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The Aerovox Research Worker

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Types of Condensers and Their Applications

By the Engineering Department, Aerovox Corporation

MOST of us know that a condenser consists of two conductors separated by an insulator. According to the kind of insulating material employed, condensers can be divided into the following types: air-dielectric condensers, usually variable, mica condensers both fixed and variable, paper condensers, electrolytic condensers. These are the types at present in use in receivers, but of course other types find application in transmitters, such as oil dielectric condensers, and some which use both glass and oil.

When designing and building a receiver it is not always evident which of the types will best perform a given function. Therefore this article will briefly discuss the various condensers employed in a typical modern receiver and indicate the various types generally considered best for each task.

Air dielectric condensers are superior from a standpoint of efficiency, constancy of capacity, but are bulky and expensive. Next in order comes the mica condenser. The fixed mica condenser usually is sufficiently constant for use in tuned circuits, although it is less efficient than the air condenser and not as constant. On the other hand it can be made smaller and will withstand a higher voltage than the air condenser. Moreover, the price is relatively low for condensers of small capacity. The variable mica condenser of the compression type is still much employed in i. f. amplifiers and as a trimmer although it is generally conceded that the capacity varies somewhat due to humidity.

Paper condensers are not quite so constant and efficient as the two preceding kinds but on the other hand, a larger sized condenser of this type can be made more economically and will be used where the cost of the other types of the same size would be prohibitive. Finally, the electrolytic condenser, enables us to obtain very large capacity-values at low cost. It has certain limitations, such as polarity, power factor, but this does not seriously interfere with its usefulness in certain fields.

Now let us turn to the circuit of Figure 1. This is the schematic diagram of a typical all-wave receiver but with only two of the coil sets shown so as not to complicate the drawing too much. The other ranges employ coils and trimmer condensers similar to the two ranges shown. Condensers C1, C2, C7 and C8 are trimmers connected across the r. f. and the first detector coils. The use of mica compression types is nearly universal. Slight variations in the capacity will bring the receiver slightly out of line but does not affect the dial setting which is controlled entirely by the oscillator. Therefore, even if very accurate calibration is required, it is often felt that the added expense of air-dielectric trimmers is not warranted.

C4. C14 and C15 are the tuning condensers and these are of course of the customary three-gang air-tuned type. C5, C6, C17, C18 and C19 are employed to bypass r.f. and i.f. currents around resistors. For the average all-wave receiver paper condensers will be employed. The value of the condenser depends on the resistance of the circuit to be by-passed and the frequency. The bias resistor of the first r.f. tube is generally a few hundred ohms. The size of the condenser is now usually .1 mfd. This should prove a satisfactory arrangement for most purposes. Some designers of special receivers have gone farther and use sizes of .5 and even 1 mfd.

There are also special cases such as ultra-high-frequency receivers which call for smaller condensers due to the higher frequency. Mica condensers are used exclusively for such purposes.

Condensers in the plate and screen circuits, such as C6, C17, C18, C22 and C23 are generally used in conjunction with a resistor of 1000 ohms in the plate circuit and many thousands of ohms in the screen circuit. A size of .1 mfd. is often used but some use .05 or even less. The reader will also find designs which omit the filter in one or more stages. Generally some kind of filtering will be required where there are two successive stages working at the same frequency.

C3 and C9 are condensers which serve as filters for the a.v.c. system. They are also in series with the tuning condensers C4 and C15. Therefore it is important that they should not cause any appreciable detuning due to possible variations in their capacity, nor cause any reduction in tuning range and they should be equal if possible. From the standpoint of the design of a.v.c. systems, the leakage resistance should be high. The types used are either paper or mica depending on the required size. If the size of C3 is very much larger than C4, small variations in the capacity do not appreciable alter the capacity of the two in series because it will be smaller than the smallest. On the other hand, if C3 is not very much larger than C4, it becomes important that the value remain the same and that the two condensers in the two stages remain the same. There is also the question of power factor. Since the condenser is used in a tuned circuit, a low power factor is desirable. All the previous considerations would point to the mica condensers as the best solution, but it becomes uneconomical to use it when the size is .05 mfd. Mica condensers of .01 and .015 mfd. are being used in some receivers.

