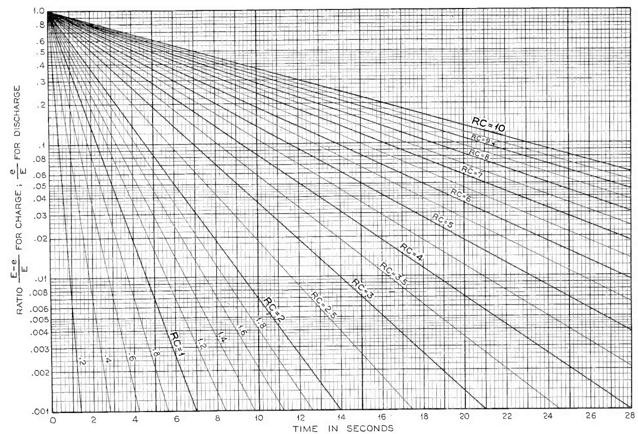

Figure 2

CALCULATING THE TIME

The time of the delay is a function of C, R and the ratio e/E where e is the voltage across the condenser which causes the relay to operate and E is the voltage across the condenser when fully charged.

When a condenser charges through a resistor the voltage across it increases according to the curve A in Figure 3, it can be mathematically expressed by the equation

$$e = E\left(1 - e^{-\frac{t}{RC}}\right)$$

From this equation it is easily seen that when t = RC, the exponent becomes —1 and e

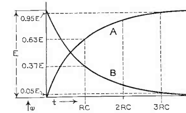

Figure 3

becomes 63% of E. Similarly if t = 3RC e is 95% of E. This product RC is called the time constant.

In the case of discharge the condenser voltage falls according to the curve B. This one being a graph of the function

$$e = E\, e^{-\frac{t}{RC}}$$

If t equals RC, the exponent again is —1 and the condenser is discharged to 37% of its original charge. It should be clear that the time elapsed to reach a given voltage in all cases depends on R and C as well as the charging voltage.

Expressing C in microfarads and R in megohms, the time delay is given by the following equations—

for charge:

$$t = RC \log_e \frac{E-e}{E} \text{ seconds}$$

for discharge:

$$t = RC \log_e \frac{e}{E} \text{ seconds}$$

There are several possible ways of arriving at the required constants for a given time delay. In Figure 2 the chart shows the time in seconds plotted against the ratio (E-e) /E or e/E for different values of RC. An example will clarify its use. Suppose, in Figure 4 the total power supply is 250 volts d.c. across R_1, R_2, R_3, the voltage across R_2 is 10 volts and the relay is so adjusted that it will operate when the grid bias is 15 volts. If the voltage drop across R_1 is 100 volts, the critical value e is 95 volts and (E-e) /E is 0.05. In order to obtain a delay of, say 12 seconds, find the point corresponding to (E-e) /E=0.05 and t = 12 in Figure 2. This point is located on the line RC = 4. Thus a 4 mfd. condenser and a 1 megohm resistor can be used or a 2 mfd. condenser and a 2 meg. resistor, etc.

In general the point will not be found exactly on one of the RC lines and interpolation may be necessary. If this is found difficult, find the corresponding time when RC is unity

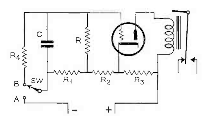

Figure 4

then divide this time into the required time to find the value of RC.

The range of the chart may be extended by multiplying all values of RC and all values of t by any convenient factor.

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AVERAGE PLATE CHARACTERISTICS OF RECTIFIERS

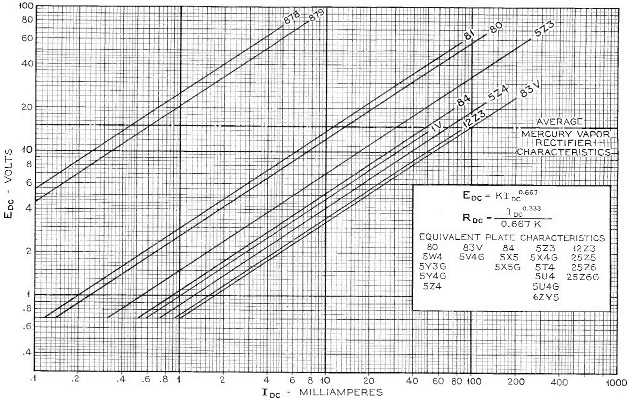

Figure 5

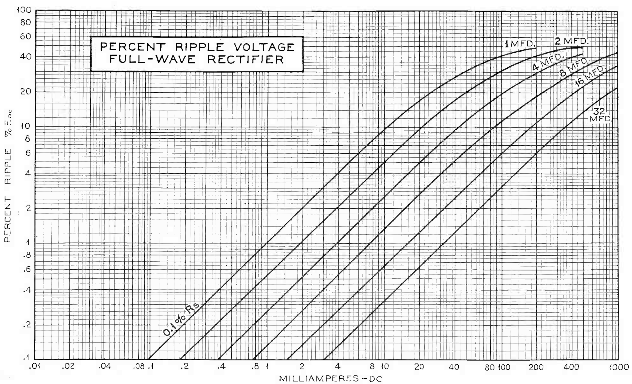

Figure 6

AEROVOX
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CONDENSERS AND RESISTORS

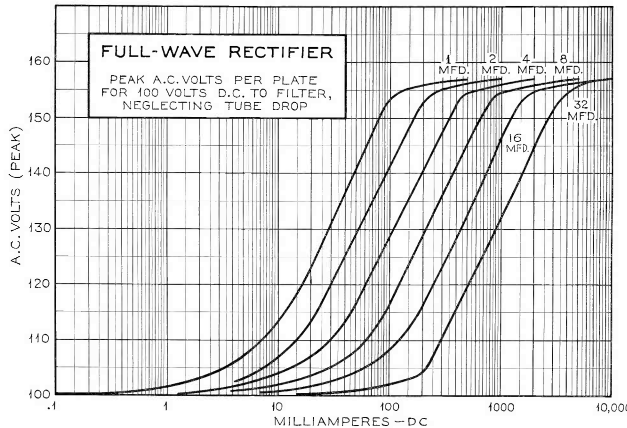

Figure 7

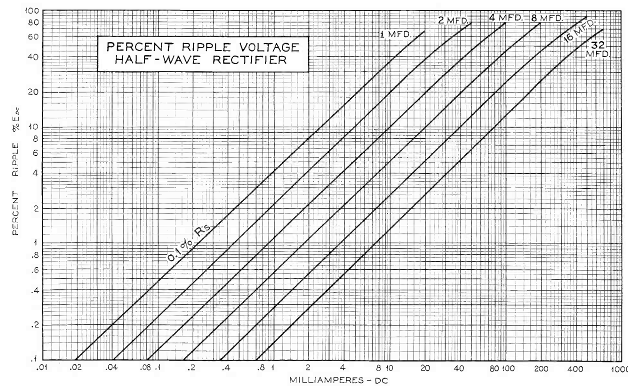

Figure 8