

(12) **United States Patent**  
**Elenga et al.**

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(45) **Date of Patent:** **Apr. 10, 2018**

(54) **LINEAR VIBRATION MODULES AND LINEAR-RESONANT VIBRATION MODULES**

(58) **Field of Classification Search**  
CPC ..... H02P 25/032; H02K 7/1876; B06B 1/166  
See application file for complete search history.

(71) Applicant: **Resonant Systems, Inc.**, Seattle, WA (US)

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(72) Inventors: **Robin Elenga**, Seattle, WA (US); **Brian Marc Pepin**, Oakland, CA (US); **Glen Tompkins**, Woodinville, WA (US)

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(73) Assignee: **Resonant Systems, Inc.**, Seattle, WA (US)

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **15/181,249**

EP 1 376 833 A1 1/2004

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*Primary Examiner* — Karen Masih

(65) **Prior Publication Data**

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(74) *Attorney, Agent, or Firm* — Olympic Patent Works PLLC

**Related U.S. Application Data**

(57) **ABSTRACT**

(63) Continuation of application No. 14/469,210, filed on Aug. 26, 2014, now Pat. No. 9,369,081, which is a continuation of application No. 13/345,607, filed on Jan. 6, 2012, now Pat. No. 8,860,337, which is a continuation-in-part of application No. 12/782,697, filed on May 18, 2010, now Pat. No. 8,093,767.

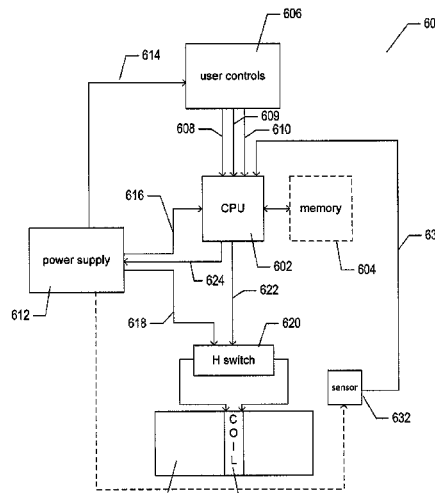
The current application is directed to various types of linear vibrational modules, including linear-resonant vibration modules that can be incorporated in a wide variety of appliances, devices, and systems to provide vibrational forces. The vibrational forces are produced by linear oscillation of a weight or member, in turn produced by rapidly alternating the polarity of one or more driving electromagnets. Feedback control is used to maintain the vibrational frequency of linear-resonant vibration module at or near the resonant frequency for the linear-resonant vibration module. Both linear vibration modules and linear-resonant vibration modules can be designed to produce vibrational amplitude/frequency combinations throughout a large region of amplitude/frequency space.

(60) Provisional application No. 61/179,109, filed on May 18, 2009.

(51) **Int. Cl.**  
**H02K 33/00** (2006.01)  
**H02P 25/032** (2016.01)  
**H02K 33/16** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H02P 25/032** (2016.02); **H02K 33/16** (2013.01)

**20 Claims, 20 Drawing Sheets**



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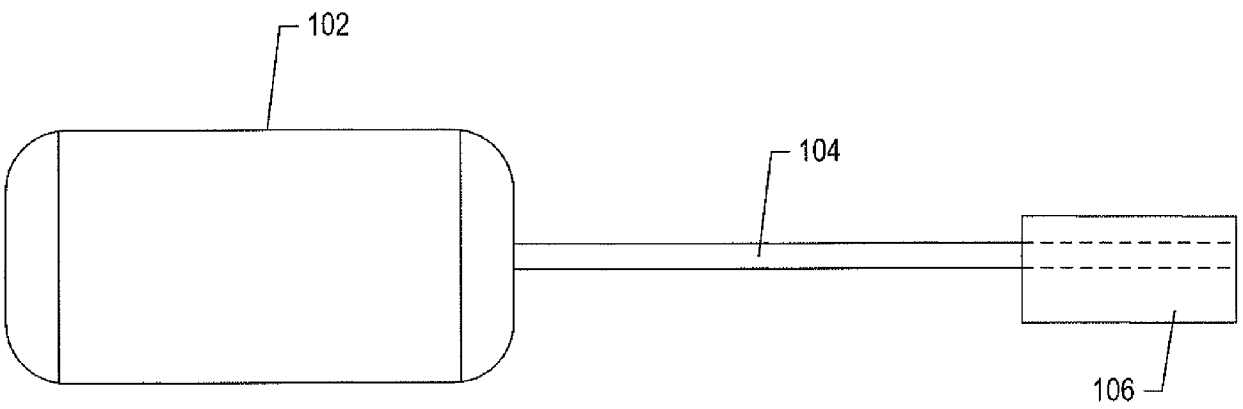


