The FLASH!

The Newsletter of
The Colorado Radio Collectors
Antique Radio Club

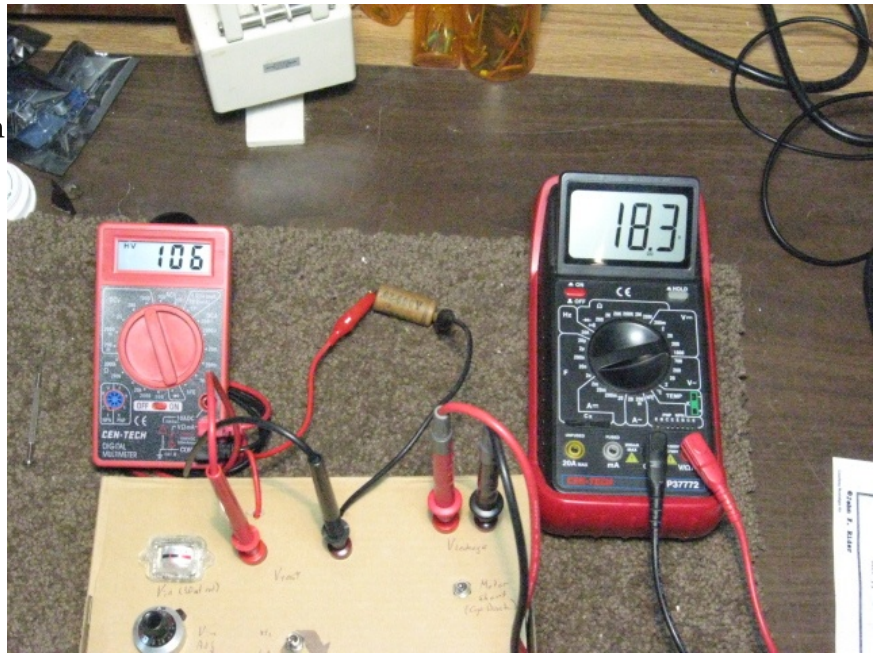
Volume 33, Issue 4 | Next meeting July 10th | July/August 2022

A Home-brewed Capacitor Leak Detector

by Ralph Brands, CRC member

I started this project playing around with surplus 9 volt batteries and a DMM to see if I could measure capacitor leakage. This showed results, but the batteries varied too much in voltage. Next I, no kidding, re-purposed an electronic fly-swatter I got from Harbor Freight. It didn't work very well killing flies but the little circuit board produced a solid 700 volts from two AAA batteries. It however it had too much RF noise and it was too hard to control the output voltage. I eventually settled on a DC-DC boost device. It produces a high voltage DC output, up to a little over 700 volts, with an on-board 50K ten turn pot to control the output voltage. I removed the on-board pot and replaced it with a larger panel mounted one with a vernier dial. I replaced the LED showing that it is powered on, with one with longer leads and mounted it where it is visible when in use. The icing on the cake is that it's powered with 9 volt batteries. Input voltage requirement is 8-32 volts DC. I'm using three 9v batteries in series to give me longer battery life.

My first prototype, shown to the right, used two DMMs for the test and leakage voltage measurements, which worked well, but I wanted something that was all self contained rather than something with separate components. The DMM setup had the advantage that it didn't include the cost of two panel meters. Using built-in meters I put it all together in a nice wooden cigar box.



The usefulness of this project is somewhat limited in that all paper caps are leaky and I just replace them all. I suppose it gives a good feeling to test the old ones and see that they really are leaky. When I think of it I test the new caps before I put them in a radio, but I've not found a leaky one yet. This is by no means a complete test of a capacitor, which is a major undertaking. Capacitors are amazingly complex devices.

(continued on page 3)

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Newsletter for The **Colorado Radio Collectors** club, founded in the Fall of 1988.
"Dedicated to the preservation and education of wireless, antique radio, television and associated equipment."

CRC MEETINGS: Meetings are held on the 2nd Sunday of every other month starting in January (except May is the 3rd Sunday) at 1:00 pm. The meetings consist of business, "show & tell", raffles, auctions, swap meets, technical discussions and other subjects of interest. Visitors are welcome!!

