Radio Editors of magazines and newspapers are hereby given permission to reprint in whole or in part, with proper credit to the Aerovox Wireless Corporation, the contents of this issue of the Aerovox Research Worker.

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.

Vol. 5 December 1931 - January 1932 No. 1

A New Type of Inductance - Capacity Reactance Chart

By the Engineering Department, Aerovox Wireless Corporation

"SHORT-CUTS" that save calculations and reduce the possibility of arithmetical errors are useful and important to experimenters and engineers alike. For extreme accuracy such simplified methods that eliminate calculations cannot usually be resorted to, but for reasonable approximations any device that eliminates calculations is extremely desirable.

Charts of various types that reduce to curves a frequently used equation are one of the most well known and generally used methods of eliminating calculations. Sometimes use is made of "alignment charts" which are arranged so that a straight edge so placed as to pass through points corresponding to two known quantities will pass through another graph from which can be read the desired quantity. For example, we can indicate capacity along one edge of a sheet and inductance along the opposite edge of the sheet. Then down the center we can indicate frequency and arrange the frequency scale so that if a straight edge is used to connect the capacity and inductance it will also pass through the frequency at which the particular values of inductance and capacity will resonate.

No one can deny that such charts are useful, but in their usual forms they have disadvantages. For one thing they are not usually equally accurate over the entire range they cover and secondly it is generally difficult to make one chart cover the entire range of values in which one is usually interested.

On another page of this issue of the Research Worker will be found a chart which has a number of important advantages over other types. This particular chart gives the reactances of various sizes of condensers and inductances at all frequencies between 10 cycles and 5,000,000 cycles. The chart covers inductances from 0.01 microhenries up to 1,000 henries (one million microhenries equals one henry) and capacities from 0.1 micromicrofarads up to 10 microfarads. To cover these extremely large ranges in any other type of chart would be impossible unless it was made inconveniently large.

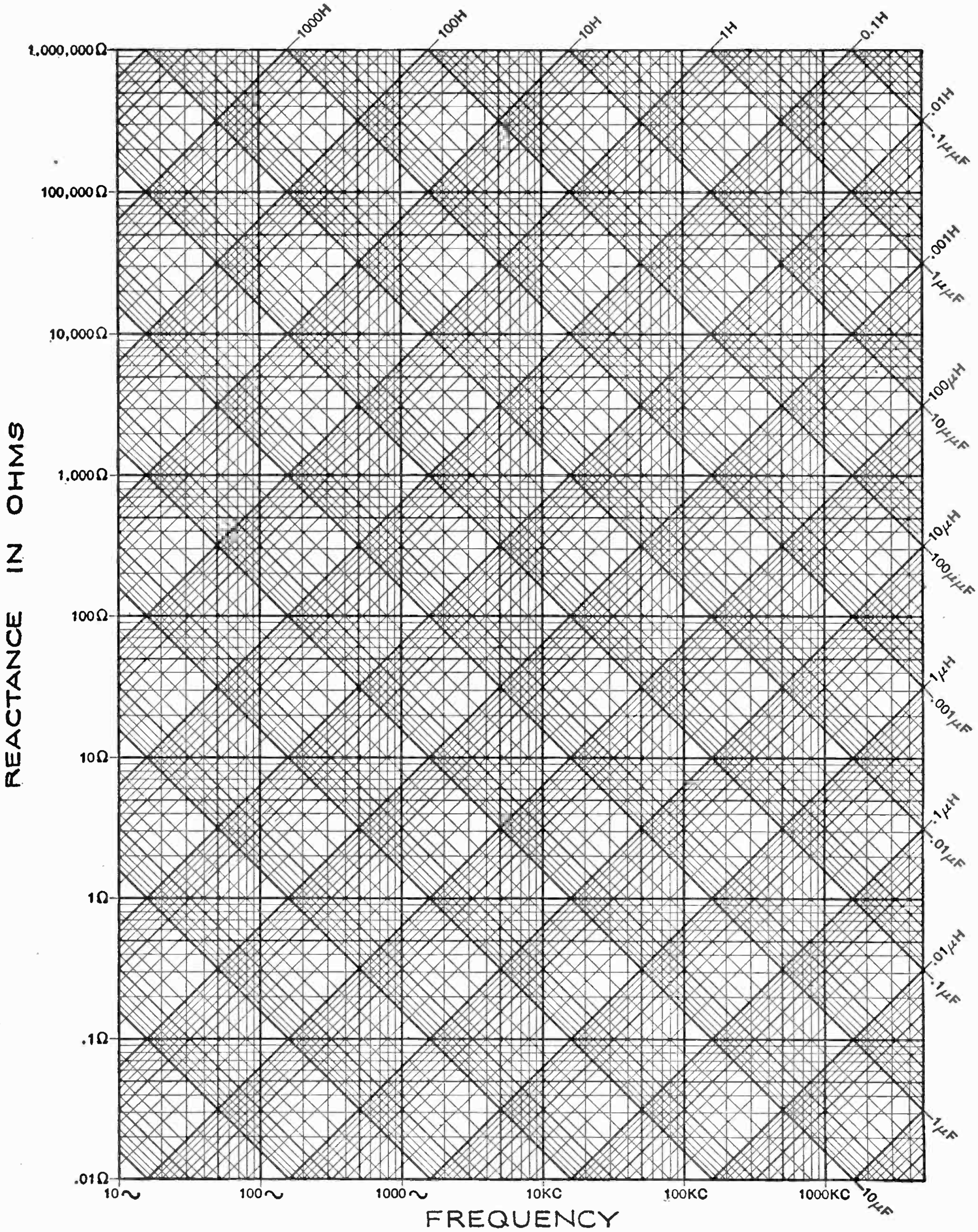
Another advantage is that it is uniformly accurate throughout the range. Other types of charts may be quite accurate over part of the range covered and quite inaccurate over other portions of the range.

