MAGNETIC & ELECTROMAGNETIC INDUCTION - LR Circuits

A 30 H coil with an internal resistance of 4.5Ω is connected to a 12 V storage battery. Two light bulbs are connected to the coil; one in series to monitor the current and one in parallel to monitor the voltage. A 4.5Ω resistor is connected and the switch is thrown, both bulbs light simultaneously when the coil is connected to the battery. The voltage bulb lights immediately while the current bulb lights slowly over a 7 second time period.

Ref: hb x61; w/ tape 4-04:04:50
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This can demonstrate L/R. The delay in the current indicating lamp is about 7 sec. It can be compared with a resistance the value of which has been adjusted to draw the same amount of current as the inductance. The reverse E.M.F., due to the collapsing field, can be shown to light a 110V 100 W lamp. The order of demonstrations: Close sw2 to the (R) Resistance side, then close sw1 (voltage + I lamps light instantly). Open sw1 then place sw2 in the (L) Inductance position; close sw1 and the voltage lamp lights as before; the I lamp is delayed approx. 7 sec. before it comes on. Then open sw2 and watch the 120V lamp, momentarily, light brightly.

\[
\frac{30H}{4.3\Omega} = 6.96\text{ sec.}
\]
GROWTH OF CURRENT IN AN INDUCTOR (LR TIME CONSTANT)

MAGNETIC & ELECTROMAGNETIC INDUCTION - LR Circuits

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September 3, 1987

X61. Time Constant in LR Circuit; 30-Henry Coil and Light Bulbs - 8W

Purpose: Demonstrate LR time constant in a transparent manner by watching the current build up in a large magnet with a 7s time constant and noting the 7-s delay with a 100W? light bulb. Show large emf developed when circuit interrupted by dumping current through 120V light bulb.

Equipment: Big 30-Henry coil with 4.5 ohms internal resistance, two 6V Light bulbs (to sense applied voltage and current), 12 V car battery, external resistor R = 4.5 ohms, switches; 110 V (25W?) bulb. Bulbs have 0.2 ohm resistance when cold.

Procedure:
Switch A applies voltage to circuit
Switch B permits substitution of resistor for the solenoid (removes inductance)
(a) Load is external resistor, Switch B down
   Close Switch A in series with battery
   Both 6V lights light "instantaneously"
   Demonstrates role of the 6V indicators when inductance in circuit is small.
   Open switch A
(b) Repeat with inductor as load; Switch B is "up"
   Voltage bulb lights instantaneously (sort of) when switch A closed
   Current bulb lights in ~7 seconds
   Compare to expected value: \( \tau = L/R = 30/4.5 = 6.7 \).
(c) OPEN Switch B while steady current flowing through inductor
   Inductor discharges through 110V (25W?) bulb
   Burns out bulb (maybe); flashes very bright at the least.
   Illustrates emf that develops in inductor when circuit interrupted

Ref: V1 video V51, tape 4, 04:04:50, 2nd of 14.

NOTES: (1) Voltage light C was lighting slowly (~1 sec) in 1986, it was better in 1987. I forget what was fixed; the inductance of the coil resistor in series with bulb C or the bulb itself could have been the problem. One should probably use a 12V bulb and no series resistor (2) I recall that in 1986, the 110V bulb would blow out; in 1987, we could not get it to do so. We tried several wattages. Check the diode: at one point it was reversed; note that the experiment will appear to work OK even if the diode is shorted (because of the relatively high resistance of the 110V bulb)
GROWTH OF CURRENT IN AN INDUCTOR

SW 1
12 VDC

V
12V
#1343

R = 4 Ω

SW 2

30H 4.10
TC ≈ 7 sec

25W 120V LAMP