CRC MEMBERSHIP: Current annual dues are $20 and membership in the CRC runs from July to June. New memberships will be prorated to the following June. Members are entitled to attend meetings, participate in our Spring show and our Fall auction, and receive our newsletter, The Flash!. Submit dues payable to: **Merril Campbell - 4723 Woodbury Dr. - Colorado Springs, CO 80915**

UPCOMING EVENTS: July 10th, CRC club meeting. The 1 PM meeting location is at the Bemis Library in Littleton. The date is not yet finalized, sometime in September, the annual CRC Auction. Details will be presented at the July meeting.

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Message from the President

Hello to all CRC'ers. The wonders of modern technology… I'm writing this as we are on vacation traveling between cities in Europe.

We had a great May meeting attended by many club members. We celebrated our success of the VVE show and started discussion on the upcoming fall auction.

We have several open items to resolve over the next few weeks including confirming the actual auction date which I will send separate email once this is finalized.

Additionally, We find ourselves in need of filling a key position for the auction. I'd like to thank Paul Thompson for taking on show and auction results tracking over the past few years however Paul announced he will be leaving us thus creating an opportunity for a new volunteer. Please contact me with your interest as this is key to our auction success.

Our next meeting is July 10th at the Bemis Library in Littleton, at 1 PM.

Finally, get those radios out and get ready for the fall auction.

Be safe!

Mike Cook

(continued from page 1)

A parts list follows. Note, it's entirely possible to combine some of these functions into fewer switches. It just so happened that this is what I had on hand. For instance, combining Off , Discharge, and Charge into one 3 position switch would be quite easy.

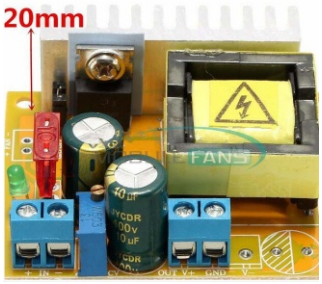
Fast Discharge DPST momentary action switch	100 ohm ¼ watt resistor x2
Fast Charge SPST momentary switch	General purpose diode
Test Power SPST switch	Test leads w/alligator clip
Meter Power DPST switch	

DC-DC Boost. **https://www.ebay.com/itm/192064800544**. About $10 shipped.

When shopping for the DC-DC boost device, be sure to look for one that has three terminals for the output, labeled: "-", "GND", "+". For the 700 volts connect between – and +. Some of these only have two output terminals and one filter cap. These won't deliver the 700 volts. Look carefully at the verbiage in the title.

Like this.

Not this.



One says "±45V-390V" and the other says "+ 45V-390V". You need the ± one, it is about a buck more.

Test Volts. 0-1000 VDC digital meter **https://www.ebay.com/itm/384458912658**. Note that these ebay listings change frequently.

I discovered that the exact same 0-1000 VDC meter I am using cannot be found anywhere. Mine has three wires, one positive for power, one positive for measurement, and one for common negative. The one listed here has four wires, and says it requires 5VDC power. Mine requires 5-30 VDC. If in fact this one requires 5V only, maybe one could use a 9 volt battery with a small "buck" device to reduce the input to 5 volts; they are inexpensive. An alternative would be to use a DMM as mentioned above. The input resistance may differ from the panel meters, so the formula to calculate the appropriate leakage reading would need to be adjusted. I did find this one that requires 5-15 VDC power.

https://www.ebay.com/itm/353204081807.

Leakage Volts. 0-35 VDC precision digital meter. This has four wires, two for power and two for measurement and requires 3.5-30 vdc for power..
https://www.ebay.com/itm/132475473708. About $12 shipped.

