Vintage Radio

by PETER LANKSHEAR

Capacitors in vintage radio — 3

Lately we have been looking at the various types of capacitors used in vintage equipment. Such is their importance, and their range so comprehensive, that, to provide even a superficial coverage of the subject we have run into an unprecedented third section. This time we look at semi-variable or 'trimmer and padder' capacitors, and then at the practicalities of capacitor repairs and replacement.

This month we provide some capacitor restoration hints for inexperienced readers. But first, left over from last month are some comments about the all important semi-variable preset *padders* and *trimmers*, essential for receiver alignment. (By the way, a *padder* is a preset variable capacitor with a relatively high value, used mostly to achieve the tuning offset for the local oscillator section of a superhet receiver. *Trimmers* are preset variables of lower value, used for fine adjustment of tuning and tracking.)

Several representative types are shown in Fig.1, but it should be realised that these are only a fraction of the number of patterns likely to be encountered. In the top row are two varieties of the superior air dielectric trimmers found in the highest grade equipment, especially test and military equipment and communication receivers. The trimmer at the top left is in reality a small conventional variable air spaced capacitor with a screwdriver slot and locknut instead of a knob. These will often be found in the coil boxes and IF transformers of the classic communications receivers.

One of the most successful air trimmer designs was the remarkable concentric 'Beehive', illustrated in the top centre and right in Fig.1 and produced by Philips over a period of at least 40 years — and possibly longer. They consisted of two sets of concentric mating cylinders, with one mounted on a coarse threaded centre rod so that its cylinders could move between the fixed set. The only insulation necessary was a ceramic sleeve section on the rod.

With air dielectric, and ceramic insulation, concentric air dielectric trimmers were very efficient and stable. Other manufacturers appreciated their worth, two diverse examples being Britain's Eddystone in their communication receivers and New Zealand's Radio Corporation in some 'Columbus' and 'Courtenay' models. Philips at one stage even scaled up the concentric capacitor to make full scale three-ganged tuning capacitors!

Very familiar are the compression preset capacitors, and a typical padder of this type is shown at the bottom left of Fig.1. Most have a ceramic body, with electrodes and dielectric, usually mica, interleaved like the pages of a book. A simple screw adjustment controls the pressure on the plates. Many tuning capacitors have integral compression trimmers of this type. This class of capacitor is generally satisfactory for medium waveband receivers, but for good shortwave performance, trimmers with better temperature stability are desirable.

For critical applications, especially oscillator tracking, ceramic trimmers with a negative temperature characteristic are preferable. One common pattern is the rotary type shown in the lower centre of Fig.1. At the bottom right is an earlier type used by Philips in the 1930's. It consists of a thin ceramic tube, with a coating of silver on the inside. The other electrode is a single layer of tinned soft wire wound on the outside and cemented. Adjustment procedure is simple: the wire is unwound until the correct capacitance is reached. Of course, what happens in real life is that the unwinding goes past the optimum point, and some of the wire then has to be rewound and fastened in position! For production alignment these trimmers were satisfactory enough, but over-enthusiastic experimenters can get into bother with repeatedly adjusting them.

Renew or repair?

A significant part of restoration work involves capacitors. There are several philosophies as to the best approach, but if you have any doubts about your ability to restore a valuable receiver, remember that it is all too easy to devalue equipment by thoughtless servicing. If there is any doubt or difficulty, my advice is — don't do *anything*. An inoperative veteran receiver in original condition is more valuable than one made workable by ill-considered substitution of irreplaceable components. Generally, the

