01.6 fun.cap Capacitors

Capacitors have two terminal and are composed of two conductive surfaces separated by some distance. One surface has charge q and the other $-q$. A capacitor stores energy in an *electric field* between the surfaces.
Let a capacitor with voltage v across it and charge q be characterized by the parameter **capacitance** C, where the constitutive equation is

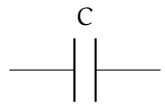
(1)

The capacitance has derived SI unit **farad (*F*)**, where $F = A \cdot s/V$. A farad is actually quite a lot of capacitance. Most capacitors have capacitances best represented in μF, nF, and pF.
The time-derivative of this equation yields the v-i relationship (what we call the "elemental equation") for capacitors.

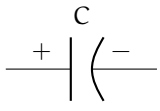
Equation 2 capacitor elemental equation

A time-derivative! This is new. Resistors have only algebraic i-v relationships, so circuits with only sources and resistors can be described by *algebraic* relationships. The dynamics of circuits with capacitors are described with *differential equations*.
Capacitors allow us to build many new types of circuits: filtering, energy storage, resonant, blocking (blocks dc-component), and bypassing (draws ac-component to ground).
Capacitors come in a number of varieties, with those with the largest capacity (and least expensive) being **electrolytic** and most common

being **ceramic**. There are two functional varieties of capacitors: **bipolar** and **polarized**, with circuit diagram symbols shown in Fig. cap.1. Polarized capacitors can have voltage drop across in only one direction, from **anode** (+) to **cathode** (−)—otherwise they are damaged or may **explode**. Electrolytic capacitors are polarized and ceramic capacitors are bipolar. So what if you need a high-capacitance bipolar capacitor? Here's a trick: place identical high-capacity polarized capacitors **cathode-to-cathode**. What results is effectively a bipolar capacitor with capacitance *half* that of one of the polarized capacitors.



(a) bipolar capacitor.



(b) polarized capacitor

Figure cap.1: capacitor circuit diagram symbols.