How to Use the Chart

Though the chart given on page 2 appears quite complicated it is really simple to use. Along the lefthand vertical scale are given the reactance in ohms, this scale beginning at .01 ohms and extending up to 1,000,000 ohms. Along the lower horizontal axis are the frequencies which extend from 10 cycles up to 5,000,000 cycles or 5,000 kc (kilocycles). The various inductances shown along the upper and right hand edges are associated with the lines drawn at an angle and extending upward from the left to the right. The capacities shown along the same edges are associated with the lines drawn at an angle and extending downward from the left to the right.

With these ideas in mind let us see if we cannot indicate clearly how to use the chart by means of some practical examples.

Suppose we want to find the reactance of a 10 microfarad condenser at 1,000 cycles. First follow along the lower edge until the vertical line corresponding to 1,000 cycles is reached. Then follow along this vertical line until it crosses the slanting line corresponding to 10 microfarads; the 10 mfd. line starts



KC = kilocycles
Ω = ohms

μF = microfarads
μμF = micromicrofarads

H = henries
μH = microhenries

By courtesy Bell Laboratories Record

at the lower right hand corner of the chart. At the point where the lines cross we find that the reactance indicated at the left is approximately 16 ohms—which is the reactance of a 10 mfd. condenser at 1,000 cycles.

For values between those directly indicated on the graph use must be made of the finer lines which subdivide the main divisions. For example, between 1,000 cycles and 10,000 cycles (10 kc) there are ten fine lines. Beginning at the 1,000 cycle line the next fine vertical line is 2,000 cycles, the next 3,000 cycles, the next 4,000 cycles and so on up to 10,000 cycles. The same condition exists in connection with the subdivisions of the other scales of reactance, capacity and inductance. For example, in the upper right hand corner are two slanting lines, one marked 0.1H and the other marked .01H (H stands for henries). Beginning at the line marked .01H and progressing towards the left, the first line is .02H, the next line .03H, the next .04H and so on until we reach 0.1H.

Therefore if we wished to find what size condenser has a reactance of 100 ohms at 1,000 kc (1,000,000 cycles) we would follow along the horizontal line marked 100 ohms until we reached the vertical line marked 1,000 kc. These two lines cross at a point between the capacity lines corresponding to .001 mfd. and .002 mfd. and the answer is therefore approximately .0016 mfd. By referring to the inductance lines instead of the capacity lines we would have found that a reactance of 100 ohms at 1,000 kc would also be obtained with a coil of about 16 microhenries inductance.

The chart can also be used to determine the resonant frequency of a particular coil and condenser. In this connection it should be recalled that a condition of resonance exists whenever the reactance of a coil is equal to the reactance of the condenser in the circuit. Therefore if we had a particular sized coil and want to make a circuit resonant at a particular frequency we must first determine the reactance of the coil at this frequency and then find the capacity which has the same reactance. For example, assume we have a coil of 100 microhenries inductance and wish to find the capacity necessary to make it resonate at 1,000 kc. We need simply to follow along the 100 microhenry line until it crosses the 1,000 kc line. This cross-point corresponds to a capacity of 250 micro-microfarads or 0.00025 mfd.

Some readers may be interested in the theory underlying the graph given on page 2.