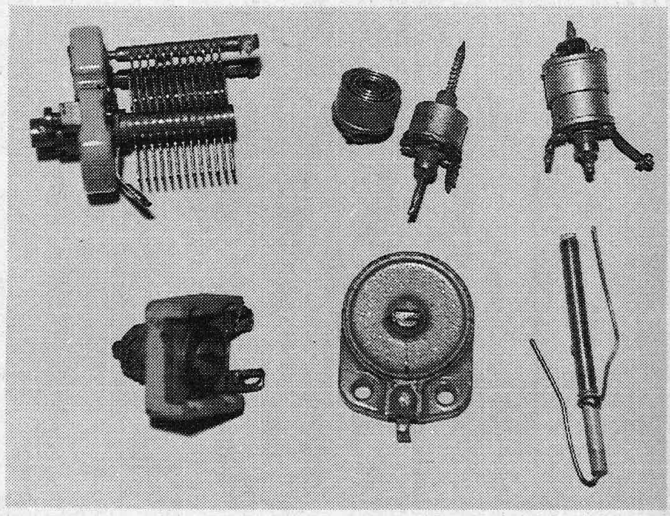


Fig.1: A selection of small variable 'trimmers' and 'padders'. At top left is a high grade air-spaced type, with examples of Philips' very successful 'beehive' concentric air trimmer at top centre and right. A mica compression padder is at lower left, then a ceramic trimmer and finally a tubular ceramic type.

older the equipment, the greater the importance in maintaining originality.

The hints that follow do not apply to very old receivers — which used very few fixed capacitors anyway — but are intended for those made after about 1930 when standardised proprietary components came into common use. A complicating factor is that previous servicing work may have to be remedied.

Several philosophies...

There are several philosophies in dealing with small components. At one end of the scale, the attitude is that, as they are out of sight under the chassis, all electrolytic and paper capacitors, regardless of condition, should be replaced with modern equivalents.

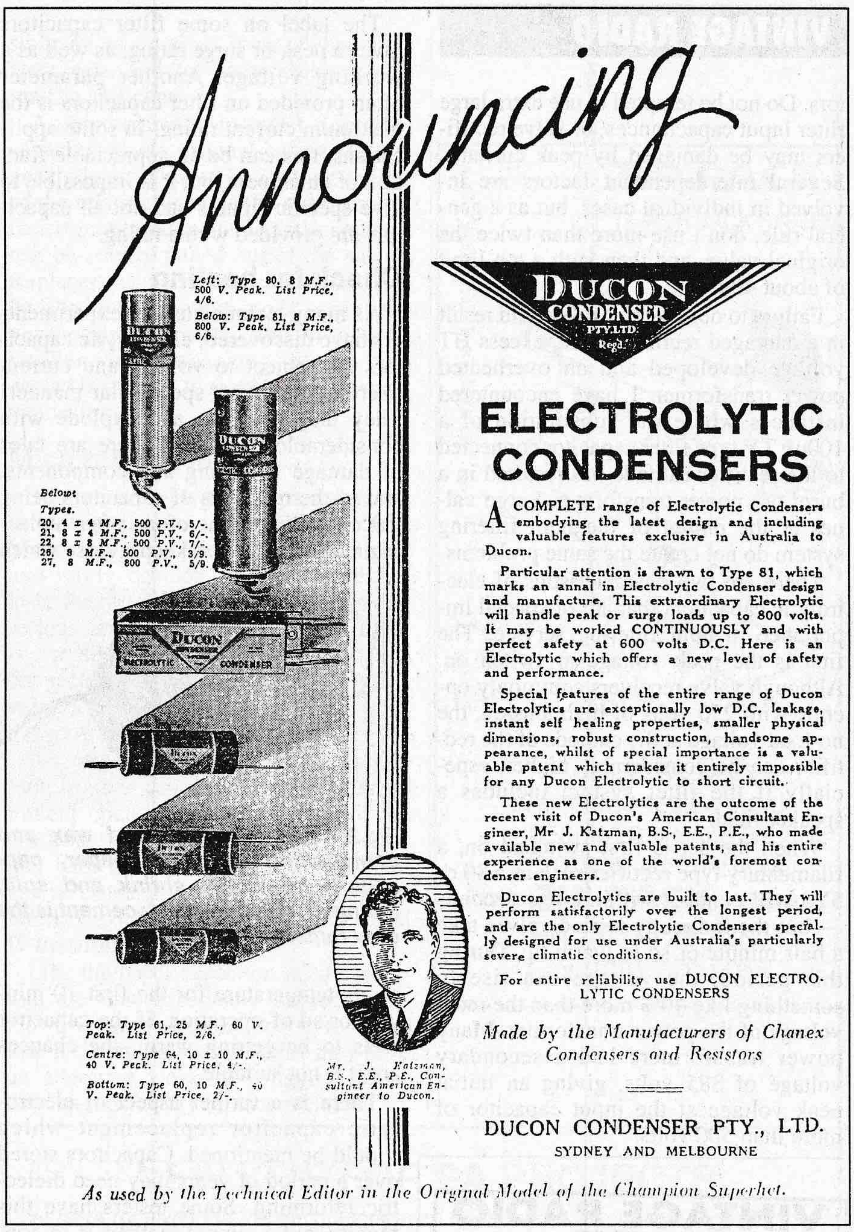
Probably the majority of restorers work on the less extreme principle of replacing only those capacitors which have failed, or are in critical locations. Some are content to use replacements 'as is'. Sticklers for originality and correctness go to considerable lengths to obtain genuine replacements, and in some instances, repair faulty capacitors, or renew the contents of the original cases. Especially distinctive components may be left in position, with a modern replacement, which is invariably smaller, placed alongside. Meticulous conservators will carefully document all work.

