load drivenly coupled with the element and connected to a first end of a fulcrum, wherein the fulcrum presents a first magnet at the opposite end, and a second magnet or ferrous material is positioned so as to selectively engage or disengage the first magnet, in accordance with a preferred embodiment of the invention;

[0016] FIG. **4** is a schematic elevation of an actuation system, including an active material element drivenly coupled with a load, a coil spring connected to the load opposite the element, and a resistance wheel positioned so as to selectively engage the coil spring, in accordance with a preferred embodiment of the invention;

[0017] FIG. **5** is a schematic elevation of an actuation system, including an active material element and a portion of a load disposed within a fluid filled sheath, in accordance with a preferred embodiment of the invention;

[0018] FIG. **6** is a schematic diagram of an actuation system, including an active material element, a portion of a load having conductive leads and drivenly coupled with the element, and a circuit comprising contacts configured to selectively engage the leads, in accordance with a preferred embodiment of the invention;

[0019] FIG. **7** is a schematic elevation of a system, including an active material element drivenly coupled with a load, a coil spring connected to the load opposite the element, a turning switch positioned so as to selectively engage the coil spring, and a circuit comprising the turning switch, in accordance with a preferred embodiment of the invention;

[0020] FIG. **8** is a schematic elevation of an actuation system, including an active material element, a portion of a load drivenly coupled with the element, defining a plurality of holes, and a photo-interrupter positioned so as to selectively engage the holes, in accordance with a preferred embodiment of the invention; and

[0021] FIG. **9** is a schematic elevation of an actuation system, including an active material element, a portion of a load drivenly coupled with the element, and a photo-transistor positioned along the stroke and shown being occluded from light by the load, in accordance with a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Referring to FIGS. **1-9**, the present invention concerns an active material actuated system **10** configured to determine, and a method of determining, at least one mid-stroke position of a load **12** drivenly coupled thereto, wherein the "stroke" is defined by the system **10**, and the term "mid-stroke position" is defined as any point between the beginning and end of the stroke. The invention is particularly suited for expanding the use of traditional two position active material actuated devices, such as, for example, an active material actuated automotive air vent. More particularly, in an air-vent application, the invention may be used to achieve precise position control between fully opened and fully closed positions, by informing the control apparatus, when the vent is at one or more mid-stroke positions. In general, the inventive system **10** accomplishes the intended function by causing a distinctively rapid change in electrical resistance within a constituent active material element **14**, or by modifying an ancillary circuit **16** through interaction with the load **12**. The embodiments described and illustrated herein are exemplary in nature; it is appreciated that other applications, configurations, and uses may be readily determined by those of ordinary skill in the art.

I. Active Material Discussion

[0023] As used herein, the term "active material" shall be afforded its ordinary meaning as understood by those of ordinary skill in the art, and includes any material or composite that exhibits a reversible change in a fundamental (e.g., chemical or intrinsic physical) property, when exposed to an external signal source. Suitable active materials for use with the present invention include but are not limited to shape memory alloys, shape memory polymers, electroactive polymers ("EAP"), piezoelectric composites, magnetostrictives, magnetorheological fluids, electrorheological fluids, and other equivalent active materials. Depending on the particular active material, the activation signal can take the form of, without limitation, an electric current, an electric field (voltage), a temperature change, a magnetic field, and the like.

[0024] More particularly, shape memory alloys (SMA's) generally refer to a group of metallic materials that demonstrate the ability to return to some previously defined shape or size when subjected to an appropriate thermal stimulus. Shape memory alloys are capable of undergoing phase transitions in which their yield strength, stiffness, dimension and/or shape are altered as a function of temperature. The term "yield strength" refers to the stress at which a material exhibits a specified deviation from proportionality of stress and strain. Generally, in the low temperature, or Martensite phase, shape memory alloys can be pseudo-plastically deformed and upon exposure to some higher temperature will transform to an Austenite phase, or parent phase, returning to their shape prior to the deformation.

[0025] Shape memory alloys exist in several different temperature-dependent phases. The most commonly utilized of these phases are the so-called Martensite and Austenite phases discussed above. In the following discussion, the Martensite phase generally refers to the more deformable, lower temperature phase whereas the Austenite phase generally refers to the more rigid, higher temperature phase. When the shape memory alloy is in the Martensite phase and is heated, it begins to change into the Austenite phase. The temperature at which this phenomenon starts is often referred to as Austenite start temperature (A_s). The temperature at which this phenomenon is complete is called the Austenite finish temperature (A_f).

[0026] When the shape memory alloy is in the Austenite phase and is cooled, it begins to change into the Martensite phase, and the temperature at which this phenomenon starts is referred to as the Martensite start temperature (M_s). The temperature at which Austenite finishes transforming to Martensite is called the Martensite finish temperature (M_f). Generally, the shape memory alloys are softer and more easily deformable in their Martensitic phase and are harder, stiffer, and/or more rigid in the Austenitic phase. In view of the foregoing, a suitable activation signal for use with shape memory alloys is a thermal activation signal having a magnitude to cause transformations between the Martensite and Austenite phases.

[0027] Shape memory alloys can exhibit a one-way shape memory effect, an intrinsic two-way effect, or an extrinsic two-way shape memory effect depending on the alloy composition and processing history. Annealed shape memory alloys typically only exhibit the one-way shape memory