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Uses of Concentrically-Wound Electrolytic Condensers

By the Engineering Department, Aerovox Corporation

IN the November, 1933 issue of the Research Worker we described briefly some of the new types of electrolytic condensers which were introduced. By referring back to that issue the reader will note that a considerable reduction in the physical sizes of electrolytic condensers is brought about by winding two or more condensers into a single roll, thereby obtaining what is termed a concentrically-wound condenser. If there is a common negative terminal for two or more condenser sections composing the concentric unit, then the condenser is referred to as being "concentrically wound—common negative". If there is a common positive terminal for the sections composing the concentric unit, then the resulting condenser is referred to as being "concentrically wound—common positive". Our purpose here is to show some of the circuit arrangements which make it possible to use to advantage these concentrically-wound combinations.

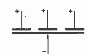

FIG. 1

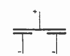

FIG. 2

It should be appreciated that an infinite number of combinations are possible, using such constructions and it is therefore not possible to describe other than some of the more generally used types and the circuit arrangements to which they are adapted. From the following descriptions of some of the more widely used types of Aerovox concentrically-wound units, the reader will appreciate the underlying factors of design and be able to work out for himself other combinations to fit special requirements. There is no question that the future is to see even wider use of concentric combinations to bring about reductions in the space requirements for filter and bypass condensers in a radio receiver.

Fundamental Characteristics

Before discussing circuit arrangements, it will be advisable first to establish clearly in mind the fundamental characteristics of the two general types of concentrically-wound units as described in the November, 1933 issue of the Research Worker.

As shown in Fig. 1 the concentrically-wound common-negative condenser consists of two or more "positives" wound into a single roll with a single negative foil common to all the anode foils. The figure shows three "positives" but theoretically there may be any number of these anodes. Generally, however, not more than three anodes are used.

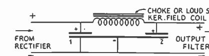

FIG. 3

As shown in Fig. 2 the concentrically-wound common-negative condenser consists of two or more "negatives" wound into a single roll with a single positive foil common to all the negative foils. Again there is no limit theoretically as to the number of "negatives" but usually there are not more than two.

Some Typical Filter Circuits

Now, let us discuss some of the circuit arrangements using these types of condensers. One of the simplest is shown in Fig. 3 where we have a concentric common-negative unit consisting of two high-voltage sections marked 1 and 2, these two sections composing, in combination with a choke coil, the main filter system of a power supply device. The choke coil is in the positive side of the circuit and the positive terminals of the condenser are connected either side of this choke coil. The negative foil common to both sections of the condensers is connected to the negative side of the filter circuit.

In the case of a filter system using two choke coils (in the modern radio receiver one of the chokes is usually the field coil of the loud speaker) we can make use of a triple-section, concentrically-wound, common-negative condenser. Such a filter circuit is shown in Fig. 4. It is similar to the

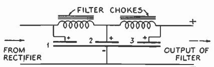

FIG. 4

circuit of Fig. 3 with the exception of the addition of another section to the condenser and another choke in the positive side of the filter system. The first types of concentric units to come into general use were the two- and three-section types illustrated in Figs. 3 and 4 and the success of these circuits has brought about the use of the more special types of concentric units now being manufactured.

One of these more special cases is illustrated in Fig. 5. Here we have combined in one unit two filter condensers marked 1 and 2 and, in addition, a low-voltage by-pass electrolytic section marked 3 which serves as a by-pass unit across a resistor, "R" from which is obtained the C-bias voltage for a power tube. Again, as in the condenser shown in Fig. 4, all three sections are concentrically wound, but instead of having three high-voltage sections, as in the case of Fig. 4, we have in Fig. 5 two high-voltage sections rated probably for a working voltage of 450 volts and a third section, 3, rated probably at only 25 or 50 volts. The first two sections are placed directly across the filter system and hence must withstand the full voltage of the filter; the third section is connected across the resistor and the voltage drop across this resistor may be less than 25 volts. Consequently, section 3 need only be designed to operate at a similarly low voltage. In Fig. 5, to clarify the circuit arrangement, we have shown very roughly the manner in which the filter system and the condenser tie into the circuit of the power tube. There is, of course, no reason why three high-voltage sections might not be combined with a low-voltage section and thereby permit the use of a two-section filter of the type shown in Fig. 4 and the low-voltage section could again be used for by-pass purposes.

"Common-Positive" Circuits

Now let us consider some circuit arrangements for concentrically-wound

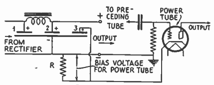

FIG. 5

common-positive units. The simplest arrangement is that shown in Fig. 6 using a two-section high-voltage condenser with one positive and two negative terminals and the choke coil in the negative side of the filter circuit.

In Fig. 7 we show a combination of a concentric common-negative unit with another *separate* condenser in a two-section filter with the first choke in the positive side of the circuit and the second choke in the negative side of the circuit. In many cases, all, or part of the voltage drop across the second choke is used also as the bias voltage for the power output tubes.

