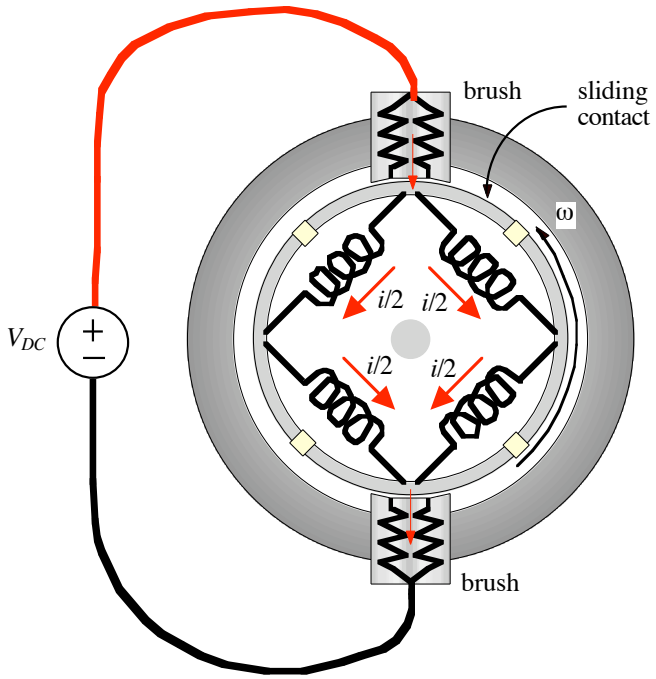
TOOL: The currents and voltages that occur during commutation in a DC motor are the solutions of R and L circuits where R consists of coil resistance and brush resistance. Reversal of current in coils must occur during the time a gap in sliding contacts passes under a brush.

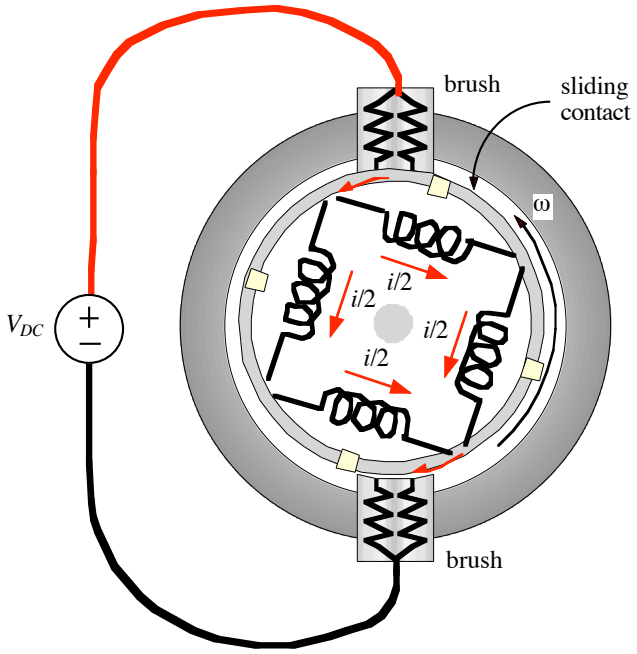
COMMENTS:



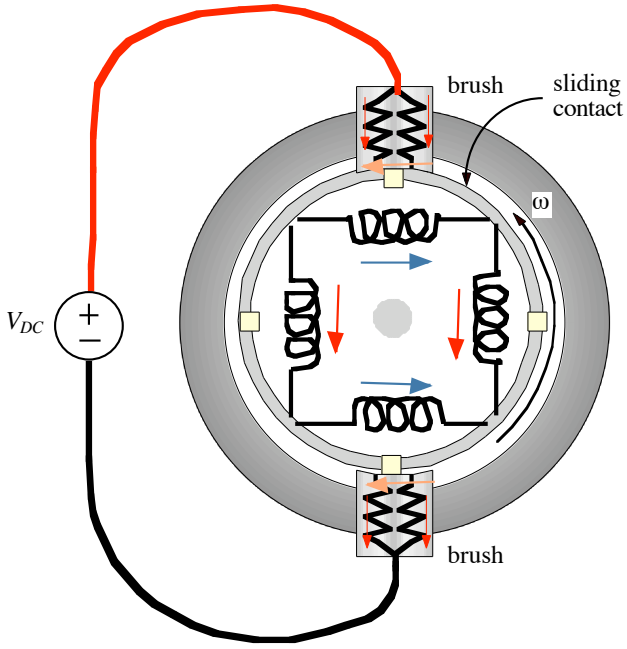
The above illustration shows a DC motor with four coils attached to four sliding contacts that make contact with two brushes. As the rotor moves, the directions of currents will eventually be reversed. We follow this process through approximately one-fourth rotation.