A good place to start is with the electrolytic capacitors. Vintage electrolytic capacitors had a limited life expectancy, and there may have been several generations used in a veteran receiver during its life. Ascertaining their exact condition can be a problem. They can dry out and lose capacitance, and consequently some method of measuring them is desirable.

For the old-time serviceman, who regarded even a good test meter as a luxury, a capacitor tester was but a dream. Consequently, rough and ready empirical methods of testing were developed. Capacitance could be estimated by the size of the 'splat' when a charged capacitance was short circuited, and leakage was judged by the length of time a charge was held after the power was turned off!

Many digital test meters have a useful capacitance measuring facility, but as many cannot measure a very wide range, a capacitance bridge is a valuable tool for the serious restorer. This does not need to be an elaborate instrument, and a suitable home-built unit was described in *Electronics Australia* for February 1991.

A most critical capacitor application is that of the filter immediately following the rectifier. In earlier receivers this was often a chassis-mounting wet type which is likely to have long since dried up, and



Sixty years ago, Australia had a thriving capacitor industry, as shown by this advertisement from the July 13, 1934 issue of 'Wireless Weekly'. Ducon and Chanex capacitors can still be found in many receivers from this period.

in all probability there is now a tubular dry type already fitted as a replacement. Repairs are impractical, and the positive terminal may have been used as a tie point for several other components.

Normally, unused wet electrolytics are disconnected and left in position for appearance. The simple approach is to connect the leads to an insulated tie point mounted on the capacitor's terminal and substitute a dry electrolytic capacitor. In many circuits, to provide a bias supply, the negative terminal of the capacitor is insulated from chassis.

Some enthusiasts use skill and ingenuity in enclosing the replacement capacitor inside the old can. One method that may work is to uncrimp or grind down the swaging around the base. Another method is to cut the can in two near the base, remove the contents and with the replacement capacitor installed inside, turn up a wooden mandrel the diameter of the original can. The mandrel, with a suitable hole for the leads, is then used as a sort of splint to rejoin the two sections of the can. A paper sleeve or the original label can hide the join.

There are some important points to note in selection of replacement capacitors. Do not be tempted to use extra large filter input capacitances, or valve rectifiers may be damaged by peak currents. Several interdependant factors are involved in individual cases, but as a general rule, don't use more than twice the original value, and then with a top limit of about 40uF.

Failure to observe this rule could result in a damaged rectifier valve, excess HT voltage developed and an overheated power transformer. I have encountered instances where the substitution of a 100uF TV type filter capacitor connected to the rectifier cathode has resulted in a burnt out power transformer. Large values at the *output* of the hum filtering system do not create the same problems.

There are two characteristics of electrolytic capacitors that are of special importance in hum filtering service. The first is the peak voltage at switch on. Although valve receivers commonly operate with 250 volts of high tension, the no-load voltage at the cathode of the rectifier can be considerably higher, especially if the filter system includes a speaker field.

When the set is first switched on, a filamentary type rectifier such as a 80 or 5Y3 will conduct within a few seconds — but the indirectly heated valves take a half minute or so to warm up. During this period, the voltage can rise to something like 40% more than the rated voltage of the power transformer. Many power transformers had a secondary voltage of 385 volts, giving an initial peak voltage at the input capacitor of more than 500 volts.

