VINTAGE RADIO

By JOHN HILL

Testing capacitors at high voltages using a megohm meter

Faulty capacitors can cause lots of problems in old valve receivers. Although this topic has been covered in previous Vintage Radio columns, other aspects keep arising which suggest that another session on capacitors is in order.

When it comes to valve receivers, we are not looking at one particular type of capacitor. There are high and low-voltage paper capacitors, high and low-voltage electrolytics, and standard mica and silvered mica capacitors. There were even a few "late model" valve receivers fitted with polyester capacitors.

Discarding all paper capacitors when restoring a receiver has been a standard procedure for me for a long time. Although I do this, there is no reason to replace all paper capacitors as even (slightly) leaky ones will work OK in some applications; eg, when used as a cathode bypass capacitor. If one is prepared to properly test paper capacitors, many can be reused although not always in their original positions.

Leaky capacitors should not be used in any high tension application or the AGC (automatic gain control) circuit, for example.

Personally, I prefer to replace all suspect capacitors in an old radio set. That way, I can be absolutely certain of eliminating one common source of problems. However, the following information will be of use to those restorers who like to retain as many of the original components as possible in their radios. This means replacing only those capacitors which really are faulty. When this is the case, those capacitors that are not replaced should be thoroughly tested and their serviceability properly established.

This Altronics megohm meter is assembled from a kit. It tests at 500V and 1000V and is powered by a 9V "AA" battery pack.

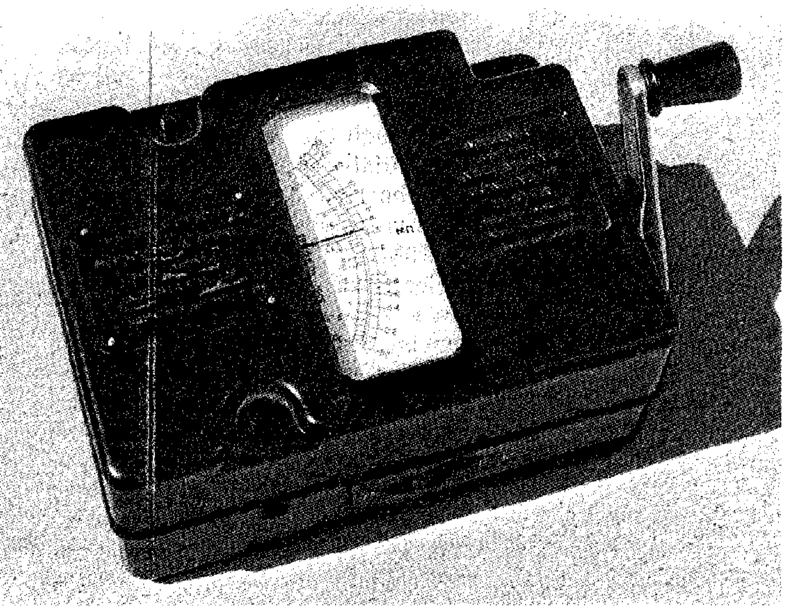
Leakage problems

When restoring a radio receiver, I often find that the high tension voltage can rise by as much as 100V after the paper capacitors have been replaced. This gives some insight as to the amount of leakage that can be involved with faulty capacitors.

Without going into details, capacitor leakage can seriously overload a variety of components such as valves, screen resistors, chokes, field coils and output and power transformers, to name just a few. This means that any paper capacitors left in the high tension circuit must be carefully tested for leakage. What's more, they should also retain their original capacitance and that may not always be the case. Sometimes a paper capacitor with no leakage also has little or no capacitance, due to internal open circuits.

Quite simply, it boils down to this: all capacitors must be carefully checked for both leakage and capacitance before using them in a high tension circuit.

I was recently embroiled in a debate over how capacitors should be tested for leakage. This is a difficult subject for some to appreciate, espe-



Above: this Megger is self-contained and requires no batteries. "Megger" is a registered trademark used by Evershed and Vignoles Limited, England.

Right: a modern electronic Megger. Gone is the old crank handle used in early design to generate the test voltage. The trademark is faintly visible at right, just below the meter scale.

cially when they are accustomed to low voltage circuits. It is difficult to appreciate the stress placed on a capacitor when it has hundreds of volts across it.

My opposition claimed that all that was needed was a capacitance test and, if the capacitor was leaky, then the capacitance reading on the meter would slowly drop away.

