Part 2 - Condenser Testers and Testing Correctly

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By: Bill Mohat / AOMCI Western Reserve Chapter

If you have read Part 1 of this Technical Series on Condensers, you will know that the overwhelming majority of your condenser failures are due to breakdown of the insulating plastic film insulating layers inside the condenser. This allows the high voltages created by the "arcing" across your breaker points to jump through holes in the insulating film, causing your ignition system to short out. These failures, unfortunately, only happen at high voltages (often 200 to 500Volts AC)….which means that the majority of "capacitor testers" and "capacitor test techniques" will NOT find this failure mode, which is the MAJORITY of the condenser failure you are likely to encounter.

Bottom line is, to test a condenser COMPLETELY, you must test it in three stages:

1) Check with a ohmmeter, or a capacitance meter, to see if the condenser is shorted or not.
2) Assuming your condenser is not shorted, use a capacitance meter to make sure it has the expected VALUE of capacitance that your motor needs.
3) Assuming you pass these first two step2, you then need to test your condenser on piece of test equipment that SPECIFICALLY tests for insulation breakdown under high voltages. (As mentioned earlier, you ohmmeter and capacitance meter only put about one volt across a capacitor when testing it. You need to put perhaps 300 or 400 times that amount of voltage across the condenser, to see if it's insulation has failed, allowing electricity to "arc across" between the metal plates when under high voltage stress.

Only if your condensers passes BOTH of these test, should you actually put it in a motor that you intend to run for any length of time. If you put a "marginal" condenser in your motor, expect to spend a lot of time being towed back to the dock!

Anyhow….let's get on with testing!

Step 1 – Testing for Shorts

Now, many people just try to use a ohmmeter to do a "quick check" of their condensers. (Either a analog, or newer-style digital ohmmeter will work for this type of test.) See the Fig. 1 below for details:

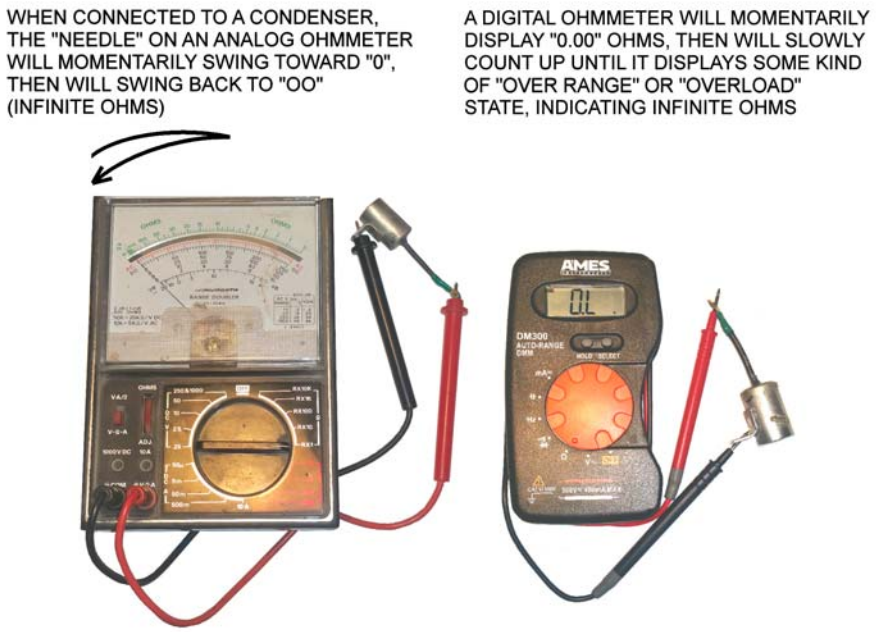

Fig. 1 - TESTING CONDENSER WITH OHMMETERS

The way this works is simple: Initially, when connected to an ohmmeter, a UNCHARGED capacitor will look like a dead short. However, the voltage that the ohmmeter uses to do it's testing will start to charge the capacitor up, and as it charges, the capacitor will draw less and less current as it charges up. The ohmmeter will mistakenly read this as a continuous increase in **resistance!** Fairly quickly, the current going into the capacitor will drop to zero, and your analog meter will read "infinite ohms".....(and your digital meter will read "OVER RANGE" or "OVERLOAD", indicating that the resistance is too high for it to measure.)