The label on some filter capacitors gives a peak or surge rating, as well as a working voltage. Another parameter often provided on filter capacitors is the maximum current rating. In some applications, this can be an appreciable fraction of an ampere, but it is impossible to give specific figures and not all capacitors are provided with a rating.

Check for heating

As many technicians and experimenters have discovered, electrolytic capacitors can object to voltage and current overload in a most spectacular manner! They may overheat and explode with considerable force, and there are tales of damage to wiring and components, and of the remnants of capacitors being left on ceilings. Therefore, after replacing a filter capacitor, keep a close watch

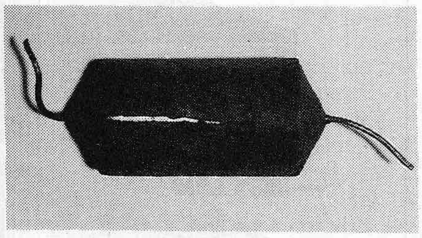


Fig.2: The cases of hard wax and composition jacketed paper capacitors frequently shrink and split, letting in moisture. Replacement is the only remedy.

on its temperature for the first 10 minutes or so of operation. If the capacitor feels to be getting warm, the chances are it is not suitable.

There is a further aspect of electrolytic capacitor replacement which should be mentioned. Capacitors stored over a period of years may need dielectric reforming. Some testers have this facility, but a simple method is to connect the capacitor via a current-limiting resistor across a voltage source comparable with the rated voltage. A value of 1k ohms per volt is suitable for the resistor, and progress is readily monitored with a voltmeter. Initially, the reading may be low, but when reforming is complete, there will be practically full voltage across the terminals.

Many vintage receivers had only two electrolytic capacitors, both used for HT filtering. More elaborate sets had others for additional filtering and for stabilising oscillator and screen supplies. Cathode bias for audio valves was avoided by many designers — in many instances, I suspect, because of the poor reliability of early low voltage electrolytic capacitors. This is no longer a problem, as with the large range of low voltage electrolytics now available, suitable replacements for sets that do use them are cheap and readily obtainable.

High voltage medium capacity electrolytics are a different story. They are becoming harder to find, especially in the range 8 - 20uF which was commonly used in older valve receivers. The reason for this is limited demand, but some manufacturers will make a special run if sufficient numbers are ordered.

Recently, one enterprising New Zealand vintage radio group was quoted a very competitive unit price for a special run of 10uF 450 volt capacitors from a Japanese manufacturer. Although the minimum order required appeared at first to be large, the attractive price encouraged plenty of sizable individual purchases and the venture proved to be quite viable. Incidently, this same group, in a similar manner, managed to organise a supply of the old style textile covered hookup wire.

Paper replacements

Paper dielectric capacitors are the most commonly found variety in vintage sets, and their condition today varies considerably. The chief problem is leakage, and this can be attributable to the difficulty of sealing against moisture. Insulation resistances, even in identical capacitors from the same chassis may vary considerably. Those with waxed cardboard sleeves are the most likely to have deteriorated, but, as illustrated in Fig.2, capacitors with thin hard wax or composition coatings can develop cracks, with disastrous results.

Leakage is equivalent to a resistor in parallel with the capacitor, and its effect varies with the position in the circuit. In the case of, for example, a bypass across a cathode resistor of a few hundred ohms, an insulation resistance of one megohm is obviously not very significant. But that same capacitor coupling the anode of the audio amplifier to the grid of the output valve, using a grid resistor of a half megohm, would have serious consequences. Similarly, this same leaking capacitor connected to an AGC line could halve the RF control bias.

My own rule is to replace paper capacitors in control grid circuits, or which are bypassing high value resistors, if their leakage is worse (i.e., lower) than 100 megohms.