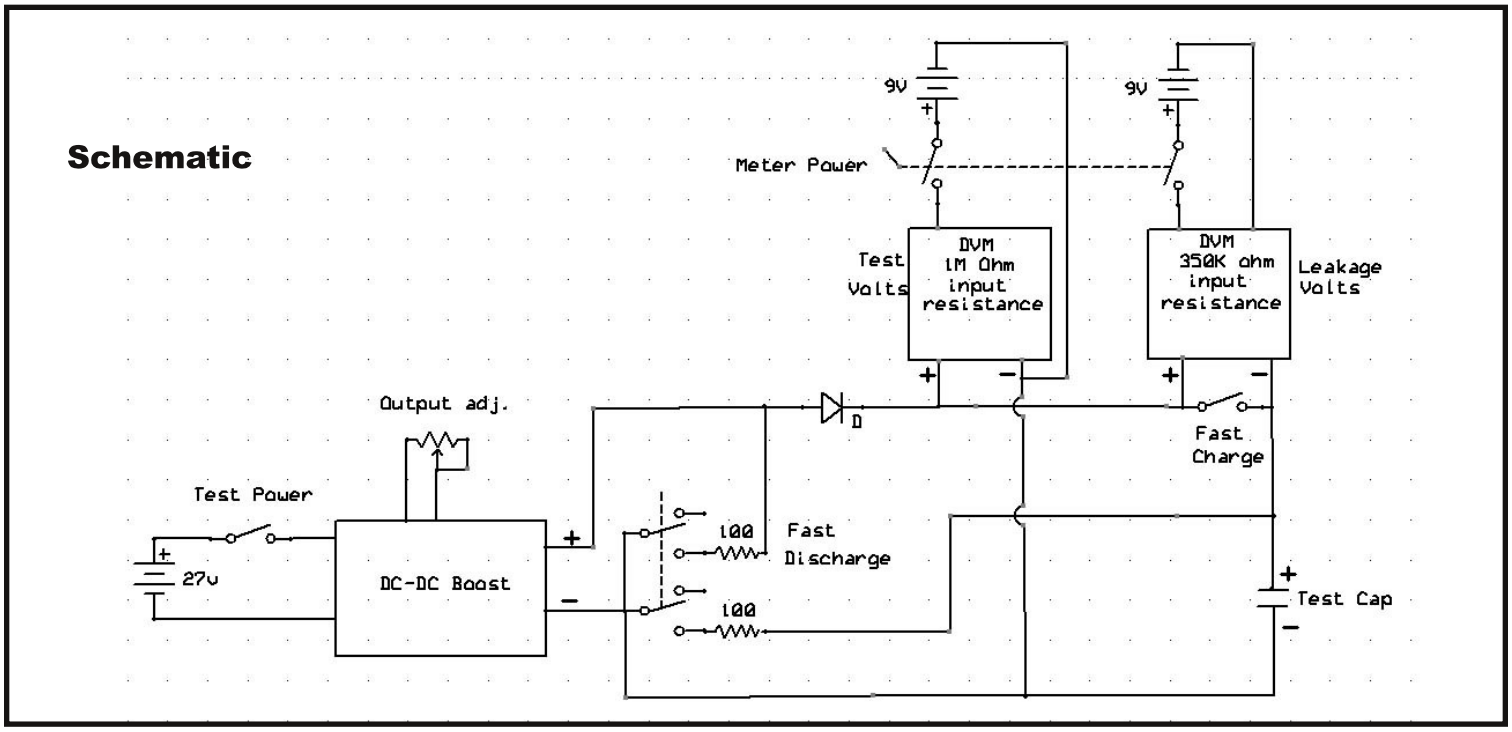
Output Adjust. 50K ohm 10 turn pot/vernier dial
https://www.ebay.com/itm/392879527511. About $10 shipped.

The 100 ohm resistors are for draining the test cap and high voltage source cap. The Fast Charge switch shorts the input to the Leakage Volts meter, thereby eliminating the meter's internal resistance when charging the test cap, to reduce the charge time.

The schematic is on the next page. I didn't come up with all this on my own. Here's where I got the idea: **https://product.tdk.com/en/contact/faq/capacitors-0015.html**.

Here's how it works. Imagine a capacitor placed in series with a voltage source and a volt meter. With an ideal capacitor of infinite Insulation Resistance (IR) , the voltmeter would read zero. All the voltage would be dropped across a seeming open circuit. However, since no capacitor is perfect there will be some, however small, leakage. A sensitive enough voltmeter with sufficient applied voltage

should be able to read a small voltage, revealing that leakage. But, if we want to calculate resistance, and all we have is volts, we need current to satisfy Ohm's Law. This is where the internal resistance of the meter is important. If we know the internal resistance of the meter and the voltage measured, we can calculate the current, or rather a voltage that represents a given current. The thing is that I really don't care what the specific insulation resistance is. What I care about is whether a cap is "good" or "leaky". I have a table, listed below, to display what reading on the Leakage Meter shows a cap to be good or bad. I have expanded the cells to display the formulas used for .047mfd caps.



