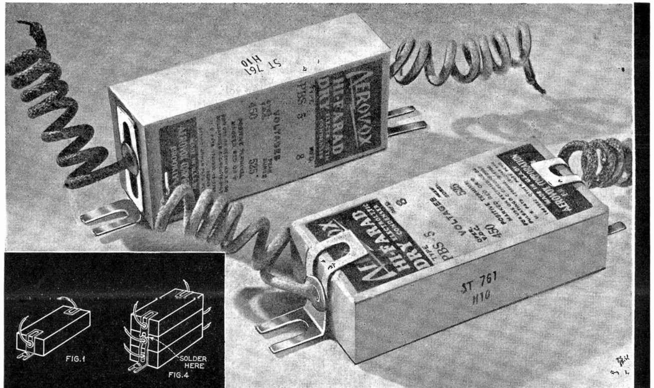

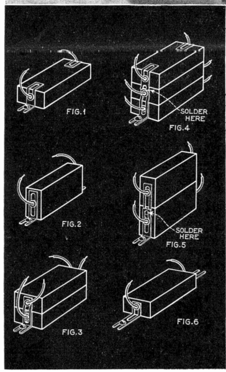

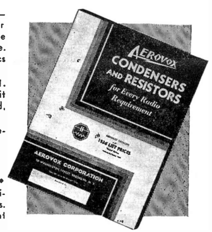

Radio Editors of magazines and newspapers are hereby given permission to reprint in whole or in part, with proper credit to the Aerovox Corporation, the contents of this issue of the Aerovox Research Worker.

The Aerovox RESEARCH WORKER

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

VOL. 8, NO. 10 | OCTOBER, 1936 | 50c per year in U.S.A. 60c per year in Canada

The Use of Mica Condensers in Transmitters

By the Engineering Department, Aerovox Corporation

THE types of condensers employed in amateur transmitters may be divided into four groups: electrolytic condensers, wax-impregnated paper condensers, air-dielectric variable condensers and mica condensers.

The first two groups, which are employed in the power supplies, have been discussed in previous issues of the Research Worker. Employing several condensers in series in order to adapt them to higher voltage was described in the June 1935 issue of the Research Worker; this can be done both with electrolytic and paper condensers.

The air-dielectric condenser is outside of our province and will not be considered here.

Mica condensers are employed mostly for bypassing plate, screen, grid or filament circuits. The required rating for these condensers has been a mystery to many and few understand why it is necessary to employ condensers with a 5000 volt rating when the highest voltage applied to the plates of the tubes is only 1500 volts.

There is also a widespread belief that the mica condenser can stand the maximum a.c. working voltage regardless of frequency which is very far from the truth. All condensers heat up somewhat due to the current that is flowing through them. This current is out of phase with the impressed voltage, it is true, and serves to charge and discharge the condenser all the time. However, there is some heating due to current flowing through the terminals and the plates and there are some losses which are transformed into heat. Consequently, there is a definite limit to the amount of current the condenser can carry, or rather to the power which can be dissipated by a condenser. This power remains approximately the same for all frequencies but since the reactance of the condenser varies, the permissible current varies with frequency and with the capacity.

There are then two maximum ratings to the mica condenser, neither of which should be exceeded; the first is the voltage rating, while the second is the current rating which varies with frequency and capacity.

It will be shown later that at certain frequencies one will be limited by the voltage rating only because that limit will be exceeded before the maximum current rating has been reached; this happens at low frequencies and for small values of capacities. However, at higher frequencies and for higher capacities the current increases for the same applied voltage and soon it is the current rating which is the first to be exceeded. This happens at high frequencies and practically always at frequencies employed by amateurs. In these cases the condenser is badly overloaded when the applied voltage is still way below the maximum voltage rating.

In order to use mica condensers intelligently, the designer must determine current, voltage and frequency whereto it will be subjected and then he should determine which condenser will be satisfactory for the purpose.

Let us discuss the second requirement first for this is the easiest one of the two. The figures 1 and 2, on page 2 of this issue give the maximum current ratings for various types of condensers which are most popular for use in amateur transmitters.

