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W. A. MARRISON
TRANSMISSION NETWORK
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FIG. 1

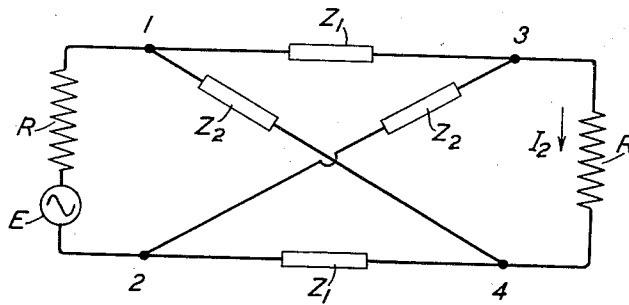


FIG. 2

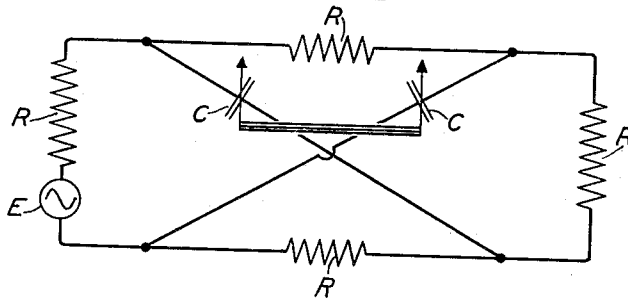
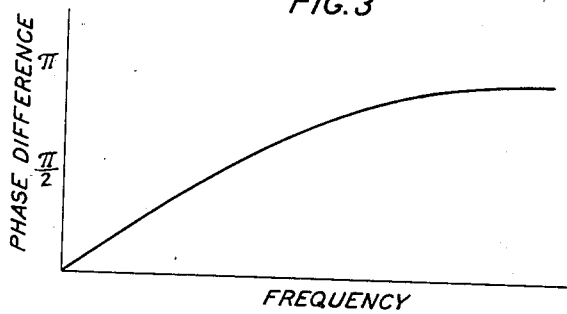


FIG. 3



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TRANSMISSION NETWORK

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6 Claims. (Cl. 178-44)

This invention relates to phase controlling networks and has for its principal object controlling the phase of a current without affecting its amplitude. Another object is the economy of electrical elements in a phase shifting network.

The nature of the invention will be most readily understood from the following detailed description and by reference to the attached drawing of which,

Fig. 1 is a theoretical diagram for the explanation of the principle of the invention;

Fig. 2 is a schematic diagram of a variable device embodying the invention; and

Fig. 3 illustrates the phase characteristic of the device of Fig. 2.

In Fig. 1 is shown a generalized symmetrical lattice network having equal line impedances Z_1 and equal lattice impedances Z_2 . Between one pair of terminals 1, 2 is connected a resistance of value R in series with a wave source of voltage E and between the other pair of terminals 3, 4 is connected another resistance of equal value. For the symmetrical arrangement shown, the value of the output current I_2 in the second resistance is given by the formula:

$$I_2 = \frac{E(Z_2 - Z_1)}{2(R + Z_1)(R + Z_2)} \quad (1)$$

In the arrangement shown in Fig. 2, the line impedances Z_1 are constituted by resistances of value R , equal to the terminal resistances, and the lattice impedances Z_2 by equal capacities of value C . For this network the value of the output current is obtained from Equation 1 by the substitution

$$Z_1 = R$$

$$Z_2 = \frac{1}{jpC}$$

where p denotes 2π times the frequency. This gives after amplification,

$$I_2 = \frac{E(1 - jpCR)}{4R(1 + jpCR)} \quad (2)$$

from which it is evident that the amplitude of the current has a constant value, independent of variation of the frequency or of the capacity C .

The phase angle θ between the current I_2 and the impressed voltage E is given by

$$\theta = 2 \tan^{-1} pCR \quad (3)$$

and the constant current amplitude by

$$|I_2| = \frac{E}{4R} \quad (4)$$

By making the two capacities simultaneously

variable so that their values are maintained equal, the phase of the output current may be varied without changing its amplitude, the phase being advanced as the capacity is increased and vice versa. The total range of the phase change as the value of the capacity is increased from zero to infinity is π radians or 180° ; with a moderate capacity variation, a large fraction of this change may be accomplished. In practice, the capacities may be constituted by similar variable air condensers mechanically coupled and provided with a single adjusting means as indicated schematically in the drawing.

The variation of the phase change with frequency, assuming a fixed adjusting of the capacities is indicated by the curve of Fig. 3 which shows the phase difference between the output current and the input voltage, plotted as ordinates against frequency as abscissae. Over a wide range of flow frequencies, the phase displacement is practically proportional to the frequency. For other adjustments of the capacities, the linear relation is maintained but the slope of the characteristic is altered.

In the arrangement of Fig. 2, the terminal resistances may represent portions of an extended telephone line, the characteristic impedance of which is generally a substantially constant resistance. The device may be used in many other obvious connections, however, where it is desired to control the phase of a current without varying its amplitude or to control the slope of the phase characteristic as described above.

The schematic arrangement of Figs. 1 and 2 is shown as a lattice network. It is well known that this is a form of Wheatstone bridge, the two line branches and the two diagonal arms of the lattice constituting the four bridge arms. The term lattice branch is used to define the diagonal arms of the lattice and the term line branch to define the other two branches.

What is claimed is:

1. A phase controlling network comprising, in combination with equal resistive terminal impedances, a lattice network having a pair of line branches constituted by resistances equal in magnitude to the resistances of the terminal impedances and lattice branches constituted by equal reactances.

2. A phase controlling network in accordance with claim 1 in which the lattice branch impedances are constituted by equal capacities.

3. A phase controlling network comprising a plurality of impedance branches arranged in Wheatstone bridge formation, two opposing arms

of the bridge being constituted by equal resistances and the other two opposing arms being formed by equal variable reactance elements mechanically coupled together to maintain
5 equality of the reactances.

4. A phase controlling network in accordance with claim 3 in which the reactance elements are variable condensers.

5. A phase controlling network adapted to
10 operate between equal terminal impedances of resistance R, comprising a plurality of impedance branches arranged in Wheatstone bridge forma-

tion, two opposing arms of said bridge being constituted by resistance of value R and the other two opposing branches being constituted by equal variable reactance elements mechanically coupled together for simultaneous adjustment, the terminal impedances being connected respectively
80 between the two pairs of opposite corners of the bridge.

6. A phase controlling network in accordance with claim 5 in which the reactance elements are
85 variable condensers.

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