Excel spreadsheet

	A	B	C	D	E	F	G
1				FILM CAP INSULATION RESISTANCE (IR) CHART			
2			MIN IR		TEST VOLTS DC*		
3	mfd	code	OHMS	100	200	400	630
4	0.001	102	1.00E+10	0.0035	0.0070	0.0140	0.0221
5	0.0015	152	1.00E+10	0.0035	0.0070	0.0140	0.0221
6	0.0022	222	1.00E+10	0.0035	0.0070	0.0140	0.0221
7	0.0033	332	1.00E+10	0.0035	0.0070	0.0140	0.0221
8	0.0047	472	1.00E+10	0.0035	0.0070	0.0140	0.0221
9	0.0068	682	1.00E+10	0.0035	0.0070	0.0140	0.0221
10	0.01	103	1.00E+10	0.0035	0.0070	0.0140	0.0221
11	0.015	153	1.00E+10	0.0035	0.0070	0.0140	0.0221
12	0.022	223	1.00E+10	0.0035	0.0070	0.0140	0.0221
13	0.033	333	1.00E+10	0.0035	0.0070	0.0140	0.0221
14	0.047	473	=(330/A14)*1000000	=(350000*100/C14)	=(350000*200/C14)	=(350000*400/C14)	=(350000*630/C14)
15	0.05	503	6.60E+09	0.0053	0.0106	0.0212	0.0334
16	0.082	823	4.02E+09	0.0087	0.0174	0.0348	0.0548
17	0.1	104	3.30E+09	0.0106	0.0212	0.0424	0.0668
18	0.15	154	2.20E+09	0.0159	0.0318	0.0636	0.1002
19	0.22	224	1.50E+09	0.0233	0.0467	0.0933	0.1470
20	0.33	334	1.00E+09	0.0350	0.0700	0.1400	0.2205
21	0.47	474	7.02E+08	0.0498	0.0997	0.1994	0.3140
22	0.5	504	6.60E+08	0.0530	0.1061	0.2121	0.3341
23	1	105	3.30E+08	0.1061	0.2121	0.4242	0.6682
24							
25			*Using voltmeter with 350K ohm input resistance.				