Now, this type of "quick test" on a ohmmeter DOES tell you that your "device" isn't shorted, and that you are connected to a CAPACITOR (as you can see the "needle swing" on the analog meter, or the increasing count on your digital meter as the capacitor charges up**.)** BUT, this "quick test" does NOT tell you what the capacitor's **value** is, **and whether or not it will work correctly when subjected to the high voltages seen across the points in your magneto. And, unfortunately, BOTH of these measurements are FAR MORE IMPORTANT than an ohmmeter check** (and they ALSO will tell you if your condenser is shorted, so they make the ohmmeter test irrelevant!)

Many people just do the ohmmeter test, and think that it's "good enough". These are the same people that wind up getting their boats towed home every once in a while! So, let's look at the CORRECT way to test condensers!

Step 2 – Using a Capacitance Meter

See Fig. 2 below for details:

Fig. 2 - MEASURING CAPACITANCE

If you get a capacitance meter, **it will not only tell you if your condenser is shorted or not, it will give you the actual VALUE of your condenser (in microfarads).** Now, I have a couple of expensive capacitance meters, but for this article, I bought a cheap **$22** Digital Multimeter from Harbor Freight (an AMES DM300 meter)….and this meter just happens to have a "capacitance test" function included. As you can see in the picture above, it measures VERY CLOSE to the measurement I get on a dedicated Capacitance meter, and it's FAR LESS EXPENSIVE. (And, it also works as a volt / ohmmeter as well!) Yes, it's a cheap meter, but quite up to doing the job.

So, with this one "capacitance meter", we replace the simple "shorted" ohmmeter test, with one that gives us the actual capacitance of our condenser. (As you will see in Part 3 of this Condenser article series, you DO need to know the correct VALUE of capacitance in your magneto system.) So, knowing the value of your condenser is important!

Step 3 - Insulation Breakdown Testing

Of all the steps listed here, this one is by far the most important! Ohmmeters and capacitance checkers only test your condenser with 1 or 2 volts across it during the test. However, in your outboard motor, your condenser will be subjected to AC voltages as high as 400 volts peak-to-peak (and sometimes slightly higher!) A condenser that measures just fine on a capacitance meter will often indicate a failure, when put on a

condenser tester that does high-voltage insulation breakdown testing. If you skip this test, many condensers with bad insulation will allow your motor to start and run just fine for a while, (although perhaps causing your engine to misfire occasionally, especially at higher RPM). This might fool you into thinking the condenser is OK, and actually cause you to try to run your motor on it…..only to have the condenser insulation completely fail and kill your motor when you least expect it. (Per Murphy's Law, this will likely be when you are several miles from shore!)

So, what is a Condenser Insulation Breakdown Tester, how can you get one, and how do you use it? Well, just like many things in the Antique Outboard world, these Condenser Insulation Testers haven't been manufactured for many years. Back in the 1950s through the 1970s, you could buy combination "Ignition Testers" that could test your coils and your condensers. See Fig. 3, below, for some examples:

