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Multi-Terminal Constant Impedance Antenna

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1. Introduction

Constant-impedance antennas introduced by the present authors were put to practical use by Rumsey and DuHamel et al. and have been paid attention as broadband antennas. The concept of the constant-impedance antennas can be extended to multi-terminal antennas. This paper reports the theory and an example of application of multi-terminal antennas.

2. Theory

Let us consider an antenna composed of rotationally symmetric planar antenna having n-terminals. In Fig. 1, the terminals are fed by electric sources with star connection. Fig. 2 shows another antenna with the same shape of Fig. 1 fed by ring connection, which is the complementary to the antenna in Fig. 1. The relations among the voltages and the currents in Figs. 1 and 2 are given by

$$V_s = I'_s/2, \quad I_s = 2\gamma V'_s, \quad 1/\gamma = (120\pi)^2. \qquad (1)$$

When the voltage V_s is given by

$$V_s = \mathrm{e}^{j\frac{2\pi}{n}(s-1)} V_1 \qquad (2)$$

the current I_s becomes

$$I_s = \mathrm{e}^{j\frac{2\pi}{n}(s-1)} I_1 \qquad (3)$$

because of the rotationally symmetric geometry, and following relation is derived using eq. (1).

$$V'_s = \mathrm{e}^{j\frac{2\pi}{n}(s-1)} V'_1, \quad I'_s = \mathrm{e}^{j\frac{2\pi}{n}(s-1)} I'_1. \qquad (4)$$

If the antenna shown in Fig. 2 rotates π/n to the left, the same antenna shown in Fig.1 is obtained and the following relations hold.

$$V'_s - V'_{s+1} = V_{s+1}, \quad I_{s+1} - I_s = I'_s.$$

By using the relations described above, the input impedance of each pair of terminals are derived as

$$Z = \frac{V_s}{I_s} = 120\pi \sin\frac{\pi}{n}, \quad Z' = \frac{V'_s}{I'_s} = \frac{30\pi}{\sin(\pi/n)}, \quad (\Omega).$$

Thus, it is shown that the input impedance of multi-terminal planar antennas shown in this paper is always constant.

3. Example of application

In the case of $n = 4$, two sources with 90° phase difference are required as shown Fig. 3, and the input impedance of each pair of terminals is given by $Z = \sqrt{2}\,60\pi\ [\Omega]$.

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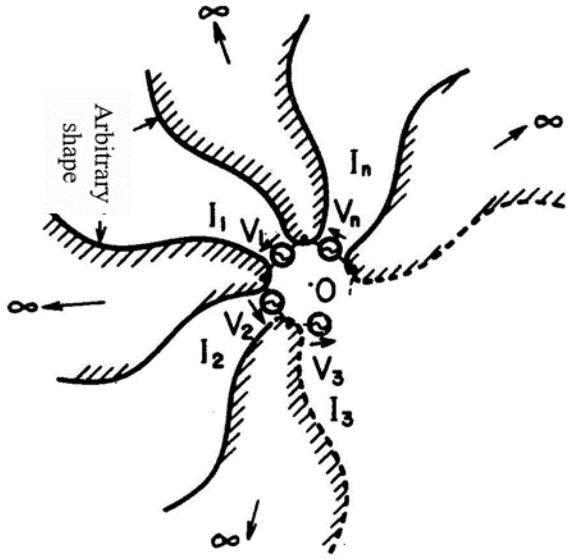


Fig. 1

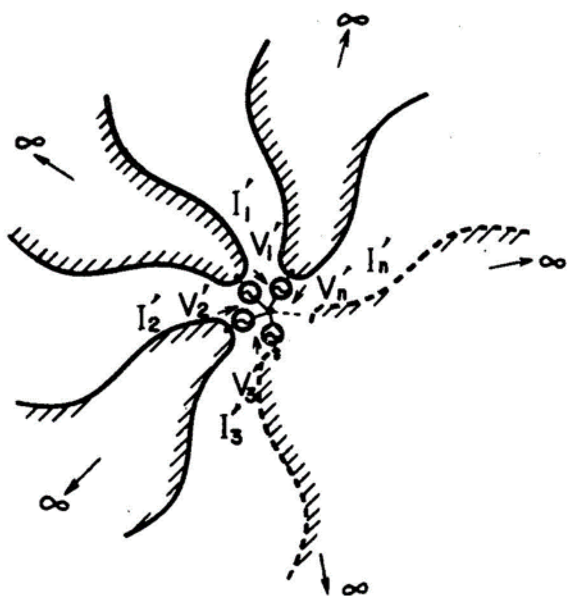
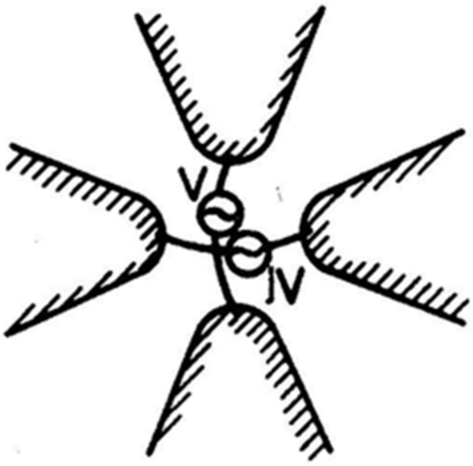


Fig. 2



$Z = \sqrt{2}\, 60\pi$ (Ohms)

Fig. 3