

[54] CORIOLIS-TYPE MASS FLOWMETER

[76] Inventor: Dahlin, Erik B., 1936 Arroyo Seco Dr., San Jose, Calif. 95125

[21] Appl. No.: 873,201

[22] Filed: Jun. 11, 1986

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 856,939, Apr. 28, 1986, abandoned.

[51] Int. Cl.⁴ G01F 1/84

[52] U.S. Cl. 73/861.38; 73/198

[58] Field of Search 73/861.37, 861.38

References Cited

U.S. PATENT DOCUMENTS

Re. 31,450	11/1983	Smith	73/861.38
3,276,257	10/1966	Roth	73/861.38
3,329,019	7/1967	Sipin	.
3,355,944	12/1967	Sipin	.
3,485,098	12/1969	Sipin	.
4,011,757	3/1977	Baatz	.
4,109,524	8/1978	Smith	.
4,127,028	11/1978	Cox	.
4,187,721	2/1980	Smith	.
4,263,812	4/1981	Zeigner et al.	.
4,393,720	7/1983	Takahashi et al.	.
4,393,724	7/1983	Werkmann et al.	.
4,422,338	12/1983	Smith	73/861.38
4,491,025	1/1985	Smith	73/861.38
4,559,833	12/1985	Sipin	73/861.38
4,622,858	11/1986	Mizerak	.
4,628,744	12/1986	Lew	.
4,658,657	4/1987	Kuppers	73/861.38
4,680,970	7/1987	Simonsen et al.	73/861.38
4,703,660	11/1987	Brenneman	73/861.38

FOREIGN PATENT DOCUMENTS

0119638A1	1/1984	European Pat. Off.	.
3329544A1	9/1983	Fed. Rep. of Germany	.
3503841A1	8/1986	Fed. Rep. of Germany	.

OTHER PUBLICATIONS

R. M. Langdon of GEC Research Labs, Marconi Research Ctr., Sensors & Instruments Div., West Hanningfeld Rd., Great Baddow, Essex, UK Review Article titled: Resonant Sensors—A Review in J. Phys. E. Sci., Instrum., vol. 18, 1985, Printed in Great Britain, 3 pages.

Bopp & Reuther. Titled: Massedurchflussmesser System Rheonik Serie RHM Cover page plus 2 pages.

W. A. Wildhack: "Review of Some Methods of Flow Measurement" in Science, 8/1954, One page, showing FIG. 12 Schematic Drawing of "Vibro-Gyro".

Endress & Hauser, m-Point Massflowmeter.

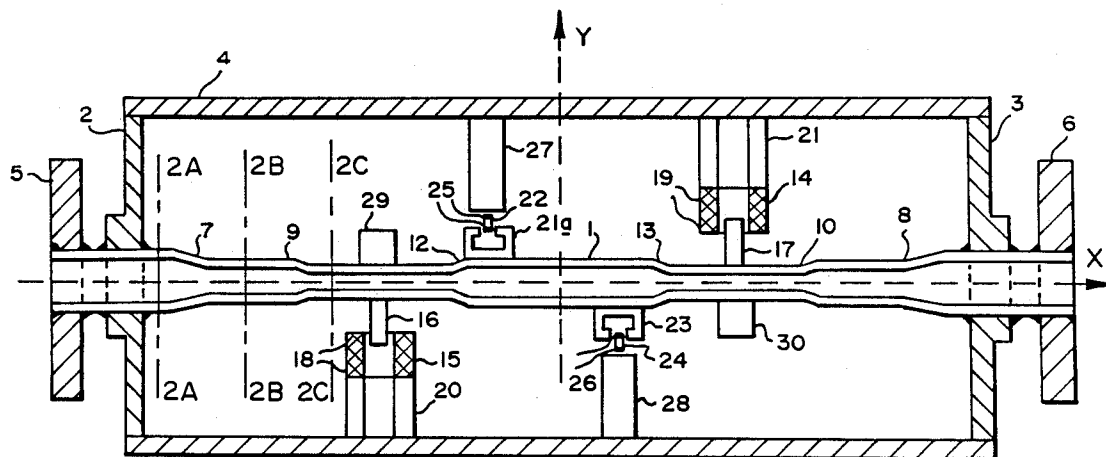
Primary Examiner—Herbert Goldstein

Attorney, Agent, or Firm—Ciotti & Murashige, Irell & Manella

[57] ABSTRACT

A Coriolis-type mass flowmeter in which the flow tube is vibrated at a resonance frequency approximately equal to the frequency for forced or natural vibration in a higher anti-symmetric mode, such as the second mode. In the preferred embodiment the flowmeter is symmetrical and has sections of oval cross section that provide low bending resistance to the vibration at the points where the amplitude of vibration is the largest. The preferred embodiment uses electronic signal detection/processing means that generates two signals proportional to flow tube velocity in the direction of vibration at equal distance but on opposite sides of the plane of symmetry of the tube, generates a sum and a difference of the two signals, integrates the sum, demodulates the integrated signal and the difference of the two signals to produce peak amplitude signals, and divides the peak amplitude signals to produce an output that is proportional to mass flow rate. The preferred embodiment is further equipped with a novel acoustic wave suppressor.

