4.10. Figure 4.30 shows a resistance welding system that uses the electrical discharge of energy stored in an inductive circuit to create a transient high-current flow between two pieces of metal. The localized heat generated forms a weld. A constant voltage source V_s is connected through a switch to a high-inductance coil of wire and the two pieces to be welded. When a high current is established in the coil the switch is opened. Because the current in the coil cannot change instantaneously, a high current is forced through the workpieces generating the heat necessary for welding.

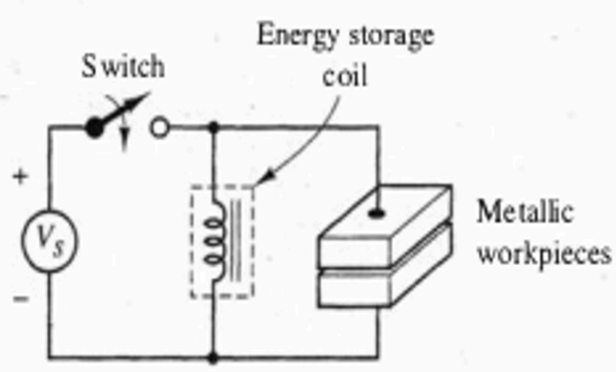


Figure 4.30: An electric welding system.

(a) How would you represent the energy storage coil using lumped elements? What element would be used to represent the metal workpieces?

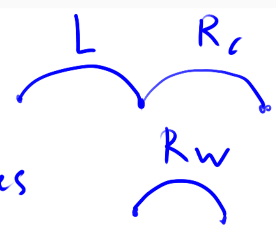
(b) Construct a linear graph representing the system when the switch is closed. What will determine the current flowing in the coil and the resistive workpieces after any transients have decayed to zero?

(c) Construct a linear graph representing the system after the switch is opened. At the instant after the switch is opened, how much current flows through the workpieces?

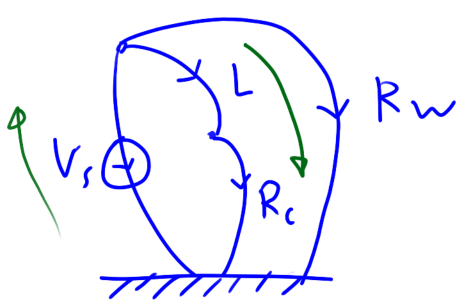
(d) What is the direction of current flow (i) just before the switch is opened and (ii) just after the switch is opened?

a. Coil

Workpieces



b.



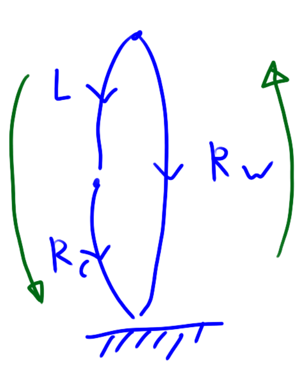
$R_w >> R_c$

$\frac{di_L}{dt} = \frac{1}{L} V_L \rightarrow V_L = 0$

$V_{R_c} = i_{R_c} R_c$

$V_s = i_L R_c \Rightarrow i_L = \frac{V_s}{R_c}$

c.



$i_L = \frac{V_s}{R_c}$

d. Since $R_w >> R_c$ $\quad i_{R_w} << i_{R_c}$