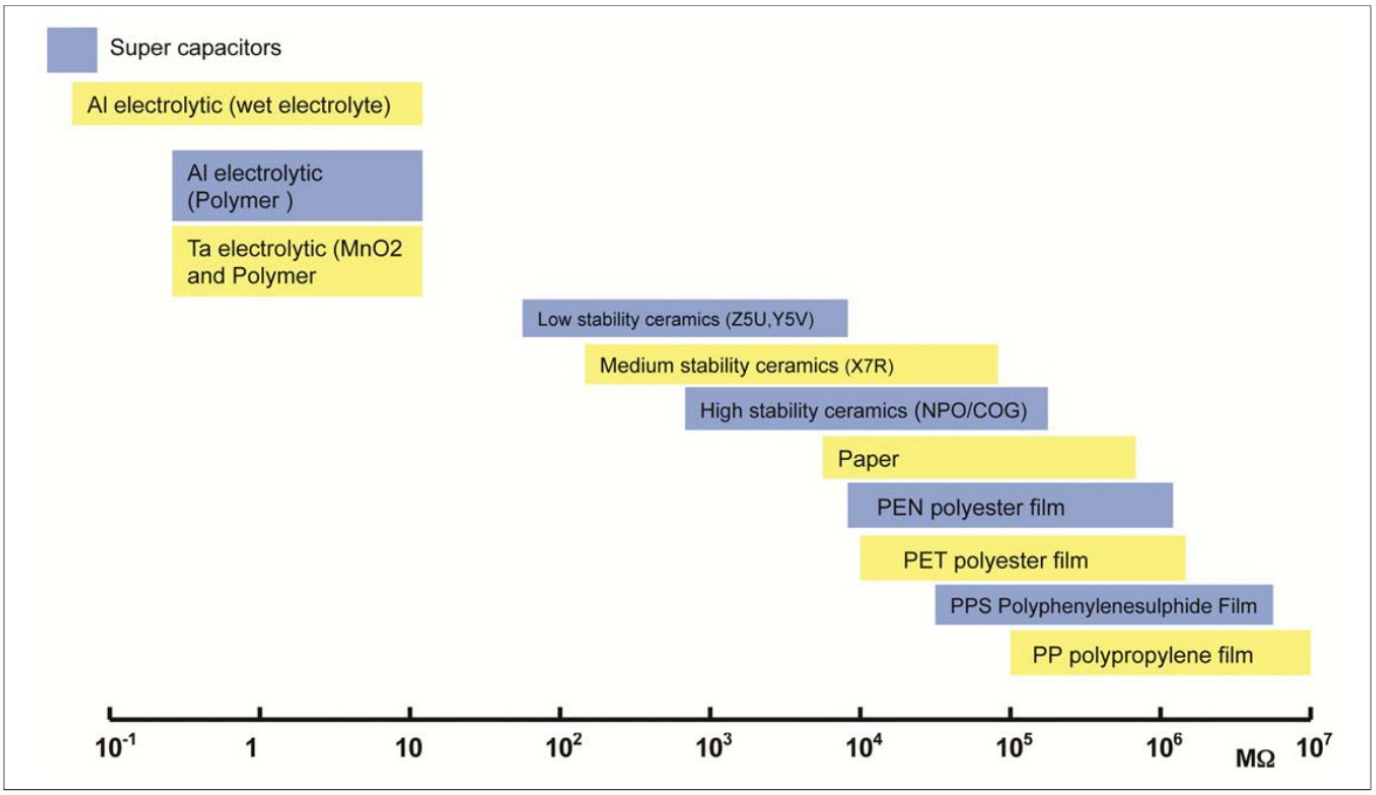


Figure 5: Values of capacitor types relative to dielectric Insulation Resistance (IR).

If anybody wants a copy of the Excel spreadsheet, or the entire original article, e-mail me and I'll send it along. *(**rebrands@juno.com**)*

Acceptable leakage/IR depends on the voltage applied, the capacitance of the cap, and the dielectric type. Temperature is also a factor, but not for our purposes.

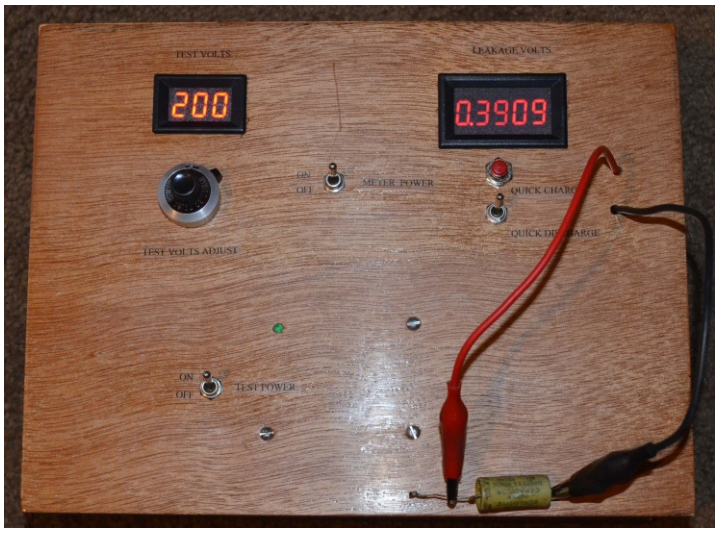
Above is a chart showing the ranges of IR based on type of dielectric. I'm using the lower end of the range for PEN (Polyester film) caps, or 10,000 Megohms (10Gohms) for my good/bad measure. According to this, paper and PEN should have about the same IR so if either type show IR less than this, they are leaky.