In all cases, when concentric common-negative combinations are used consideration *must* be given to the voltage between the two "negatives" due to the voltage drop across the choke or other apparatus connected between the two "negatives". The polarity of this voltage drop is shown in Figs. 6 and 7 by the small polarity marks (plus and minus) near the chokes connected in the negative sides of the circuits. This voltage drop is due to the current flowing through the choke coil and the direction of this current is such that the polarity of the

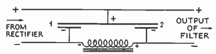

FIG. 6

side of the choke nearest the output of the filter is positive and the polarity of the side of the choke nearest the input to the filter is negative. The amount of voltage drop across the chokes (and hence the voltage drop between the two "negatives") will be determined by the resistance of the choke and the current and will be equal to the product of the resistance in ohms and the current in amperes.

This voltage drop between the two "negatives" will cause a high leakage current to flow between the two "negatives" and very adversely affect the effectiveness of the entire filter system unless one of the "negatives" of the condenser has a film formed on it to limit the current flow. In the case of Fig. 6 the "negative" of section 2 will be of positive polarity with respect to the "negative" of section 1 by the amount of the voltage drop across the filter choke. Hence the negative foil

of section 2 must have a film on it capable of limiting the current flowing between the "negatives" to a very small value. If the voltage drop is 100 volts then the film must be such as to limit the current to a small value at

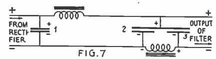

FIG. 7

100 volts. If we were to use a condenser in this circuit which did not have such a film on one of the "negatives" the receiver would hum very badly due to excess leakage current across the choke coil.

Similarly in the case of Fig. 7 the "negative" of section 3 is of positive polarity with respect to the "negative" of section 2. Again the "negative" of section 3 must have a film on its surface such as to limit the current flow.

Design Factors

In the case of common-positive concentric units all the positive foils have a film on their surfaces and we therefore do not have to consider leakage paths between "positives". In the case of common-negative concentric units leakage must be considered and failure to take this factor into account undoubtedly will result in unsatisfactory operation of the receiver. The importance of this point cannot be overemphasized.

In many circuits use is made of a combination of common-positive and common-negative constructions in a single unit. Such combinations may bring about some reduction in the physical size of the unit but there is frequently no advantage from a cost standpoint and naturally the more complicated the arrangement the greater are the possibilities of field trouble.

For example, instead of using a single-section condenser and a two-section, common-negative condenser we can combine them into one unit, as shown in Fig. 7, with, as indicated above, a slight reduction in physical size. This latter arrangement is shown in Fig. 8. From the standpoint of sections 1 and 2 we have a concentric common-negative because both of the sections are connected to a common-negative foil, A. However, from the standpoint of sections 2 and 3 we have a common-positive construction because both sections have a common-positive foil, B. The complete unit is therefore a mixture of common "positives" and the common "negatives" but the resulting arrangement is electrically equivalent, at least, to the filter circuit of Fig. 7.

The following points may furthermore serve to indicate the desirability of giving serious consideration to the filter circuit arrangement. In both Figs. 7 and 8 there is present a common-positive concentric unit and hence formation of one of the negative foils will have to be resorted to in order that there shall not be excessive leak-

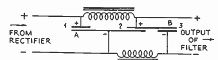

FIG. 8

age between "negatives". By slightly rearranging the circuit of Fig. 7 this disadvantage can be eliminated.

In Fig. 9 we show the same filter circuit but we have combined sections 1 and 2 thereby making them a concentric common-negative and section 3 is a separate unit. In other words, by simply rearranging the connections we can change from the common-positive, plus one separate section arrangement of Fig. 7 to the common-negative, plus one separate section arrangement of Fig. 9—and it is always preferable to use a common-negative unit if this can be accomplished without unwarranted increase in cost of the complete radio receiver.

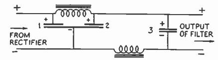

FIG. 9

It will be obvious to the reader that although we have only covered in this article concentric combinations with respect to their application to filter systems, that similar concentric combinations can also be applied generally to the by-pass circuits of radio receivers. There are many points in the receiver, for example, where two 5 or 10 mfd. low voltage sections (25 or 50 volts) can be wound concentrically and used to by-pass certain audio circuits. Almost invariably where low voltage by-pass condensers are wound concentrically they are of the common-negative type; it is seldom that such condensers are wound with common-positives.

The preceding discussion will serve to indicate some of the fundamental factors underlying the design and use of concentrically wound electrolytic condensers of various types. It has of course been impossible to cover all phases of the subject, but the essential point will, we hope, be apparent from the foregoing. There is no question but that the general use of concentrically wound units in radio receivers of today has somewhat complicated the problem of design and servicing in the sense that reasonable care must be exercised to make certain that all factors have been considered.