SYSTEM AND METHOD FOR GENERATING A DISPLACEMENT WITH ULTRA-HIGH ACCURACY USING A FABRY-PEROT INTERFEROMETER

BACKGROUND OF THE INVENTION

This invention relates generally to means and methods for generating a displacement of an object from a reference position and relates, more particularly, to such means and methods for generating a displacement of known magnitude of an object with relatively high accuracy.

High accuracy measuring devices, such as scanning-tunnelling microscopes, atomic force microscopes, high-precision capacitance gauges, air bearing LVDTs, optical interferometers are known to be difficult, if not impossible, to calibrate with conventional calibration devices because such conventional calibration devices may not possess any greater accuracy than the measuring device desired to be calibrated. Moreover, many of these high accuracy measuring devices are difficult to couple with conventional calibration devices for calibrating purposes.

It would be desirable to provide means and a method for generating, with ultra-high accuracy, a desired displacement of an object from a reference position so that the generated displacement could be used in applications such as the calibration of high accuracy measuring devices.

Accordingly, it is an object of the present invention to provide new and improved system and method for generating a desired displacement of an object with ultra-high accuracy.

A further object of the present invention to provide a new and improved calibration system and method for use when calibrating a high accuracy measuring device.

Another object of the present invention is to provide such a calibration system which can be used as a dimensional calibration tool through a relatively broad range of displacement.

still another object of the present invention is to provide such a system which is capable of being easily coupled to measurement and test equipment to be calibrated.

SUMMARY OF THE INVENTION

This invention resides in a system and method for generating a desired displacement of an object with ultra-high accuracy wherein the object is movable from a reference position or, with additional means, senses movement of the object relative to the displacement generator.

The system of the invention includes a Fabry-Perot etalon which includes a tube cavity having two ends, a length between the ends which is adjustable from a reference condition. The tube cavity also includes a pair of spherical mirrors disposed adjacent the ends thereof having a reflectivity of at least about 99.99% so as to provide the etalon with a relatively high reflectivity finesse. The tube cavity is disposed in the aconfocal configuration and is arrangable with the object so that an adjustment in length of the tube cavity effects a corresponding displacement of the object from its reference position.

The system also includes means for controllably adjusting the length of the etalon cavity so that in order to provide a desired displacement of the object from a reference position, the length of the tube cavity is adjusted by a corresponding amount.

In one embodiment of the system, the etalon cavity is incorporated within a micropositioning stage having a platform and a stage which are attached to one another for movement of the frame relative to the platform. In this embodiment, the tube cavity is connected generally between the platform and frame of the micropositioning stage so that an adjustment in length of the tube cavity effects an amplified movement of the frame relative to the platform. The etalon and stage cooperate so that the magnitude of the movement of the frame relative to the platform corresponds with the change in length of the etalon tube cavity as the tube cavity length is adjusted from its reference condition. Therefore, in order to provide a preselected displacement of the stage frame relative to the platform, the tube cavity is adjusted in length by a corresponding amount. This embodiment is particularly useful for calibrating a high accuracy measuring instrument.

The method of the invention includes the steps performed by the system of the invention. Such steps include the providing of a Fabry-Perot etalon of the system and controllably adjusting the length of the etalon cavity so that in order to provide a desired displacement of the object from a reference position, the length of the tube cavity is adjusted by a corresponding amount.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view illustrating schematically a calibration system within which features of the system of the present invention are incorporated.

FIG. **2** is a plan view illustrating schematically a micropositioning stage and etalon assembly of the FIG. **1** system.

FIG. **3** is a schematic view of the etalon assembly utilized in the assembly of FIG. **2** and drawn to a slightly larger scale.

FIG. **4** is a perspective view of an alternative etalon/stage assembly, shown exploded and partially cutaway, capable of being utilized in an alternative system of the invention.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

Turning now to the drawings in greater detail, there is schematically shown in FIG. **1** a system, generally indicated **20**, for use when calibrating a high accuracy measurement instrument **22**. Although the instrument **22** to be calibrated may be any of a number of instruments capable of measuring and/or distinguishing very small increments of distance, the depicted instrument **22** is adapted to measure increments of length along the illustrated X-coordinate axis. To this end, the instrument **22** includes, for example, a probe **24** which is moved between two locations for the purpose of measuring the distance between the two locations.

For purposes of calibrating the instrument **22** and as best shown in FIG. **2**, the system **20** includes means providing a movable target **30** against which the instrument probe **24** is positionable. The instrument **22** is calibrated by arranging the target **30** in an initial reference position and then positioning the probe **24** in a first position at which the probe **24** contacts the target **30**. The target **30** is then moved away from the probe **24** along the X-axis by a known incremental amount. As the target **30** is moved along the X-axis, the probe **24** is