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Journal of Sound and Vibration 291 (2006) 566–603
JOURNAL OF SOUND AND VIBRATION
www.elsevier.com/locate/jsvi

Synchronization of two coupled escapement-driven pendulum clocks

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Received 30 October 1998; received in revised form 6 June 2005; accepted 17 June 2005
Available online 2 September 2005

Abstract

The synchronization of two coupled, similarly sized, escapement-driven pendulum clocks is studied. These clocks are coupled by having their extended cases suspended from adjacent stiff beams that can move together horizontally. This setup models the system that Huygens studied in 1665, using clocks that he had designed for determining a ship's longitude. Huygens observed that the two clocks soon ran at a common rate, with the pendulums moving in opposition to each other. A quantitative approximate theory of this synchronization is developed herein. This theory explicitly includes the essential nonlinear elements of Huygens' system, which are the escapements, as well as the suspended-clock-case and non-identical-clock features of his setup.

1. Introduction

Synchronization of two or more coupled, similarly sized, nonlinear, autonomous oscillating systems occurs frequently, with many cases now being actively investigated. For instance, Mirollo and Strogatz [1] have analyzed a model that can represent the synchronized firings of the pacemaker cells that trigger heart beats. They also provide references to other studies of the synchronization of biological and mechanical oscillators.

Perhaps the earliest reports of the synchronization of two coupled, similarly sized, nonlinear, autonomous oscillating systems were by Huygens in 1665 [2,3]. Huygens observed that when two

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doi:10.1016/j.jsv.2005.06.018