FIG. 1A  
--Prior Art--

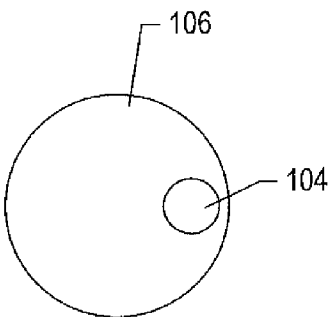


FIG. 1B  
--Prior Art--

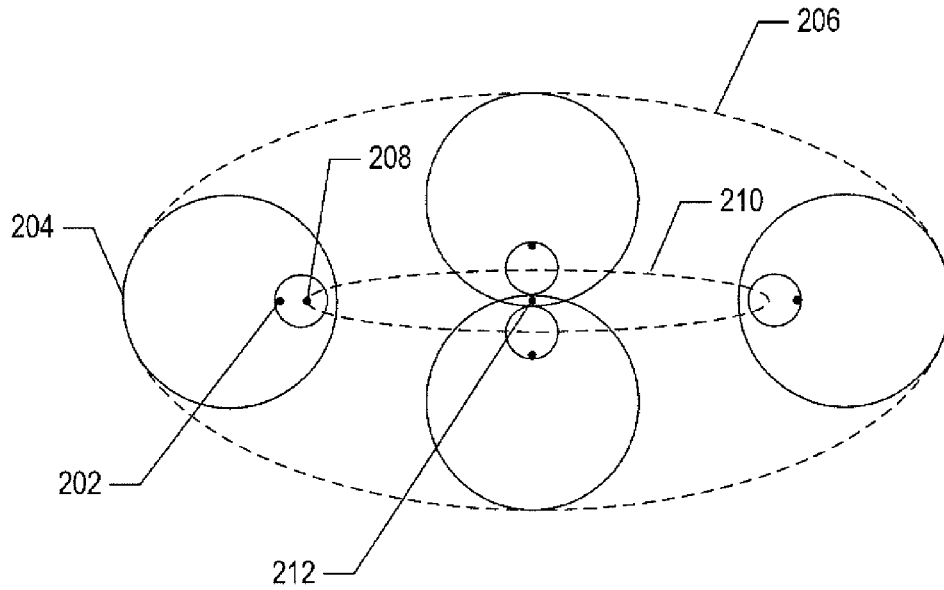


FIG. 2A

--Prior Art--

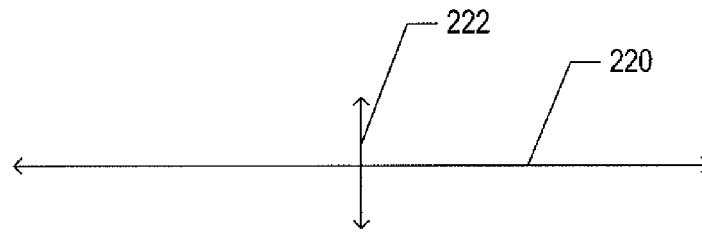


FIG. 2B

--Prior Art--

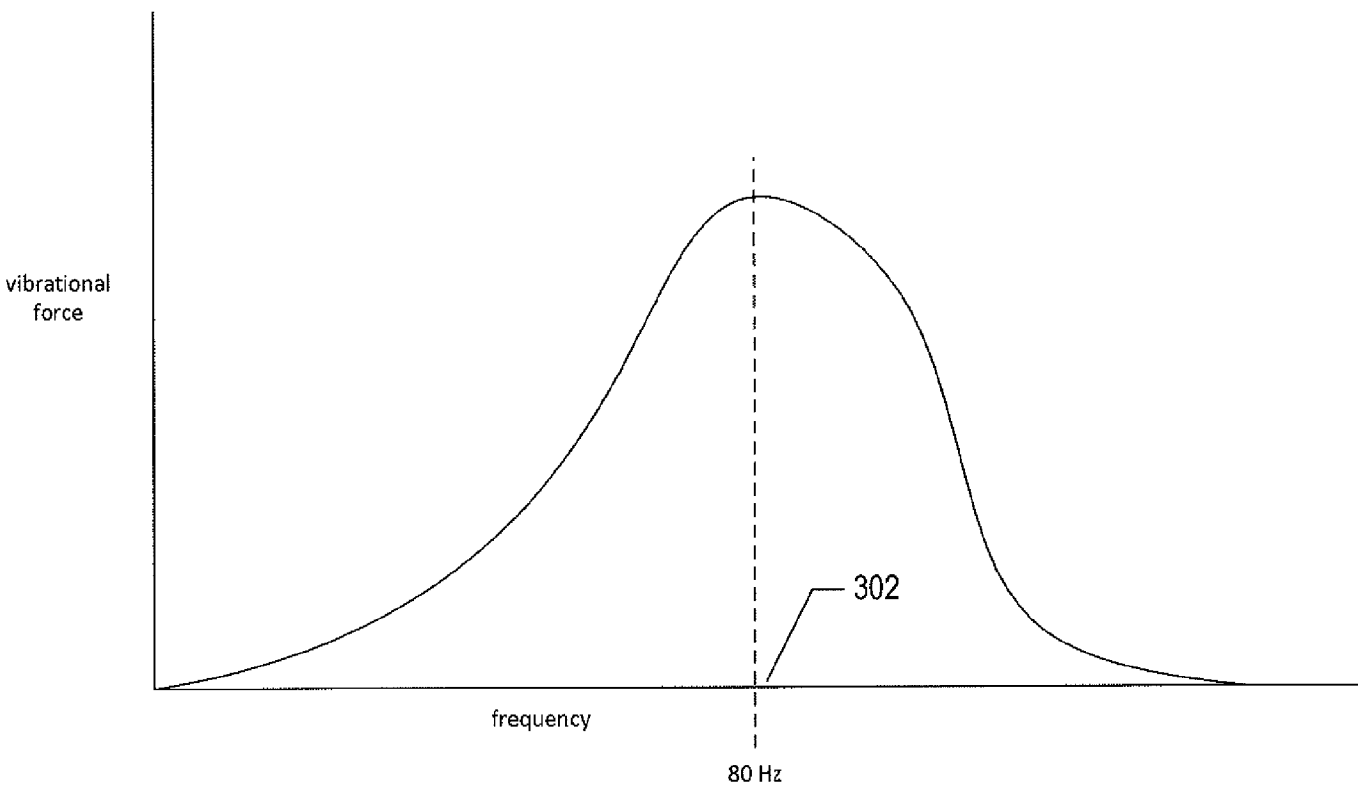


FIG. 3  
--Prior Art--

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