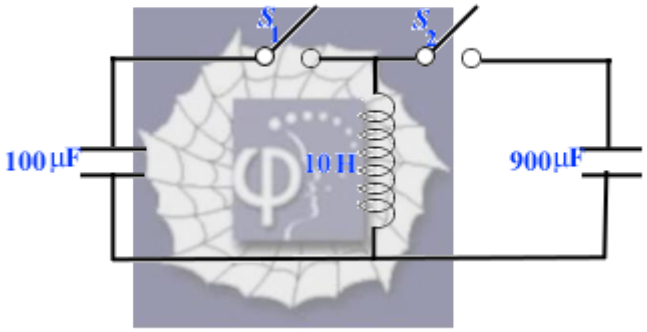
**529.**

**Problem 38.64 (RHK)**

*In the circuit shown in the figure the* 900-$\mu$F *capacitor is initially charged to* 100 V *and the* 100-$\mu$F *is uncharged. We have to describe in detail how one might charge the* 100-$\mu$F *capacitor to* 300 V *by manipulating switches* $S_1$ *and* $S_2$.




**Solution:**

It is given that initially the 900-$\mu$F capacitor is initially charged to 100 V and the 100-$\mu$F is uncharged.

Therefore, an amount of energy

$$U = \frac{1}{2}CV^2 = \frac{1}{2}\times 900\times 10^{-6}\times (100)^2 \text{ J} = 4.5 \text{ J}$$

is stored in the 900-$\mu$F capacitor. The switch $S_2$ is closed and the switch $S_1$ is kept open for a time interval that will

be determined next. The circuit is then a *LC*-oscillator with frequency

$$\omega_1 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10\times 900\times 10^{-6}}} \text{ rad s}^{-1} = 10.5 \text{ rad s}^{-1};$$

period

$$T_1 = \frac{2\pi}{10.05} \text{ s} = 0.596 \text{ s}.$$

After a lapse of time equal to $T_1/4 = 0.149$ s the energy which was initially stored in the 900-$\mu$F capacitor will be transferred to the 10 H inductor and will be stored in it as magnetic energy. At this stage the switch $S_2$ is opened and the switch $S_1$ is closed. We now have a *LC*-oscillator with frequency

$$\omega_2 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10\times 100\times 10^{-6}}} \text{ rad s}^{-1} = 31.6 \text{ rad s}^{-1};$$

period

$$T_2 = \frac{2\pi}{31.6} \text{ s} = 0.198 \text{ s}.$$

The energy in the 100-$\mu$F when its potential is 300 V will be

$$U' = \frac{1}{2}CV^2 = \frac{1}{2}\times 100\times 10^{-6}\times (300)^2 \text{ J} = 4.5 \text{ J}.$$

In time $T_2/4 = 0.05$ s the 4.5 J energy stored in the inductor will be transferred as electrical energy on to the 100-$\mu$F capacitor and the potential difference across it then will be 300 V.