C 10, C11, C12 and C13 are the trimmer and padder condensers employed in the oscillator circuit to make it track with the r.f. tuning condensers. When high precision is required air-tuned condensers are desirable but they are not used much except in special receivers for amateurs which employ band spreading. In the majority of cases, condensers with mica dielectric are employed for the purpose. The trimmers, C10 and C12 must be variable for all ranges. The padder condensers generally have to be of a rather large size. The required capacity for the broadcast band employing a 456 kc. intermediate frequency is in the neighborhood of 400 mmfd., or slightly more. If the intermediate frequency is 175 kc., the required size is somewhere near 750 mmfd. For the short-wave bands the values become larger, up to 2000 mmfd. and more. In the smaller inexpensive receivers, these padders

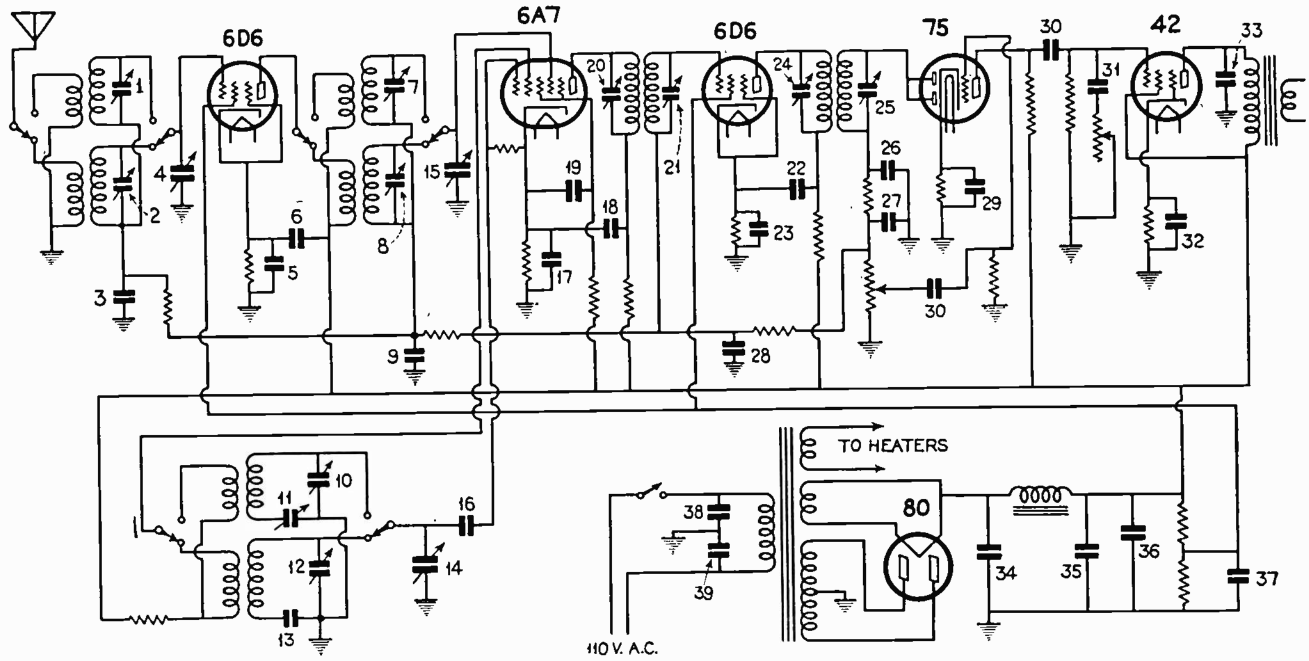

Fig. 1

are often fixed condensers of the mica type and one also encounters fixed paper condensers. Other sets have the mica compression type for the two highest-wavelength ranges and fixed ones for the short-wave ranges. Then there are some designers who use a mica condenser in parallel with a small mica trimmer. These arrangements are satisfactory unless very accurate logging is required; in that case the air-tuned padder and trimmer is the only solution.

The grid condenser C16 is always a mica condenser. Now we come to the variable condensers in the i.f. amplifiers C20, C21, C24 and C25. The capacity value of these trimmers is somewhere between 70 and 100 mmfd. as an average.

Compression type mica condensers are used for the purpose. In recent years, high quality receivers have been built which employ the air dielectric type in order to obtain greater constancy of adjustment.

C28, in the a.v.c. system usually has a value of .05 mfd. and is of the paper type. Since it is used in a high resistance circuit the leakage resistance should be high. C26 and C27 serve to filter the r.f. component from the output of the detector. Since rather small condensers are used here, the mica type is most often employed. The capacity value of these condensers may be .0001 mfd. In these days of high-fidelity receivers it is necessary to make the by-pass condenser as small as possible because the higher audio frequencies might be by-passed too. The trend is at present towards using only one condenser and reducing its size to .000075 or .00005 mfd.

C29 is employed to by-pass audio frequencies because the triode section of the tube is an audio amplifier. Before the advent of high-capacity electrolytic condensers it never was possible to get a big enough condenser so as to amplify the low notes adequately. The bias resistor of the tube is in the neighborhood of 2000 or 3000 ohms. If this is shunted by a 1 mfd. paper condenser which used to be the practice, the impedance of the combination is still over a thousand ohms at 100 cycles. Here indeed the bigger the condenser, the better. The low-voltage high capacity electrolytics serve the purpose admirably. Condensers of 50 mfd. at 50 volts are popular.

