TRIPEDAL FLEXURE MEMBER AND LOAD/TORQUE MEASUREMENT SYSTEMS USING SAME

FIELD OF THE INVENTION

[0001] This disclosure pertains to flexure structures for use in load cells and other force measurement applications, and more particularly to a novel "tripedal" flexure consisting of the integral combination of three substantially S-shaped flexure beams arranged in parallel but cooperatively joined only by integral top and bottom structures, wherein the inward S-openings of the two outside flexure beams are oriented in the same direction while the inward S-openings of the center flexure beam are oriented in the opposite direction. The surfaces of the beams can be instrumented with strain gages in various combinations for measuring tension, compression or torsional forces and/or combinations thereof.

BRIEF SUMMARY

[0001a] According to a first aspect, the present disclosure refers to a tripedal flexure comprising the unitary combination of: a pair of substantially S-shaped outside beams with reversely curved upper and lower portions with edge surfaces; and a single substantially S-shaped center beam having reversely curved upper and lower portions with edge surfaces; the upper and lower portions of the outside beams being oriented in the same direction whereas the upper and lower curved portions of the center beam are oriented in the opposite direction; the beams being spaced apart from one another along the upper and lower curved portions but integrally joined to form a common top structure and a common base structure; wherein each of the beams provides strain concentration areas.

[0001b] According to a second aspect, the present disclosure refers to a force and/or torque sensor comprising: three substantially identical S-shaped flexure beams including a center beam oriented east to west and two side beams oriented west to east, all of said beams having outside edge surfaces; the three S-shaped beams being arranged parallel to one another and laterally spaced apart but integrated structurally by a common mounting structure on one axial end and a

common loading structure on the other axial end; the three beams being structurally and flexurally separated from one another other than at the mounting and loading structures; and the edge surfaces of one or more of the three beams being instrumented to produce electrical signals when loaded in one or more of tension, compression and torque.

[0002] The present disclosure, according to a first example, is a tripedal flexure comprising three substantially S-shaped flexure beams arranged in parallel, spaced apart relationship but integrally joined at the top and bottom by structures that permit load quantities such as compression forces, tension forces and/or torque to be applied to the flexure. Strain sensing elements such as variable-resistance strain-gages may be applied by any of various methods to surfaces of the beams in various arrangements.

[0003] By way of example, the center beam may be instrumented alone to measure tension and/or compression forces. Alternatively, the side beams can be instrumented to measure torque. As a further alternative, all of the beams can be instrumented to measure torque, compression and/or tension forces and/or combinations thereof.

[0004] In accordance with an illustrative example hereinafter described, all of the flexure beams assume a “modified S-shape” in that they all have rounded inwardly curved edge

surfaces and flat, planar outside edge surfaces. In theory either internal curved surfaces of the beam, or its external flat surface can be used for instrumentation with strain gauges, but it the flat outside edge surfaces are preferred from a manufacturing stand point to have strain gages or other strain-responsive devices affixed. The beams also have planar and parallel side faces with narrow spacings between them.

[0005] The entire flexure can be and preferably is manufactured from a single piece of elastically formable metal stock such as Inconel, stainless steel and aluminum and can be variously sized to accommodate various load ranges extending, by way of example from 100gram to 1k pounds. Exemplary dimensions for very small or "nano" flexures are provided hereinafter.

[0006] The strain-sensitive elements may be applied using state-of-the-art techniques such as bonding, depositing, and/or printing. These elements are typically variable resistors and are connected in bridge circuits in conventional fashion to produce output signals in the form of variable voltages.

BRIEF DESCRIPTION OF THE DRAWING

[0007] The flexure element is disclosed herein with respect to a single representative physical configuration and is further represented in the figures in various operating modes and with various strain gage instrumentation arrangements. The figures are as follows:

[0008] FIG. 1 is a perspective view of an illustrative tripedal flexure;

[0009] FIG. 2 is a side view of the flexure shown in FIG. 1;

[0009a] FIG. 2A is a side sectional view along a section line 2A-2A in FIG. 2;

[0009b] FIG. 2B is a side sectional view along a section line 2B-2B in FIG. 2;

[0009c] FIG 2C is a side sectional view along a section line 2C-2C in FIG. 2;

[0010] FIG. 3 shows two perspective views of the flexure in tension and compression modes, respectively;

[0011] FIGS. 4A – 4D show single-sided instrumentation for the flexure;

[0012] FIG. 5 shows a generalized bridge circuit for the T and C strain gages of FIG. 4;