In general, the larger the cap, the larger the leakage/the less the IR. For smaller caps there is a point where the IR remains the same as the size is reduced. That point for polyester film caps is .033mfd. For .033mfd and larger it is according to the formula: 330/cap mfd x1,000,000. Many of the caps we're replacing are in the <.033mfd range, hence we'll be looking for the same value much of the time. A glance at the table on the previous page will show that for caps <.033mfd measured at 200 volts the voltage should always be .0070 volts or less. The polyester film caps almost always come in well under this measure. The yellow tubular axial caps you get from Sal_6 are polyester film. I generally test at 200 volts to reduce charge time and battery drain. I'm looking for leakage rather than ability to withstand full rated voltage. Maybe I'm just lazy and/or stingy.

A critical part of this concept is the resistance of the "Leakage Volts" meter. That spec was not listed on the meter I got. I measured the resistance with a DMM and an analog ohmmeter, and assumed that it was 1) reasonably accurate, and 2) that it remains relatively constant. I measured 350K ohms on both ohmmeters and used that in the calculations for the voltage I should see to give a passing grade to a test cap. To calculate that I use the formula: ***voltmeter input resistance*test voltage/minimum acceptable IR***.

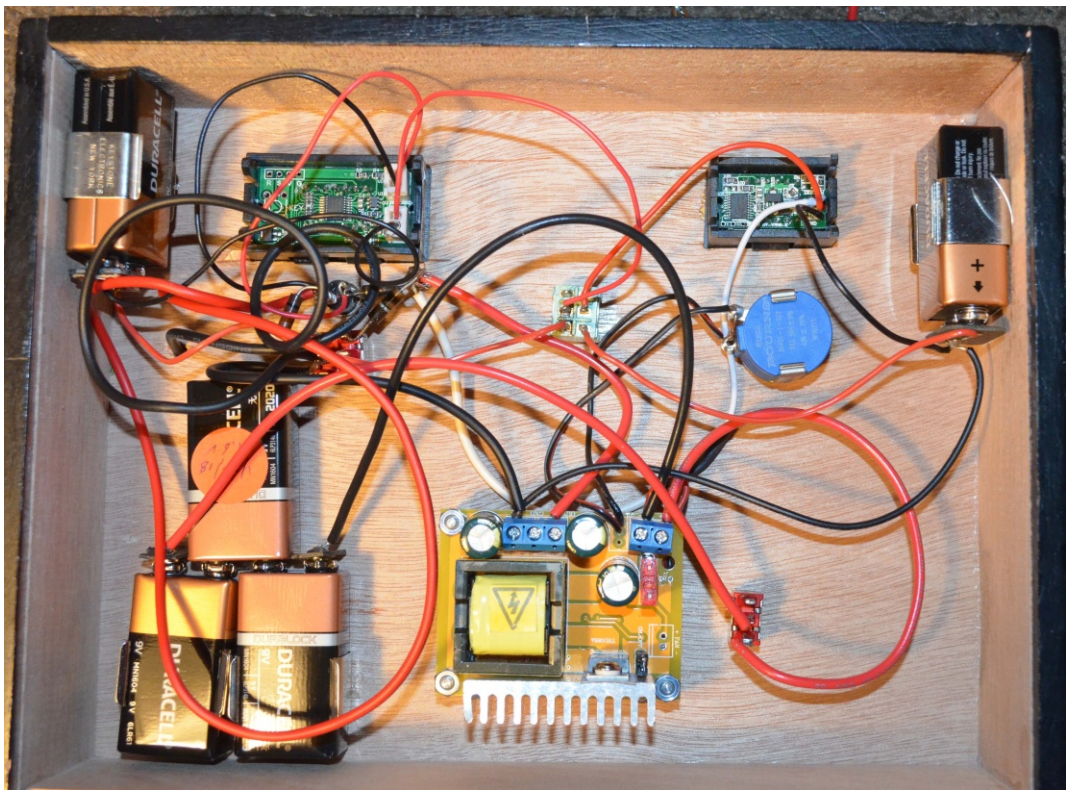
To verify the above I put five precision 500 megohm resistors in series as a test case. The result was reasonably good. I calculated I should read .28 volts with 200 test volts (35K ohms*200 volts/250M ohms) and I got a reading of .273 volts. That's pretty close!

Below are pictured examples of a couple of test results. A shorted cap reads 35.000 leakage, the max on this meter.