The equation for the reactance of a coil is of the form Y=mx and plotting this equation on ordinary graph paper gives us a group of straight lines all of which pass through zero. Due to the reciprocal relation of condenser reactance and condenser capacity curved lines are obtained when we plot Xc as a function of *f*. By employing log scales we can obtain straight lines throughout and cover a wide range in values. The relationship is still linear but of the form $Y=x\pm b$ where x is the log $2\pi L$ or log $\frac{1}{2\pi c}$ and b is the log of *f*.

For both C and L the Y term is the log of the reactance. For inductive reactance b is positive and the inductance lines therefore slope upward to the right. For capacity reactance b is negative and the capacity curves therefore slope upward to the left.

Although charts of various types are used a great deal it is probable that their utility has been restricted because of the difficulty of incorporating into a single chart a sufficiently wide range in values to cover all cases. This difficulty is eliminated by the chart given on page 2 and it will, we hope, prove useful to our readers.

We wish to acknowledge our appreciation to the Bell Laboratories for permission to reprint this chart. It was published originally in the November, 1931, issue of the Bell Laboratories Record.

Voltage Divider Circuits

By properly utilizing Aerovox type 1094 and 1095 carbon resistors the experimenter can improve the performance of his receivers. The ordinary arrangement of a voltage divider system is shown in figure 1 where a single resistor, usually wire-wound, is placed across the output of the filter and the taps serve to supply the lower voltages for the operation of the various tubes. Each tap is bypassed by a condenser.

A somewhat better arrangement is shown in figure 2. In this case a single resistor or several carbon resistors are connected in series across the output of the filter system. Lower voltages for the various tubes are obtained by means of series resistances R1, R2 and R3 connected between the plate circuit of the tube and the high voltage of the filter circuit. These series resistances serve not only to drop the voltage to the required value but also to filter the circuits so that the a. c. currents are effectively kept out of the filter circuit. In the usual receiver these dropping resistors would be placed as close as possible to the tube and the bypass condensers are connected directly from the tube side of the resistors to ground.

The resistance required to decrease the voltage to the desired value is readily determined by noting the normal plate current or screen current drawn by the tube. This current in amperes multiplied by the resistance in ohms gives the voltage drop across the resistance. For example, suppose point A of figure 2 was to supply 180 volts and 1 ma. If the maximum output of the filter system is 300 volts then the drop in the resistance R1 must be 300 minus 180 or 120 volts. 120 volts divided by .001 amperes (1 ma.) gives the required resistance which in this case is 120,000 ohms.

It is of course important that the rated wattage of the resistors is not exceeded. The type 1094 is rated at one watt and the type 1095 at one-half watt. The maximum voltage which can safely be placed across the resistance can be determined by the relation,

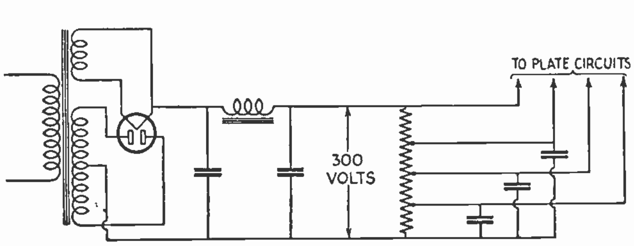


Fig. 1.