21 Claims, 8 Drawing Sheets



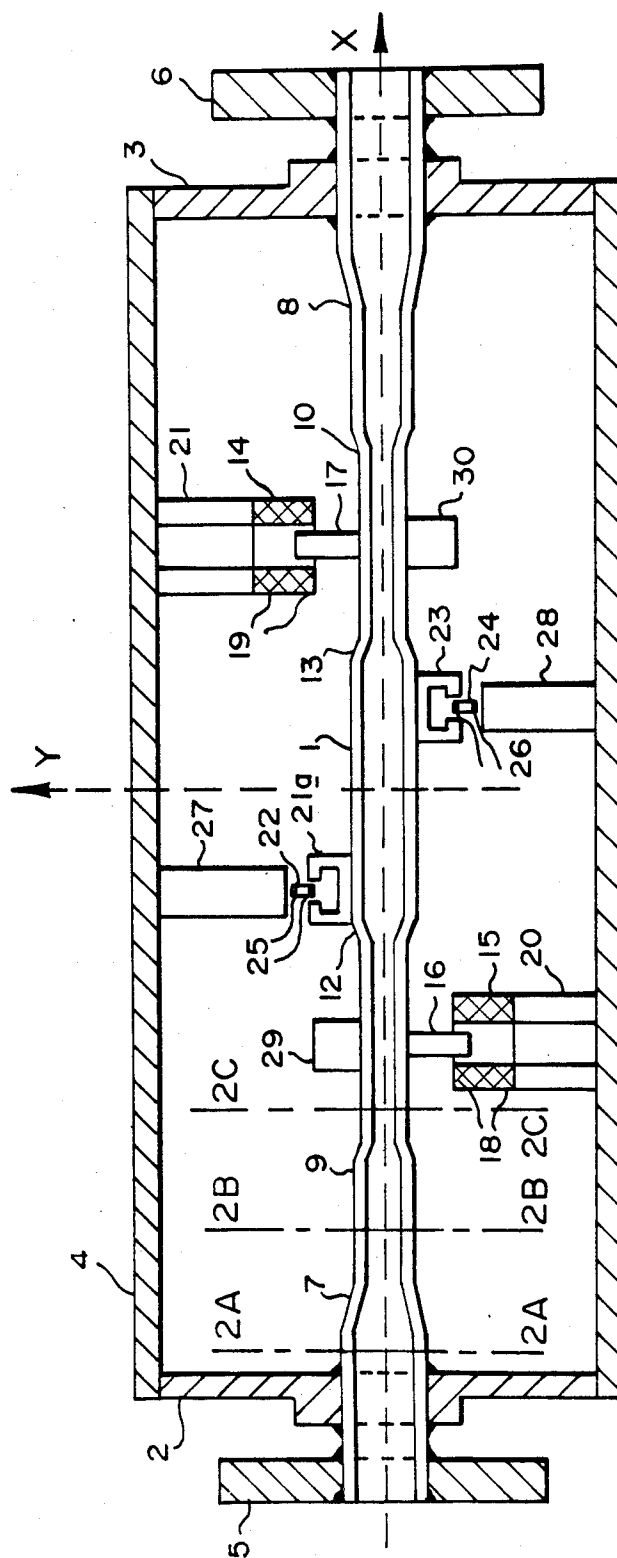


FIG. 1

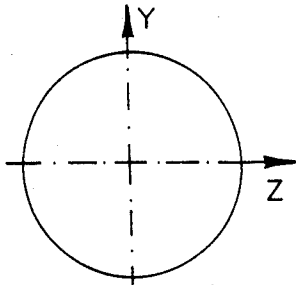


FIG. 2A

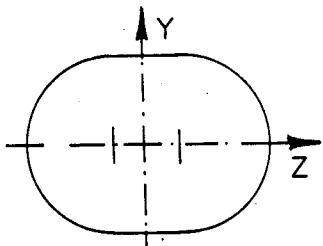


FIG. 2B

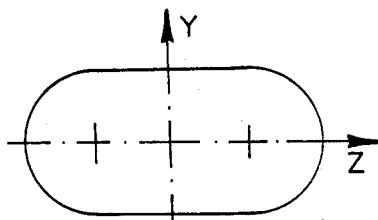


FIG. 2C

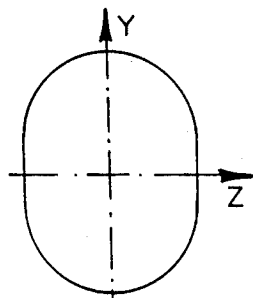


FIG. 2D