Leaky

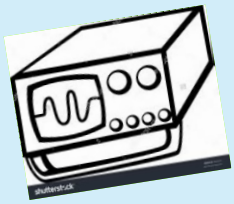
Good



Above is a look under the hood.

Sources:

1. https://www.murata.com/en-sg/support/faqs/capacitor/ceramiccapacitor/char/0003
2. https://www.yuden.co.jp/ap/product/support/faq/q035.html
3. https://sh.kemet.com/Lists/TechnicalArticles/Attachments/6/What%20is%20a%20Capacitor.pdf
4. https://www.mouser.com/datasheet/2/40/bf-bq-1158567.pdf
5. https://product.tdk.com/en/contact/faq/capacitors-0015.html
6. http://www.tuberadios.com/capacitors/



Classified Ads

Ads are free for CRC members. To place an ad send your ad description along with personal contact information to Steve at **stevetou@comcast.net** or Larry at **Lsnyder200@cs.com**.

FOR SALE:
Starting to gradually sell off restored radios from my extensive collection to club members and friends. Prices are very reasonable and will gladly negotiate. Range from the early 1920's to mid 1950's. Mostly wood radios from the 1930's...my favorite styles!
David Boyle
Castle Rock Area
email: **djboylesr@msn.com**

FOR SALE:
Tube Radios - Tombstone, Cathedral and Novelty Transistor Radios.
I have collected radios of all types for 35 plus years and now it is time to let them go to new home/s. I have over 250 tube type and over 5,000 transistor (both novelty and shirt pocket type)
Please call 303-2381384
radios4us@aol.com
Thank You, Ron Smith

REPAIR SERVICE: Radio repairs for club members. Reasonable rates. Good references.
Call David Boyle 303-681-3258

Just a Reminder: Club Dues are due in June.

Submit your $20 dues payment payable to :
Merril Campbell - 4723 Woodbury Dr. - Colorado Springs, CO 80915
or pay in person at the July 10th meeting, at the Bemis Library in Littleton.

Please provide the following information:

Enrolled in eGroup?

yes_____ no_____ unsure_____

email address_____

(a valid email address is required if you want to receive the digital Flash! and meeting locations and auction updates !!)

Name:_____

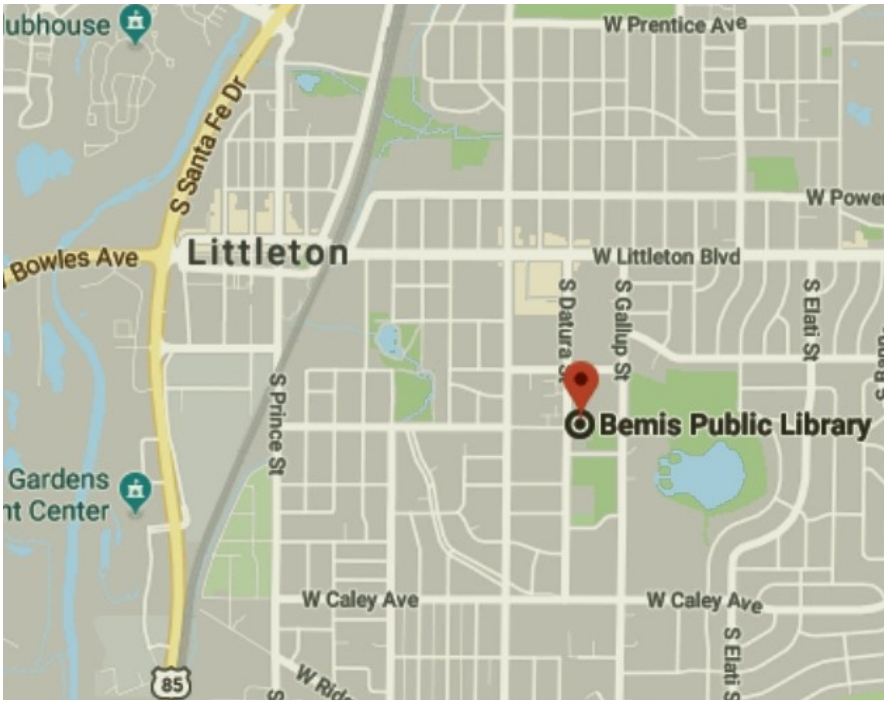
Address:_____

City:_____State:_____ Zip:_____

Phone:_____

Paid by: check # _____ or Cash (at CRC meeting only) _____

CRC Meeting July 10th at 1:00 PM



Directions to Bemis Library in Littleton

From Santa Fe and Bowles: Head east through downtown Littleton, continue to Littleton Blvd. Go south (right turn if coming from downtown Littleton) on Datura St, almost 1/2 mile from Littleton Blvd
The Bemis Public Library is on the east side of the street at 6014 S. Datura St.

