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(54) **TUNING FORK VIBRATORY MEMS GYROSCOPE**

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(58) **Field of Classification Search** 73/504.04, 73/504.12, 504.14, 504.16
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,349,855 A 9/1994 Bernstein et al.
5,747,690 A 5/1998 Park et al.
6,415,663 B1 * 7/2002 Mochida et al. 73/504.12
6,742,390 B2 * 6/2004 Mochida et al. 73/504.14
6,786,094 B2 * 9/2004 Konaka et al. 73/504.14
6,845,666 B2 * 1/2005 Mochida 73/504.12
6,860,150 B2 * 3/2005 Cho 73/504.12
6,915,693 B2 * 7/2005 Kim et al. 73/504.12
7,004,024 B1 * 2/2006 Park 73/504.16
7,051,591 B2 * 5/2006 Chaumet et al. 73/504.12
2006/0037396 A1 * 2/2006 Nicu et al. 73/504.12

FOREIGN PATENT DOCUMENTS

JP 2004205492 7/2004

* cited by examiner

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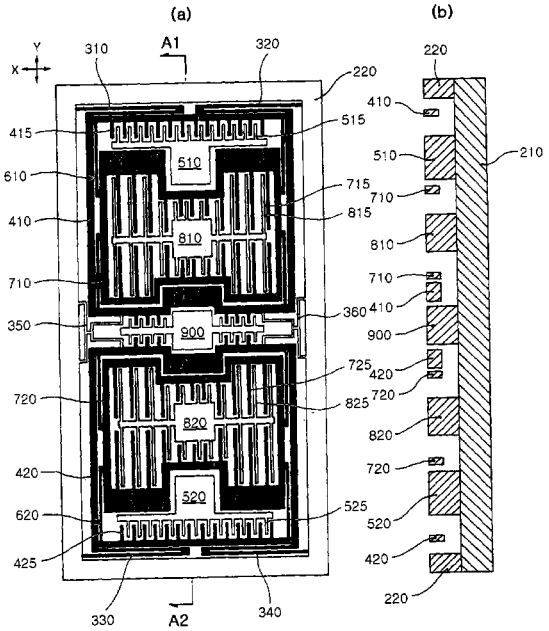
(57) **ABSTRACT**

A tuning fork vibratory MEMS gyroscope for sensing angular velocity and angular acceleration generated due to the rotation of a movable body. The tuning fork vibratory MEMS gyroscope includes an external fixed support portion formed on a substrate; a plurality of external elastic members; first and second external frames respectively including driving combs; first and second driving electrodes respectively including comb drivers; first and second internal elastic members respectively including a plurality of spring members; first and second internal frames respectively including sensing combs; and first and second sensing electrodes respectively including comb sensors. The tuning fork vibratory MEMS gyroscope withstands a noise at a peripheral area, is driven at the external portions of internal frames, is sensed at the internal portions of the internal frames, and comprises the elastic members having a wine glass shape, thereby being more stably operated.

33 Claims, 13 Drawing Sheets