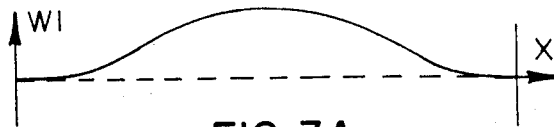


FIG. 3A

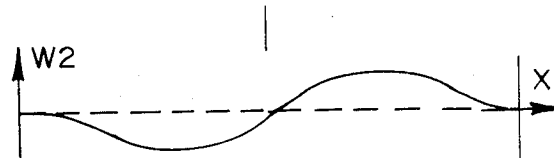


FIG. 3B

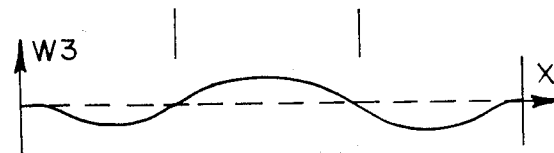


FIG. 3C

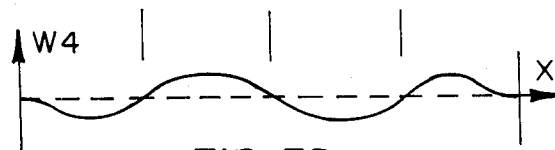


FIG. 3D

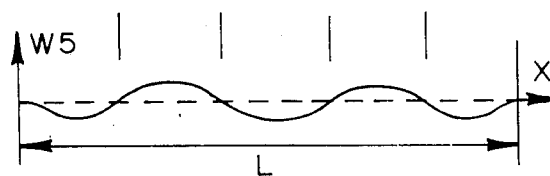


FIG. 3E

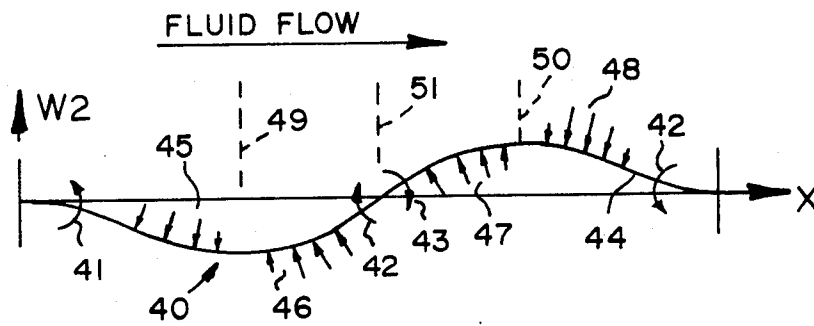


