vith conducting paint on a
mmeter connected between

is applied to open types of line
iaterial should extend out to a
s-section if accurate results are

igital-computer methods can be
configurations yield to a simple
13 we have from (6-10-8) for L
e

$$7\sqrt{\frac{\mu}{\epsilon}}\log\frac{b}{a} \qquad (\Omega) \qquad (21)$$

μ_0 and (21) reduces to

Coaxial line impedance (22)

line, dimensionless

units as a

2) (23)

E 12-13
transmission line with 18.3 transmis-
cells in parallel and 2 in series.

Example 12-2 Circular coaxial line. The air-filled coaxial line in Fig. 12-13 has a radius ratio $b/a = 2$. Find its characteristic impedance.

Solution. From (23)

$$Z_0 = 138 \log 2 = 41.4\ \Omega \qquad \text{(exact)}$$

From the graphical field map in Fig. 12-13

$$Z_0 = \frac{N_s}{N_p} 376.7 = \frac{2}{18.3} 376.7 = 41.2\ \Omega \qquad \text{(map)}$$

This value agrees well with the exact value.

In a similar way, the characteristic impedance can be obtained for a *two-wire line*, as in Fig. 12-14. Thus, if $D \gg a$, we have

$$Z_0 = \frac{1}{\pi}\sqrt{\frac{\mu}{\epsilon}}\ln\frac{D}{a} = 0.73\sqrt{\frac{\mu}{\epsilon}}\log\frac{D}{a} \qquad (\Omega) \qquad (24)$$

If there is no ferromagnetic material present, $\mu = \mu_0$ and (24) reduces to

$$\boxed{Z_0 = \frac{276}{\sqrt{\epsilon_r}}\log\frac{D}{a} \qquad (\Omega)} \qquad \text{Two-wire line impedance} \qquad (25)$$

where ϵ_r = relative permittivity of medium, dimensionless
D = center-to-center spacing (see Fig. 12-14)
a = radius of conductor (in same units as D)

If the medium is air, $\epsilon_r = 1$, and (25) becomes

$$Z_0 = 276 \log\frac{D}{a} \qquad (\Omega) \qquad (26)$$

The impedances of various media and lines are summarized in Table 12-1.

12-6 THE TERMINATED UNIFORM TRANSMISSION LINE

Thus far we have considered only lines of infinite length. Let us now analyze the situation where a line of characteristic impedance Z_0 is terminated in a load impedance Z_L, as in Fig. 12-15*a*. The load is at $x = 0$, and positive distance x is measured to the left along the line. The total voltage and total current are expressed as the resultant of two traveling waves moving in opposite directions as on an

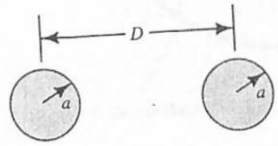

FIGURE 12-14
Two-wire transmission line.