It is incredible the things some people say when they have not even tried out such a theory. In fact, it was immediately disproved by testing a known faulty capacitor with a multimeter set to capacitance. The reading remained static for quite some time, then it increased slightly, a characteristic of that particular meter. Yet the same capacitor measured about 2MΩ when tested with the same meter set on the ohms x 1000 scale.

My counter argument was that a high voltage megohm meter – such as a "Megger" – should be the ideal instrument to conveniently test suspect capacitors. If the dielectric can withstand a 400-500V potential without showing leakage on the meter, then there would be little to worry about if that capacitor were to be put back into service.

Again, unproven theories were thrown into the discussion on the basis that a Megger was never intended to test capacitors. According to my opponent, "a Megger would produce high voltage spikes that would blast holes in the dielectric, thus rendering what may have been a perfectly good capacitor totally useless". Well, that's what I was told!

Now before going any further, let's clear up the terminology regarding the word "Megger", which is often carelessly and incorrectly used.

The word "Megger" is in fact a trade name for a particular brand of megohm meter. The old familiar type used a black bakelite cabinet fitted with a dual range meter scale and used a folding crank handle that was used to spin a small generator! Anything else – without the Megger trademark – is simply a megohm meter.

Trial runs

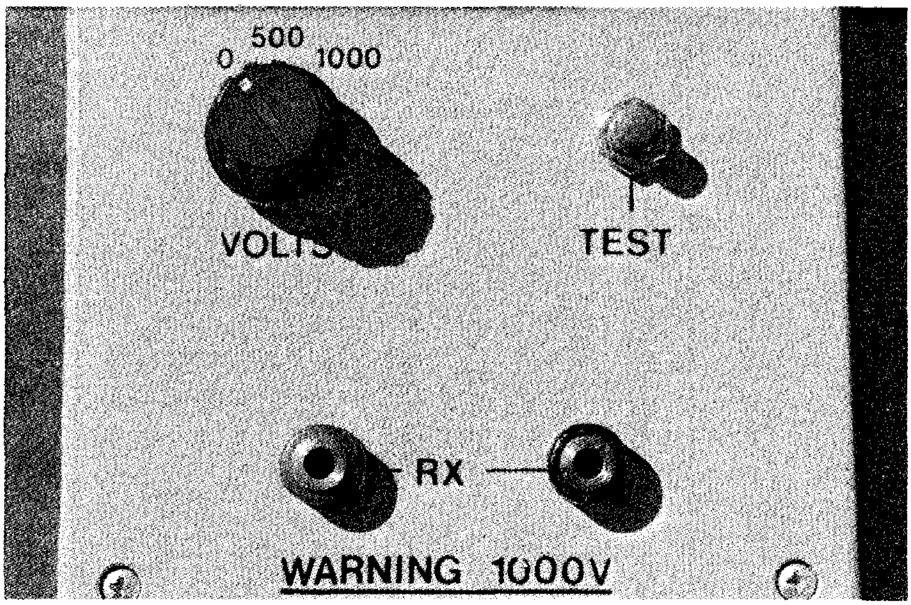
Doing a few tests on a range of capacitors with a borrowed megohm meter seemed to support all my assumptions. Testing capacitors at 400V clearly showed up any leakage problems. Good capacitors kept the meter needle hovering around the infinity mark, while the not-so-good ones showed various amounts of leakage in megohms, or zero ohms in the case of a shorted capacitor.

(Editorial comment: our oldest contributor recalls that one of the first jobs he was given when he entered the radio industry back in the mid-30s – yes, mid-30s – was to help test hundreds of paper capacitors, as they came from the makers. And his job was to crank the Megger while another operator applied the test prods to rows of the capacitors laid out on the bench. There was never any suggestion that this was detrimental).

