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Transformer Couplings for Equivalent Network Synthesis

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It may be shown that regardless of the type of analogy chosen ("impedance" *versus* "mobility"), disconformity will be encountered in synthesizing the equivalent network of a mechano-acoustic array. A method is described employing transformer couplings for getting around this difficulty. As a result, it becomes possible to construct equivalent circuits of mechanical arrays in a simple and straightforward manner by the method of impedance analogy. Similar benefits are achieved for the method of mobility analogy in the synthesis of equivalent circuits of acoustic arrays. Equivalent networks for certain mechano-acoustic arrays which cannot be conventionally synthesized become feasible through this method.

I. INTRODUCTION

THE subject of this paper is best developed by reference to Fig. 1. At the left center is a mechanical array consisting of masses, springs, and mechanical resistors. The central mass M_4 is in the form of a piston which actuates an acoustic array consisting of volumes and connecting pipes. Below, is an equivalent network by the method of "impedance" (classical) (voltage-force-pressure) analogy. Above, is an equivalent network by the method of "mobility" (voltage-velocity-volume current) analogy. We find a measure of conformity between the mechanical array and the mobility-analog network, which is evidenced by the similarity of connection between the circuit components in the two schemes. On the other hand, there is disconformity between the mechanical array and the impedance-analog network as evidenced by a dissimilarity of connection. Therefore, synthesis of equivalent networks of complex mechanical arrays by the impedance analogy can often become difficult. These facts have been reported at intervals during the past quarter of a century,[1-3] alerting us to the debility of the impedance analogy with respect to mechanical arrays.

To overcome this debility, Bloch[2] has suggested a procedure which requires, as a preliminary step, the construction of a *mobility* analog, this to be followed by the construction of a *dual* network, which turns out to be desired *impedance* analog. In this paper we propose a new system for building the impedance-analog networks of complex mechanical arrays without the necessity of taking the mobility-analogy route charted by Bloch. This new system requires a minor revision in the usual concept of impedance analogy, and the use of ideal transformers. It not only provides us with a systematic approach, but it also permits us to deal with certain mechanical arrays which cannot be handled conventionally by the impedance analogy.

Turning our attention to the acoustic array at the right-hand side of Fig. 1, we note the vice-versa relationship existing between the impedance and the mobility analogs. It is evident that with acoustic arrays, the impedance analogy becomes conformant

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[3] P. Le Corbeiller and Ying-Wą Yeung, J. Acoust. Soc. Am. 24, 6 (1952).