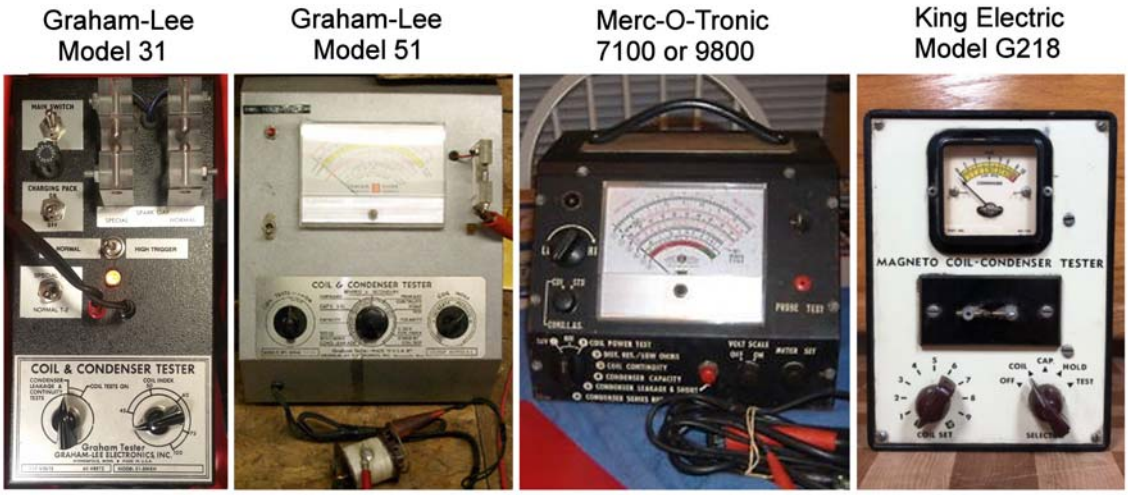

Fig. 3 - Vintage Ignition / Coil / Condenser Testers

You can find these old testers up on e-bay from time to time, at various price points (depending on whether they work or not!) If you're in a hurry, check with your local chapter of the AOMCI; there are MANY of these old testers floating around in the club, and usually the guys that own them will gladly test your condensers for you. If you want to buy one, either prepare to spend about $200 or more for a good tester, or be willing to repair one if you're on a budget. Or, ... you could build your own from scratch for about $30 (more about that later!)

ALL of these old testers put about 200 to 300 volts DC across the condenser under test. They then either user a meter (to indicate "leakage current"....and show what is considered "good" vs. "bad" amounts of leakage). Or, the tester may just have a neon light, that flashes if the insulating is bad, and electricity is able to jump across the plates.

Now, personally, I prefer the neon light style of testers, for two reasons. First, many of these old testers used VACUUM TUBES in their construction. Vacuum tubes are very

high failure rate devices…..and if your tube is weak, your condenser might measure "good" when it actually is BAD! The second reason meters are slow, mechanical devices. Occasional arcs through your condenser's insulation might not cause the meter "needle" to move enough for you to notice it. But, a FLASH on a neon light is impossible to miss! (And, that type of tester is FAR SIMPLER, and less likely to break over time!) Here's a picture of my own Graham-Lee Model 31 testing a condenser, with the neon light glowing to indicate a dead shorted condenser. (Refer to Fig. 4).

Fig. 4 - Using "Neon Lamp Style" Tester

And, here's my own homebuilt "Neon Lamp" style condenser tester, showing the same thing. (This tester can be built by anyone for about $25 or $30 in parts, in just a few hours.) See Fig. 5 on the next page, for a picture of my "homebuilt" tester!

