16

hown here, the magnetic flux is almost
ned to the interior of the winding.

(4)

medium inside coil, H m^{-1}
ss

nstructed of conducting cylinders
n the inner conductor is I. The
ame magnitude. The flux density
n g straight conductor with

(5)

n d times the integral of (5) from

FIGURE 6-17
Coaxial transmission line.

the inner to the outer conductor or

$$\Lambda = d\int_a^b B\,dr = \frac{d\mu I}{2\pi}\int_a^b \frac{dr}{r} = \frac{d\mu I}{2\pi}\ln\frac{b}{a} \tag{6}$$

Hence, the inductance of a length d of the coaxial line is

$$L = \frac{\Lambda}{I} = \frac{\mu d}{2\pi}\ln\frac{b}{a} \qquad \text{(H)} \tag{7}$$

or the *inductance per unit length* (L/d) *for the coaxial line* is given by

$$\boxed{\frac{L}{d} = \frac{\mu}{2\pi}\ln\frac{b}{a}} \qquad (\text{H m}^{-1}) \tag{8}$$

where μ = permeability (uniform and constant) of medium inside coaxial line, H m^{-1}
b = inside radius of outer conductor
a = outside radius of inner conductor (in same units as b)

It is assumed that the currents are confined to the radii a and b. This is effectively the case when the walls of the conductors are thin.

Evaluating (8), the *inductance per unit length d of the coaxial line* is

$$\boxed{\frac{L}{d} = 0.2\mu_r \ln\frac{b}{a} = 0.46\mu_r \log\frac{b}{a} \qquad (\mu\text{H m}^{-1})} \tag{9}$$

where μ_r = relative permeability, dimensionless.

Let us consider finally a ***two-wire transmission line*** as illustrated in Fig. 6-18. The wire radius is a, and the spacing between centers is D. At any radius r from one of the wires the flux density B due to that wire is given by (5). The total flux linkage due to both wires for a length d of line is then d times twice the integral of (5) from a to D, or

$$\Lambda = 2d\int_a^D B\,dr = \frac{\mu I d}{\pi}\int_a^D \frac{dr}{r} = \frac{\mu I d}{\pi}\ln\frac{D}{a} \tag{10}$$

Hence, the inductance of a length d is

$$L = \frac{\Lambda}{I} = \frac{\mu d}{\pi}\ln\frac{D}{a} \tag{11}$$

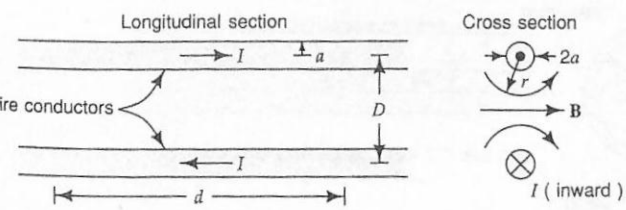

FIGURE 6-18
Two-wire transmission line.