Paper capacitors have been, as noted previously, largely superseded by plastic dielectric capacitors, and provided that the working voltage of the replacement is adequate, substitution presents no

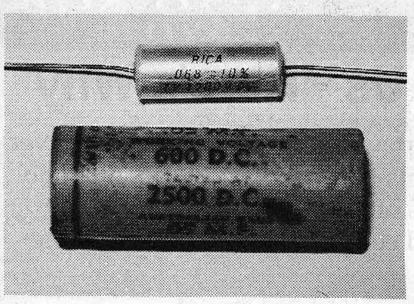


Fig.3: A modern polyester capacitor can be fitted into the tubular sleeve of an old paper type with room to spare. This provides a practical compromise between originality and using modern components in old receivers.

problems. Just remember that any capacitor connected to the HT line, even through a resistor, may have a high voltage present during warm up and the voltage rating of the replacement should be adequate. If authenticity is not a problem, for general receiver applications, high-K ceramics — provided that their working voltage is adequate — make compact replacements in most paper capacitor applications.

Frequently, tubular capacitors have one end marked with a band. This indicates the lead to the outside foil, which is normally connected to the lowest impedance side of the circuit; for example, earth in the case of bypasses, and the anode in resistance coupled amplifiers.

Repair or renew?

In the case of older equipment, the question arises as to the possibility of restoring paper capacitors or at least, the best method of retaining their original appearance. Most deterioration is from moisture absorption and it is possible in many cases to drive it out.

In a practical exercise, I tested several 60 year old cardboard cased 0.05uF tubular paper capacitors, and none had an insulation resistance better than two megohms. They were then immersed in molten paraffin wax held at 120°C in an electric oven. After about half an hour, when the seething and bubbling had ceased, they were drained and allowed to cool. Finally, the ends of the cases were sealed with wax. Their resistances are now all greater than 200 megohms.

These capacitors are now serviceable, but this process may not always be successful, and of course, it's no good for composition or hard wax coatings. How long they will remain in good order will be very dependent on their environment. Given similar conditions and effective sealing, their life expectancy could possibly be as good as it was when they were new, and for some restorers this may be sufficient.

A compromise is to insert a modern capacitor in the original casing. This is generally quite easy, Fig.3 giving an idea of the relative sizes. If the old capacitor is first immersed in hot wax, the contents can be readily pulled out of the sleeve. Replacement plastic capacitors can also be fitted into the metal boxes used in the very early receivers, and of course, smaller value capacitors can be connected in parallel to make up high capacitance units.

Mica replacements

The remaining type of capacitor found in vintage radios is the mica dielectric. Mica capacitors are generally reliable and rarely develop leakage. Nevertheless, they can have some problems. A serious tendency mentioned previously is for silvered mica capacitors, when connected across a high potential, to develop a short circuit from metallic bridges growing through the mica.

An often unsuspected, but annoying fault in mica capacitors can be an intermittent open circuit when some of the electrode foils do not make proper contact with the terminal leads. This fault can be especially frustrating in the fixed tuning capacitors for permeability tuned IF transformers.

Like the paper capacitor, mica capacitors are now practically unprocurable. However in most cases, polystyrene and low-K ceramics, provided that they have an adequate working voltage, can be used as satisfactory replacements. ❖

NEW KITS FOR EA PROJECTS

We have received the following information from Jaycar Electronics regarding their release of kits for recent *Electronics Australia* construction projects:

Playmaster Pro Series 3 Amplifier (February/March 1994): The Jaycar kit is complete, with case and all components as described in the articles. All lower-value capacitors are MKT, and all low power resistors 1% high stability metal film. The kit carries the catalog number KA-1760 and is priced at $599.00.

EGO Tester (February 1994): The Jaycar kit is of the 'short form' type, consisting of the printed circuit board, all electronic components, PCB pins and other minor hardware items (but no case). With the catalog number KA-1758, the kit is priced at $19.95.

MIDI Breakout Box (February 1994): This Jaycar kit is again of the 'short form' type, with the PCB and all minor components, but no case. Priced at $13.95, the kit carries the catalog number KA-1756.

Hi-Res Mod for the 1GHz Counter (March 1994): This Jaycar kit is also of the 'short form' type, with the PCB's, all electronic components, connectors etc., ready to be installed in the original counter case as described in the article. It carries the catalog number KA-1757 and is priced at $19.95.

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