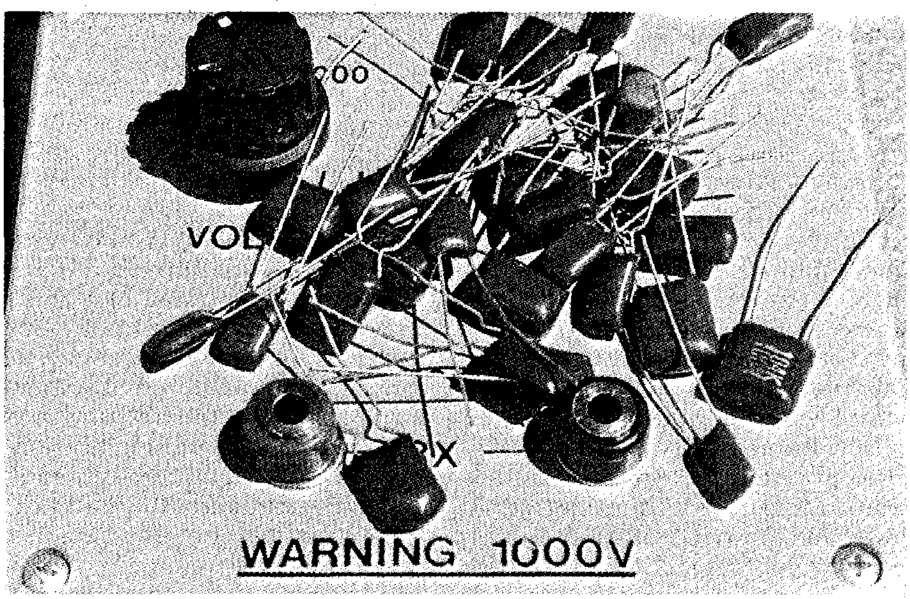
The interesting aspect of the high voltage test is that a crook capacitor that shows a leakage of around 1-2MΩ at 400V will appear quite good when checked with a normal multimeter set to the ohms x 1000 range.

Leakage and straight resistance are two different things. A 10MΩ resistor will measure the same on both types of meters but leakage through a capacitor will usually increase with the voltage and that is why capacitors require a high voltage test. If an old paper capacitor is going to be operated at several hundred volts, then it needs to be tested at that voltage or more.

Many of the old capacitors from the early 1930s have the test voltage



A close-up view of Altronics meter. Despite the 1000V warning, there is little sensation at the test terminals but always be sure to discharge fully-charged capacitors before touching their test leads, or you could get a nasty shock.



Most 100V greencaps will withstand a 1000V test. That indicates that they should work OK in a lot of valve radio situations without much trouble.

clearly marked on them and a 400V capacitor was often tested at 1500V – well above its normal operating potential.

Using a borrowed megohm meter was a great help in establishing whether or not it was a suitable test instrument for capacitors. But someone else's Megger is not mine, so I set about finding an equivalent for my own use.

A kit-based meter

After a period of unsuccessful searching, I came across an advertisement for a megohm meter in kit form for $80 from Altronics. There was a minor problem with the kit, with the parts layout diagram and circuit board showing the wrong battery polarity. However, that problem has since been rectified if you are thinking of buying one. So, despite the minor hiccup, I eventually had myself a working megohm meter.

The Altronics kit seems to be a good design and is an electronic type, not an electromechanical device like the old Megger. It has two test potentials (500V and 1000V) with the desired voltage selected by a rotary switch – see photo. These voltages can be varied to some extent by internal adjustment.

Although the megohm meter tests at potentials as high as 1000V, one can hold the test leads and not feel as much as a tickle. This is because there is a 10MΩ resistor in series with the test leads and this restricts the current flow to such a degree that the instrument is quite shock proof, even though it carries a warning referring to the 1000V potential at the test leads. But a charged capacitor is another story and they can really bite!

The 10MΩ resistor also overcomes another of the "anti megohm meter" comments made during the great debate. Because of this high value resistor, there is no great inrush current to internally damage any delicate capacitor. As a result of this resistor, it takes about 20 seconds to fully charge a 0.47μF capacitor. But there is no doubt about the effectiveness of the high voltage test if a capacitor is shorted. The discharge spark can be clearly seen and heard. ZAP! (Editorial note: shorting a charged capacitor is not good practice, as it can cause internal damage).

If the capacitor is left connected after testing, it will discharge through the meter. Larger capacitors need longer discharge times, so be careful here.

