USE OF GRATING STRUCTURES TO CONTROL ASYMMETRY IN A MAGNETIC SENSOR

This application is a divisional of U.S. patent application Ser. No. 11/317,811 filed Dec. 23, 2005, which is a continuation-in-part of U.S. patent application Ser. No. 11/190,388 filed Jul. 26, 2005.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to sensors for detecting magnetic fields.

2. Description of the Related Art

Magnetic storage media, such as magnetic storage tape drives and hard drives, rely on magnetic sensors to read data contained within the storage media. The magnetic sensor detects variations in a sensed magnetic field as the sensor passes over the media. The variations in the magnetic field may be used to read the data contained on the storage media.

The sensitivity, reliability, and stability of magnetic sensors to measure magnetic fields in storage media applications is limited by spacing losses between the media and magnetoresistive sensor and by signal distortion arising from the sensor. In addition, the lack of sensitivity and signal distortion of magnetic sensors can be problematic in other applications, such as sensing the integrity of current carrying aluminum or ferrous metal weld joints and forensic investigations of audio tape and hard drives. Therefore, it would be advantageous to have an improved apparatus and method for increasing the sensitivity, detection reliability, and stability of magnetic sensors.

In addition, asymmetry of the response of a magnetic sensor to presents a problem to accurately reading the information stored in the magnetic fields of a magnetic storage device. In addition, controlling the bias point and asymmetry of a magnetic sensor can result in increasing the effectiveness of a magnetic sensor. Therefore, it would be advantageous to have an improved apparatus and method for reducing the asymmetrical properties of magnetic sensors' response and controlling the bias point of magnetic sensors.

SUMMARY OF THE INVENTION

The present invention provides an apparatus and method for increasing the sensitivity, detection reliability, and stability of magnetic sensors relative to different magnetic detecting applications. The present invention includes a substrate and one or more leads disposed on the substrate. A magnetic sensor is disposed on the substrate and operably connected to one or more leads. The magnetic sensor may be either a contact bearing surface magnetic sensor or a proximity magnetic sensor. The magnetic sensor may also have a zigzag shape, a grating, or both a zigzag shape and a grating.

In addition, the present invention provides an apparatus and method for controlling asymmetry of a response of a magnetic sensor. First, a grating is established on a magnetic sensor. Second, properties of the grating to control the asymmetry of the response of the magnetic field of the magnetic sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives

and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

FIG. **1** shows three different types of proximity magnetic sensors, in accordance with illustrative embodiments of the present invention;

FIG. **2** shows three different types of contact bearing surface magnetic sensors, in accordance with illustrative embodiments of the present invention;

FIG. **3** shows a prior art proximity magnetic sensor;

FIG. **4** shows a prior art contact bearing surface magnetic sensor;

FIG. **5** shows a prior art contact bearing surface magnetic sensor having a grating;

FIG. **6** shows a prior art contact bearing surface magnetic sensor having a grating;

FIG. **7** shows a prior art proximity magnetic sensor having a zigzag shape;

FIG. **8** shows a prior art proximity magnetic sensor having a zigzag shape;

FIG. **9** shows a contact bearing surface magnetic sensor having zigzag shape, in accordance with an illustrative embodiment of the present invention;

FIG. **10** shows a contact bearing surface magnetic sensor having zigzag shape, in accordance with an illustrative embodiment of the present invention;

FIG. **11** shows a contact bearing surface magnetic sensor having a hybrid zigzag grating, in accordance with an illustrative embodiment of the present invention;

FIG. **12** shows a contact bearing surface magnetic sensor having a hybrid zigzag grating, in accordance with an illustrative embodiment of the present invention;

FIG. **13** shows a proximity magnetic sensor having a grating, in accordance with an illustrative embodiment of the present invention;

FIG. **14** shows a proximity magnetic sensor having a grating, in accordance with an illustrative embodiment of the present invention;

FIG. **15** shows a proximity magnetic sensor having a hybrid zigzag grating, in accordance with an illustrative embodiment of the present invention; and

FIG. **16** shows a proximity magnetic sensor having a hybrid zigzag grating, in accordance with an illustrative embodiment of the present invention.

FIG. **17** is a graph showing the asymmetrical properties of a group of magnetic sensor elements of a magnetic sensor that does not have gratings, in accordance with an illustrative embodiment of the present invention;

FIG. **18** is a graph showing the effect of exemplary gratings on the asymmetrical properties of the group of magnetic sensor elements shown in FIG. **17**, in accordance with an illustrative embodiment of the present invention;

FIG. **19** is a graph showing the effect of the bias points of a group of magnetic sensor elements of a magnetic sensor that does not have gratings, in accordance with an illustrative embodiment of the present invention; and

FIG. **20** is a graph showing the effect of exemplary gratings on the bias points of the group of magnetic sensor elements shown in FIG. **19**, in accordance with an illustrative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures and in particular with reference to FIG. **1**, three different types of proximity mag-