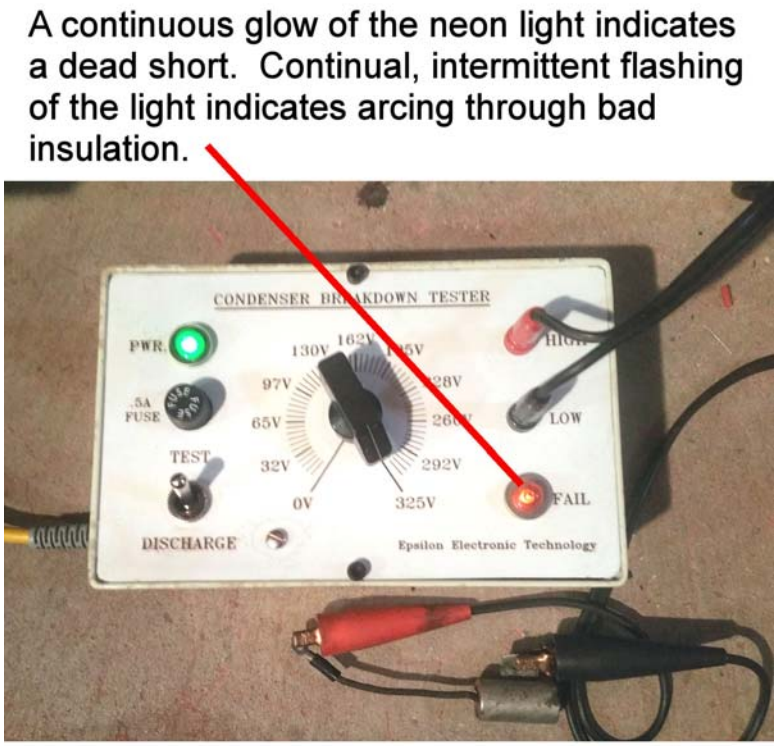

Fig. 5 - Using Home-Built "Neon Lamp Style" Tester

WARNING!!

As I mentioned, all of these testers put about 300 volts DC across the “condenser under test”……but for safety reasons, the current is very limited. Just the limiting resistor in the neon indicator lamp assembly by itself would limit the current to less than 5 milliamps. So, because it takes about 100 to 200 milliamps to kill a person, these testers are not life-threatening to operate, but you can still get a nasty shock off of them if you aren’t careful. Connect the test leads to the condenser under test, then PUT THEM DOWN on your workbench….don’t be holding the condenser or alligator clips with your bare hands while running these tests! (While you probably won’t get a "Darwin Award" for doing so, you will likely be a great source of amusement for your friends!)

On the plus side, by putting about 300 volts DC across your condenser, these testers will VERY RELIABLY indicate if your condenser’s insulation is good or not. If these testers FLASH (or indicate high current on their meters), DO NOT ARGUE with the test results! The condenser is BAD, and must be replaced if you want your outboard to run reliably!

For those that are interested in building their own Condenser Insulation Breakdown Tester (for less than $30) using my design, the schematic diagram, parts list and some simple instructions can be obtained by contacting me directly at:

wmohat@hotmail.com

Please note: I strongly suggest that you DO NOT attempt to build this tester if you don't have some experience building electronics projects in the past. Just.....don't.

As a side note; for anyone that has an old Graham-Lee Model 31 that's not working well, I did draw up schematics for it, and wrote up a Test and Troubleshooting guide for that old tester. You can find it on the Western Reserve Chapter's website (along with User's Manuals for the Graham-Lee Models 31 and 51) , at:

https://wrcoutboards.org/technical-info/ ← Lots of good information here!

SUMMARY:

Simply "testing" a condenser with an ohmmeter is FAR from adequate, and will likely fool you into thinking that bad condensers are good. (Yes, I've done this myself, with VERY EXPENSIVE CONSEQUENCES.) To test a condenser correctly, you must have a capacitance meter to give you the condensers electrical VALUE (in microfarads), and you must use a Condenser Insulation Breakdown Tester to verify that the condenser can operate at the high voltages present in magneto-based ignition systems. Only if a condenser passes BOTH of these tests should you put it in an engine…..or, at least an engine you are relying on to bring you back to shore!

Fortunately, you don't have to spend a lot to do these tests. Many AOMCI club members will likely do this testing for you. But, if you want to own your own test equipment, a Capacitor (value) tester can be obtained for as little as $22. The Condenser Insulation Breakdown Tester may have to be purchased surplus on e-bay (and will likely need to be repaired.) Or, you can build your own Condenser Insulation Breakdown Tester for less than $30, using the schematics and parts lists I have mentioned.

NOTE: The next part of this Technical Series on Condensers will explain why the capacitance VALUE of a condenser is important, exactly how critical (or not!) it really is, and how to "size" a condenser for an old motor when the original value isn't know. This "Part 3" will be where the real learning comes in!

Keep the blue smoke flowing!

-Bill Mohat / BSEET, MS/CIS, CCNA
AOMCI – Western Reserve Chapter