In the first illustration, above, the motor is running at a constant speed and the rotor coils are fully charged in a symmetrical position. A total current, i, flows through the two parallel sets of coils. We assume that the L/R time constant for charging the coils is short enough that the maximum current is flowing in the coils.

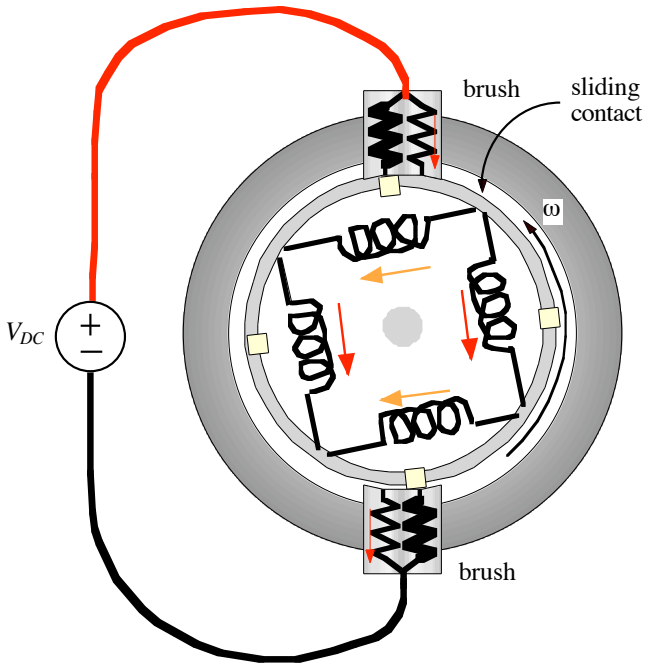
The rotor now rotates slightly, as shown in the next figure.



The maximum current still flows in the coils, but a gap between the sliding contacts is about to pass under the brush.



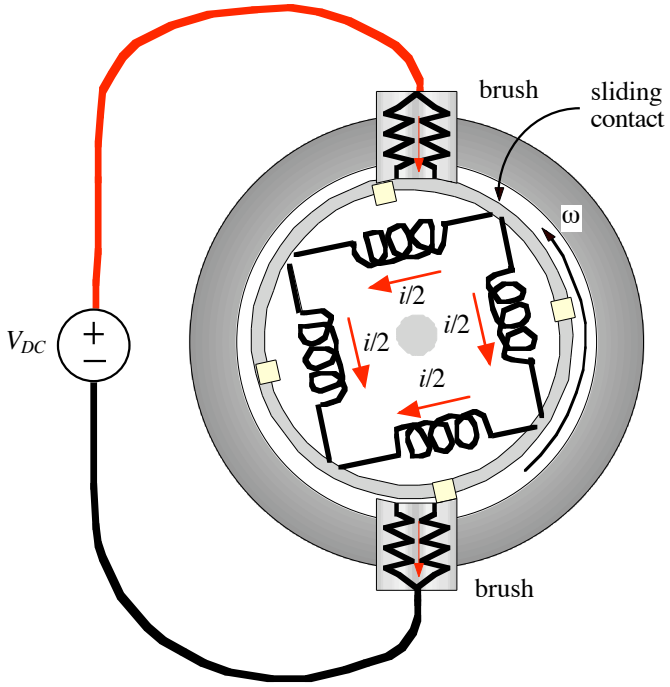
The top coil is now shorted *through the brush*, and its current begins to drop toward zero.



As the rotor moves slightly farther, the coil on the left side, which was drawing current through the left side of the brush, sees an increasing resistance as the contact area with the left side of the brush pinches off. Although the top coil is still shorted through the resistance of the top brush, the coil on the left requires a constant current (since it acts like an inductor). Thus, the coil on the left will change the voltage on the left end of the top coil to increase the current flowing through the brush. This will also cause current to start flowing through the top coil in the opposite direction to what it was when the gap in the sliding contact first came under the brush.

In the next illustration, the sliding contact on the top left breaks contact with the top brush, and the current for the coil on the left must all flow through the top coil. If the current in the top coil is less than the current in the coil on the left, there will be arcing of current from the top left sliding contact back to the brush.

NOTE: A high value of brush resistance makes the time constant L/R shorter, facilitating commutation. A high value of R will limit current flow, however.



As the top-left sliding contact breaks contact with the brush, all the current for the coil on the left now flows through the top coil. Complete reversal of current has been achieved, and the next quarter cycle begins.