The "USEFUL CIRCUIT" shown below, is from the 1935 December issue of *Radio-Craft*.

CONDENSER TESTER. This novel circuit will test condensers as low as 50 mmf. Enough plate voltage is used on V2 to cause the meter to swing to maximum with no voltage applied to V1. The latter tube acts as a rectifier, and when A.C. is applied to it, a varying voltage will be applied in turn to the grid of V2. This voltage will vary in accordance with the size of the condenser being tested. By closing the switch, resistance or A.C. volts may be read at the proper binding posts. Inductance can also be measured. Calibration is made by comparison with known values.

---- Arthur Zagon

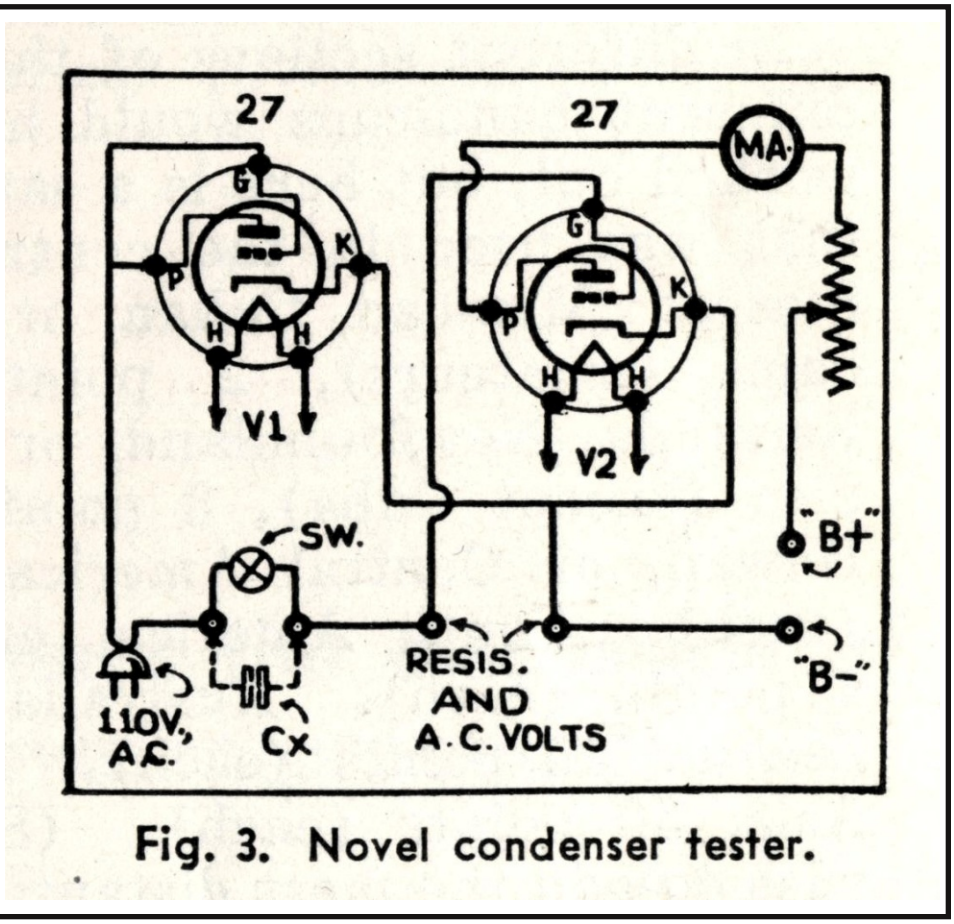


Fig. 3. Novel condenser tester.