C30 should be a condenser with a capacity large enough to give proper bass response, and it should have a low leakage because leakage will cause a change of bias on the next tube which will destroy the quality and maybe the tube. With the usual sizes of grid-leak, the value of C30 ranges from .1 to .01 mfd. There are very few audio amplifiers which employ larger condensers unless they are designed for special purposes. A good paper condenser will serve.

The tone-control condenser C31 is generally a paper type with a capacity of .05 mfd. or thereabouts. Some different designs are now used which do not employ the variable resistor but use a variable condenser instead; this is then a mica compression type.

C32 is another condenser which must provide an easy path for low frequencies around a low resistance. A large electrolytic condenser with a low voltage rating has to be employed. There are several alternate ways of obtaining the bias for this tube, as described in the previous issues of the Research Worker. The bias can be obtained from a tap on a choke in the negative lead of the power pack. In this case, if the series resistance is high, a smaller paper condenser can be used.

C33 is often found necessary to remove some of the hiss and frying noises in circuits with a pentode output tube. A paper or a mica condenser are found in today's receivers with tubular paper types in the majority.

In the powerpack, C34 and C35 are of the high-voltage electrolytic type. Hardly any receiver in existence uses any other type. Some designers find that the electrolytic condenser does not provide a satisfactory by-pass for r.f. current and wishing to filter the B-supply for disturbances in the line, a paper condenser, C36 is connected across the electrolytic condenser. The hum-voltage passes through the big condenser and the r.f. passes through the smaller paper condenser.

C37 is another condenser which shunts a low resistance. The frequency in question however is high so a paper condenser of .1 or .5 mfd. will be found to work well.

C38 and C39 which filter the line are usually paper condensers with capacities between .1 and .5 mfd. each.

APPLAUSE FROM THE ANTIPODES

A manufacturer, like an actor, does like a bit of applause now and then as an indication of how his products are faring. That is why AEROVOX is especially pleased with the comments of H. B. Davey of 239 Charles Street, Launceston, Tasmania—just about on the opposite side of the globe from Brooklyn, N. Y.

"In Australia (just north of Tasmania) Aerovox are becoming hard indeed to procure; in fact, I have a very special job under construction for my own use—the fruit of over 12 months spare-time work—that is hung up because I find it impossible to secure one only 0.01 400-volt Aerovox. I've searched without result; therefore, this job will go up on the shelf until this can be secured. I will not under any circumstances leave this special job with one weak link, which by adopting any other make would be the case," writes our Tasmanian radio man.

"I trust these lines will clearly convey to you the absolute faith with which I regard your products; faith only gained by the loyal and splendid service rendered by these condensers consistently over so long a period. I think it may be safely said that your product is regarded with affection."

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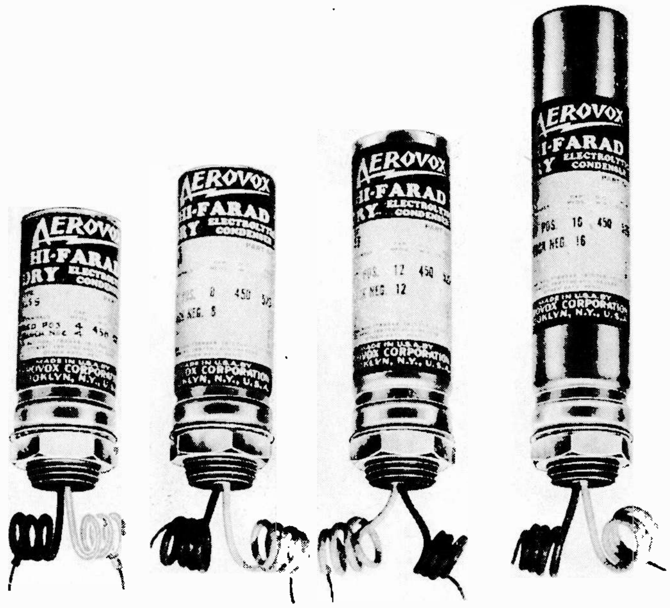

Type GLS-5 ELECTROLYTICS
525 Volts Surge Peak—450 Volts D.C. Working

Cap.	Dimensions	List Price
4	1 x 2-3/16 ins.	$0.85
8	1 x 2-11/16 ins.	1.05
12	1 x 3-3/16 ins.	1.40
16	1 x 4-3/8 ins.	1.55

Type GLS-250 ELECTROLYTICS
300 Volts Surge Peak—250 Volts D.C. Working

Cap.	Dimensions	List Price
4	1 x 2-3/16 ins.	$0.75
8	1 x 2-11/16 ins.	.95
12	1 x 2-11/16 ins.	1.10
16	1 x 3-3/16 ins.	1.35

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