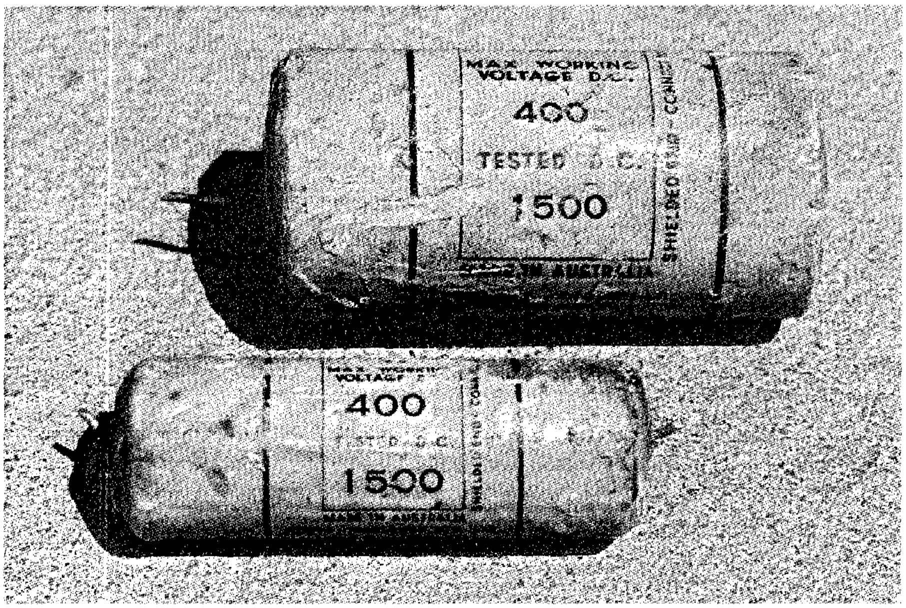
Mica capacitors

One very interesting test procedure was carried out on a couple of known faulty silvered mica capacitors that were causing a distinct crackle in a receiver.

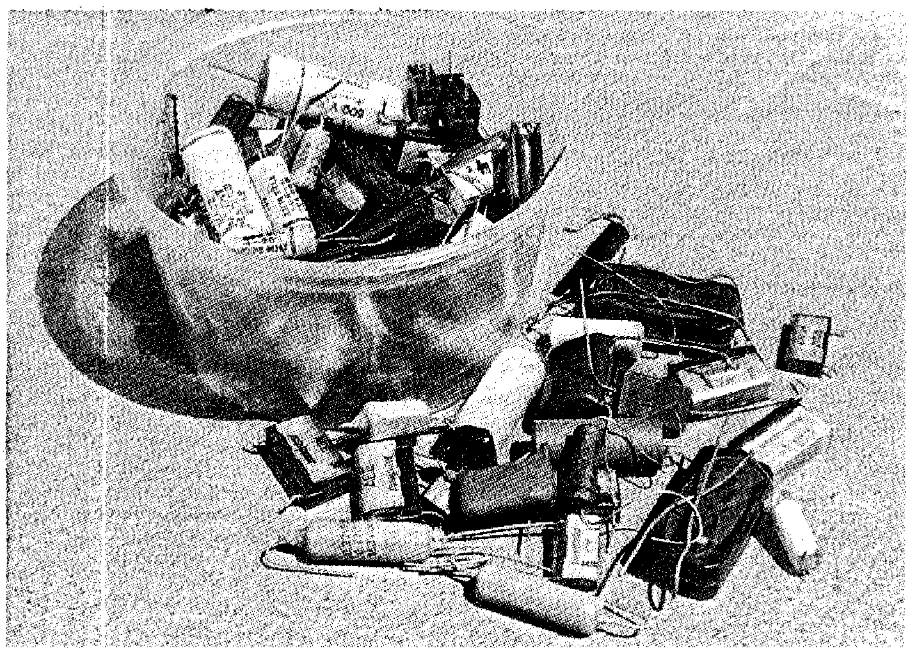
When tested with the megohm meter, the needle continually fluctuated up and down the scale. In other words, the problem could be clearly seen when the capacitor was subjected to a high voltage test. However, when one of these capacitors was reversed, the needle swung over to infinity and held steady.

This test seems to indicate that whatever happens inside a faulty silvered mica capacitor can create a rectifying effect whereby there is current leakage in one direction but not the other.

The next time I have a crackly mica capacitor problem, I will reverse the capacitor to see if that cures the fault. Although there is some possibility that it might, whether it lasts is another



The test voltage should be in excess of normal operating potentials and 400V paper capacitors were often tested at 1500V. Both of these capacitors dismally failed the high voltage test.



All of these old capacitors failed the high voltage test. They have varying amounts of leakage, with some registering less than a megohm of resistance when tested on a megohm meter. A good capacitor should not show any DC current leakage.

question. While I am not suggesting that this technique be adopted as a recommended practice, it will be an interesting experiment.

In conclusion, it would appear that a high voltage megohm meter is an entirely suitable instrument for checking capacitors for leakage. It works on all types of capacitors, except electrolytics, provided that the voltage rating of the capacitor to be tested is appropriate for the test voltage.

Finally, high voltage testing of power transformers, chokes, field coils, etc can also be carried out using a megohm meter.

Footnote: the High-Voltage Insulation Tester described in the May 1996 issue of SILICON CHIP is also ideal for testing capacitors for leakage. It has a 10-step LED bargraph display and provides five selectable test voltages ranging from 1000V down to as low as 100V. **SC**