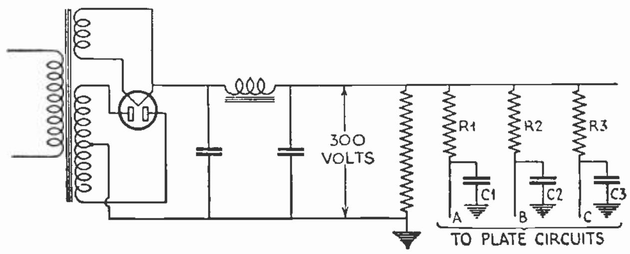


Fig. 2

$$E^2 = WR$$

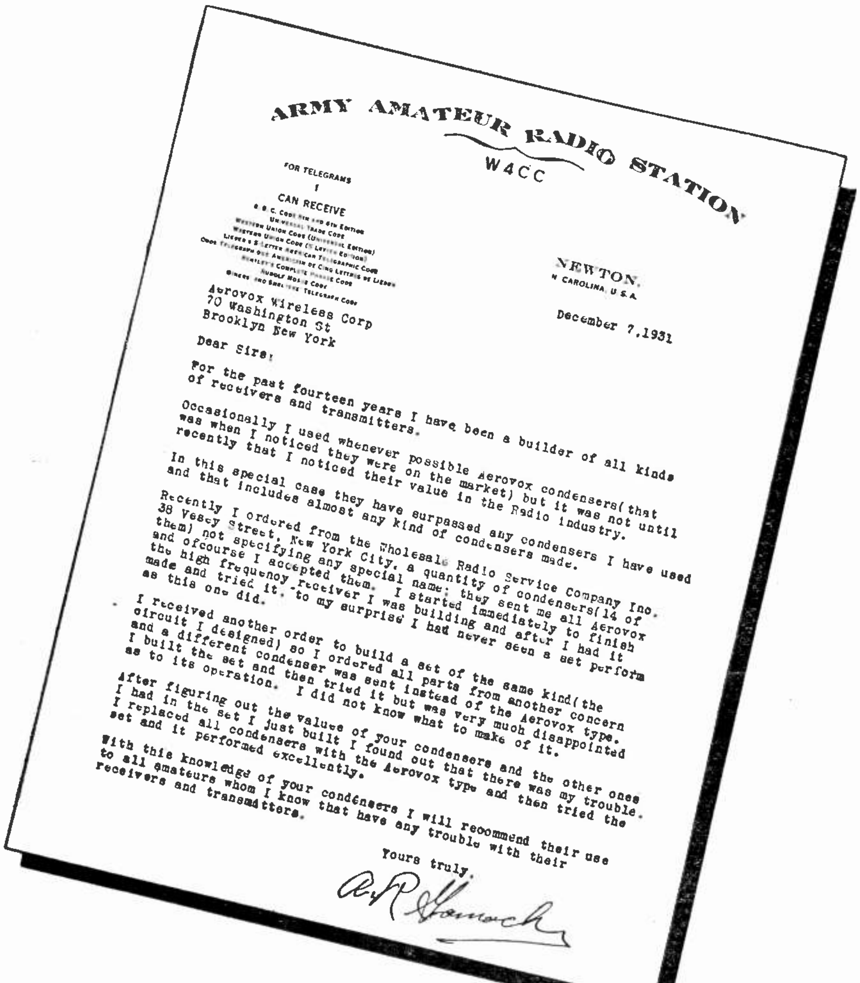
$$E = \sqrt{WR}$$

where W is the rated watts load of the resistance,
E is the maximum permissible voltage across the resistance,
R is the resistance in ohms.

Praises Aerovox Products For Short-Wave Uses

The letter shown herewith is typical of many received from amateurs praising the performance of Aerovox condensers and resistors in short-wave receivers and transmitters. As Mr. Gamache points out, it is essential that only the highest quality units be used in the construction of short-wave units. In such cases the care taken in the manufacture of Aerovox products results in a decided improvement in performance over that obtained using inferior products. Aerovox condensers are all non-inductively wound and are conservatively rated as to working voltage. Increasing numbers of amateurs are taking advantage of the Hi-Farad Dry Electrolytic Condenser for the construction of filter circuits capable of withstanding high voltages. In such applications it is customary to connect a number of Hi-Farad condensers in series in order to obtain the necessary voltage rating..

Amateurs are invited to write our Engineering Department regarding their problems connected with the use of condensers and resistors in short-wave transmitting and receiving circuits.



ARMY AMATEUR RADIO STATION

W4CC

FOR TELEGRAMS
I
CAN RECEIVE

NEWTON,
N CAROLINA, U.S.A.

December 7,1931

Aerovox Wireless Corp
70 Washington St
Brooklyn New York

Dear Sirs:

For the past fourteen years I have been a builder of all kinds of receivers and transmitters.

Occasionally I used whenever possible Aerovox condensers(that was when I noticed they were on the market) but it was not until recently that I noticed their value in the Radio industry.

In this special case they have surpassed any condensers I have used and that includes almost any kind of condensers made.

Recently I ordered from the Wholesale Radio Service Company Inc. 38 Vesey Street, New York City, a quantity of condensers(14 of them) not specifying any special name; they sent me all Aerovox and ofcourse I accepted them. I started immediately to finish the high frequenoy-receiver I was building and after I had it made and tried it, to my surprise I had never seen a set perform as this one did.

I received another order to build a set of the same kind(the circuit I designed) so I ordered all parts from another concern and a different condenser was sent instead of the Aerovox type. I built the set and then tried it but was very much disappointed as to its operation. I did not know what to make of it.

After figuring out the values of your condensers and the other ones I had in the set I just built I found out that there was my trouble. I replaced all condensers with the Aerovox type and then tried the set and it performed excellently.

With this knowledge of your condensers I will recommend their use to all amateurs whom I know that have any trouble with their receivers and transmitters.

Yours truly,