FIG. 4

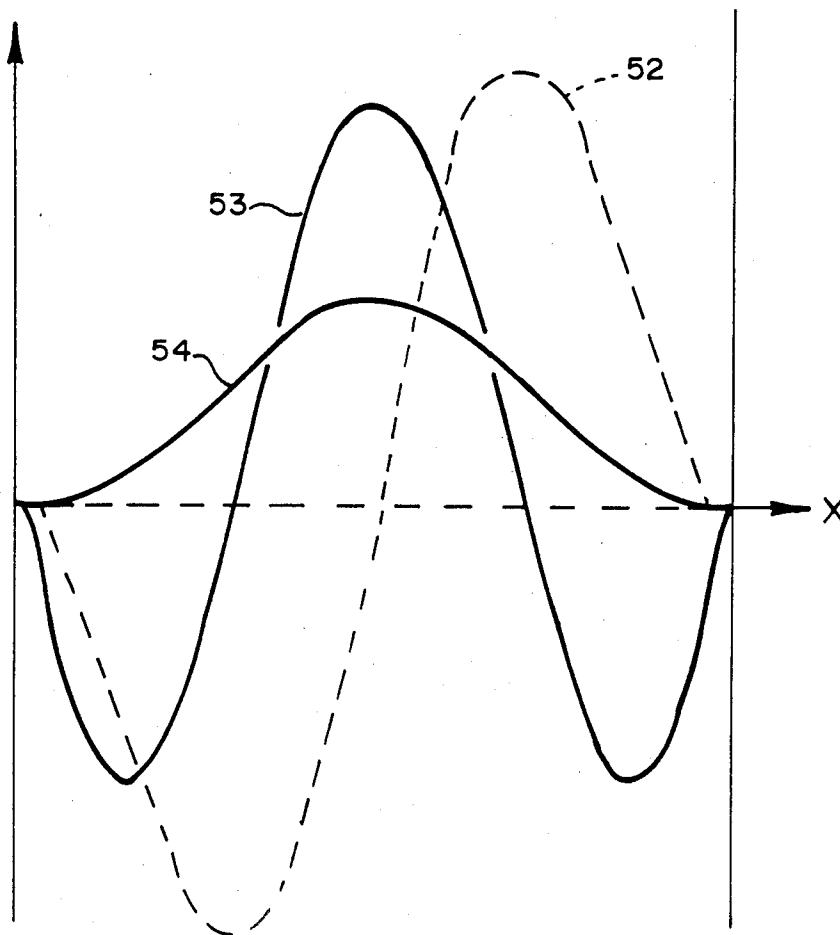


FIG. 5

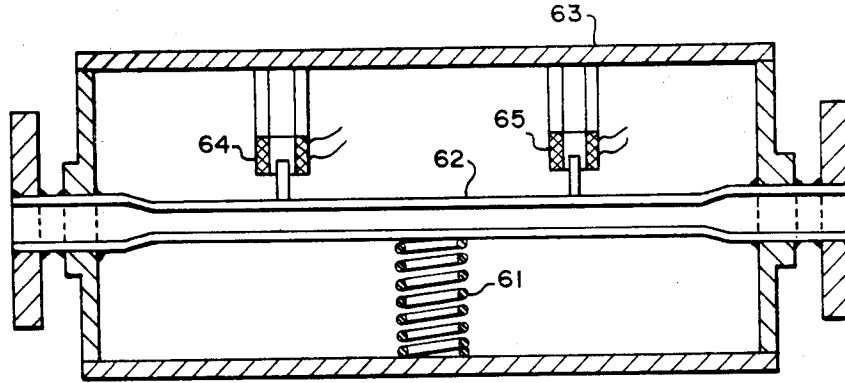


FIG. 6

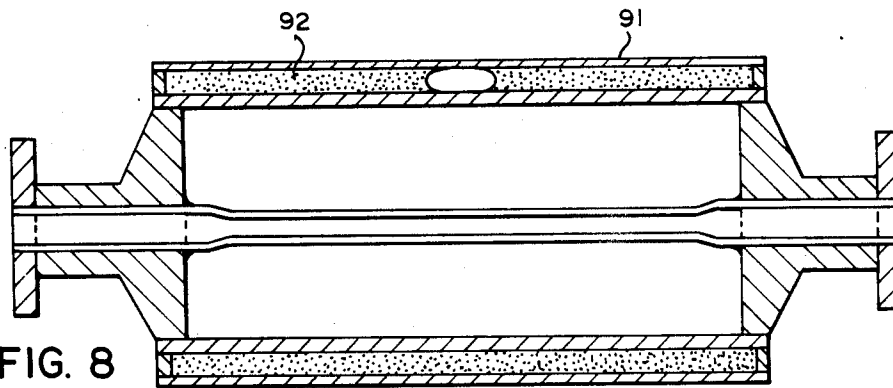


FIG. 8

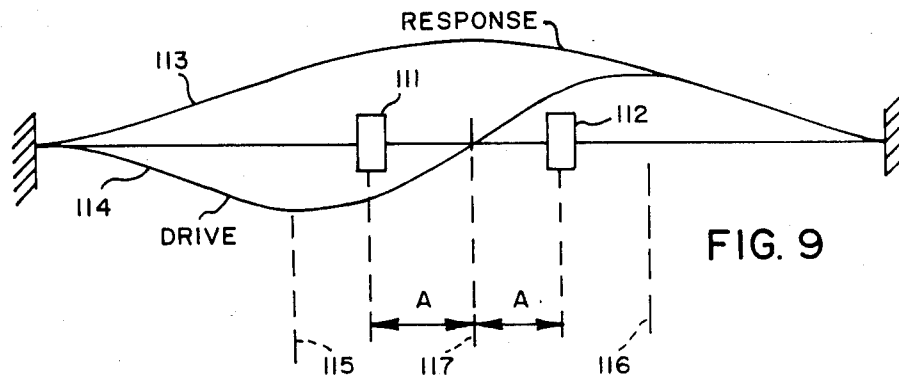


FIG. 9

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.