Figure 1 refers to the mica condensers types 1771, 1772 and 1773. The

TYPES 1771, 1772 & 1773

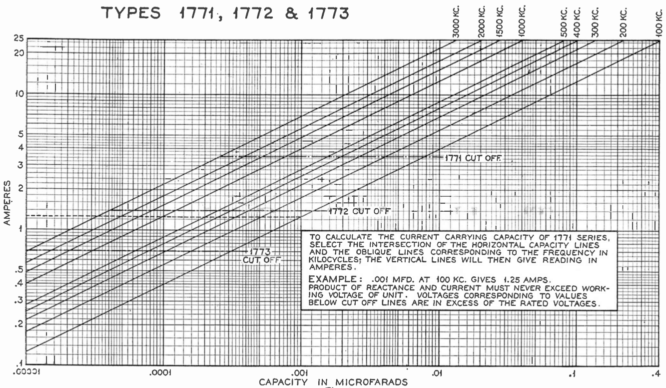

Fig. 1

TYPES 1881, 1882 & 1883

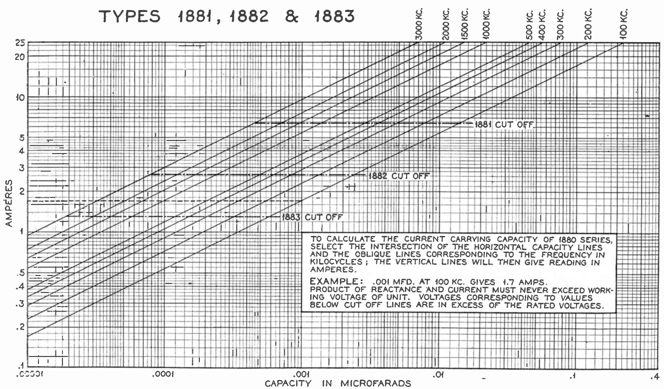

Fig. 2

AEROVOX BUILT BETTER CONDENSERS AND RESISTORS

maximum a.c. working voltage for these types are 500 volts, 1250 volts and 2500 volts respectively. The maximum d.c. working voltage of these condensers is 1.4 times as high: 700 volts for type 1771, 1750 volts for type 1772 and 3500 volts for type 1773. When the condenser is subject to both a.c. and d.c. voltages, the sum of the d.c. voltage plus the peak a.c. voltage should not exceed the d.c. working voltage rating.

The maximum current ratings are given in Figure 1. Suppose a .00025 mfd. condenser is to be used at 1000 kc. The chart is consulted and the intersection of the oblique line marked 1000 kc., and the vertical line marked .00025 mfd. is located. The horizontal line is followed from the intersection to the left and the maximum current rating is found to be 1.95 amps.

This intersection, as will be noted, lies below the 1771 cut-off line which means that the voltage rating of the 1771 type condenser will be exceeded with less current than 1.95 amps. and for this type one needs to pay attention to the voltage rating only. On the other hand, if the condenser is of the 1772 type, the maximum current just found will not result in too high a voltage and it is the current rating which should be observed.

Note that the above results determine whether a type 1771 would be satisfactory or not. If the applied r.f. voltage is to be higher than 500 volts, this condenser is not suitable and a 1772 can be used unless the r.f. current is going to be more than 1.95 amps.

As a further illustration of the effect of frequency, suppose the frequency was lowered to 500 kc., then the mamximum current rating would be 1.35 amps. But this point is below the 1772 type cut off line. So this type condenser, at 500 kc. would be limited by its voltage rating since the current of 1.35 amps would result in too high a voltage.

The same size condenser of the 1773 series however would be limited by the current rating and not by the voltage rating because the intersection on Figure 1 is still above the 1773 cut-off line. It is not until the frequency is lowered to about 120 kc. that all three types are limited by the voltage rating (for the .00025 mfd., size only).

Figure 2 gives similar information on the mica condenser types 1881, 1882 and 1883. The maximum a. c. working voltage for these types is again 500 volts 1250 volts and 2500 volts respectively and the maximum d. c. working voltages are 700 volts, 1750 volts and 3500 volts respectively. The use of this chart is exactly the same as the one in Figure 1. The previous example and the one indicated on the chart should be sufficient to make its application clear.

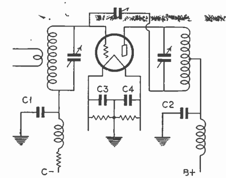

Fig. 3

Determining the amount of current actually flowing through a bypass condenser or the voltage across it will no doubt be the hardest task for the average amateur. These quantities can either be measured or calculated. Since most amateurs have a radio-frequency ammeter, it is a good plan to place such a meter in series with the bypass condenser in question in order to measure the current. It is true that the insertion of the ammeter changes the conditions somewhat but it would give an approximate idea.

The vacuum-tube voltmeter is another means of determining the voltage or the current. Measure the voltage across the condenser with the v.t. voltmeter and calculate the current by the equation

$$I = \frac{2\pi f C E}{1000}$$

where f is in kc. and C in microfarads. E in volts, I in amps.

The cathode-ray oscillograph can also be used as a measuring instrument. Connecting the vertical plates across the condenser one can measure the height of the pattern which can be read in volts when the sensitivity is known. The current can then be calculated as before.

When it comes to calculation of the current or voltage, it may become complicated but this is a way to do it. Referring to Figure 3, which is a diagram of an r.f. power amplifier stage, C_1, C_2, C_3 and C_4 are usually mica condensers. The preferred size seems to be .002 mfd. The current flowing through C_2 is equal to the r.f. current flowing through the tube and this same current must also flow through C_3 and C_4 in parallel. Therefore, C_2 passes twice as much current as C_3 and C_4. Approximately, the current through C_2 cannot be more than .7 times the direct plate current.

On the other hand one may consider the tube as a generator with a voltage of mu times the applied grid voltage. This voltage is applied to a circuit consisting of the tube's a.c. resistance, the equivalent resistance of the tuned circuit, C_2, and the two condensers C_3 and C_4 in parallel. When all these impedances are known the current can be calculated. It will not be a great error to ignore the bypass condensers and consider the tube and the load in series. The tube's a. c. plate resistance can be obtained from the manufacturer's ratings and can also be taken from a family of plate characteristics. The equivalent resistance of the parallel tuned circuit is given by the equation

$$R_1 = \frac{C R}{L}$$

where R_1 is the equivalent resistance of the circuit and R is the r.f. resistance of the coil plus the r.f. resistance of the tuning condenser.