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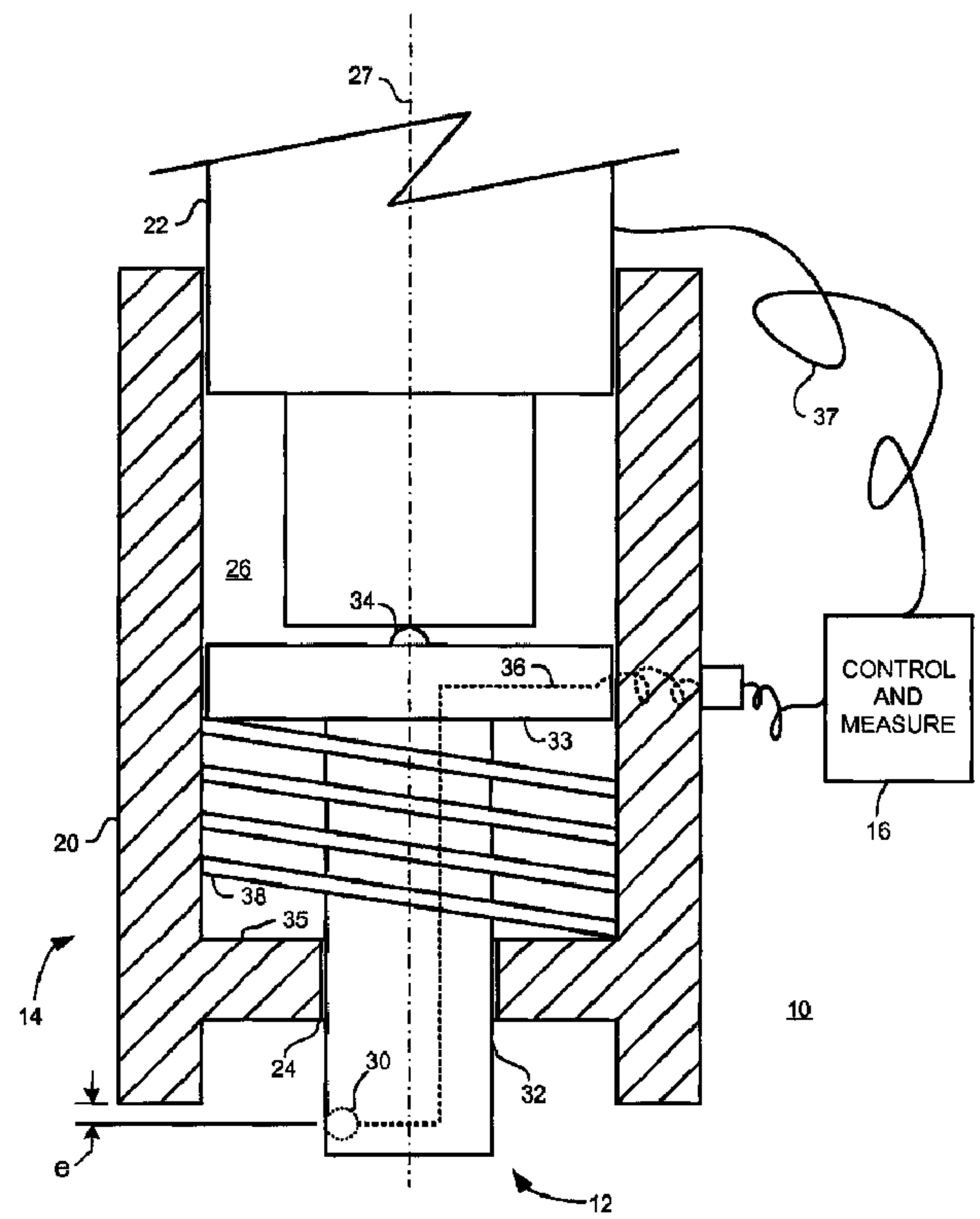
(54) **Titre : APPAREIL ET PROCEDE D'EVALUATION DE COUCHES DANS UNE STRUCTURE MULTICOUCHES**
(54) **Title: APPARATUS AND METHOD FOR EVALUATING LAYERS IN A MULTI-LAYER STRUCTURE**



(57) **Abrégé/Abstract:**
An apparatus for evaluating layers, including interlayer gaps, in a multi- layer structure; the multi-layer structure presenting a plurality of edges generally aligned athwart an axis; the apparatus includes: (a) a sensing unit configured for sensing at least one parameter;

(57) **Abrégé(suite)/Abstract(continued):**
(b) a positioning unit coupled with the sensing unit; the positioning unit being configured to effect moving the sensing unit generally along the axis; and (c) a control unit coupled with at least one of the positioning unit and the sensing unit. The control unit provides an electrical signal to the sensing unit. The control unit monitors changes in the at least one parameter as the sensing unit moves past the plurality of edges. The control unit employs the changes in the at least one parameter to effect the evaluating.

APPARATUS AND METHOD FOR EVALUATING LAYERS IN A MULTI-LAYER STRUCTURE

ABSTRACT

An apparatus for evaluating layers, including interlayer gaps, in a multi-layer structure; the multi-layer structure presenting a plurality of edges generally aligned athwart an axis; the apparatus includes: (a) a sensing unit configured for sensing at least one parameter; (b) a positioning unit coupled with the sensing unit; the positioning unit being configured to effect moving the sensing unit generally along the axis; and (c) a control unit coupled with at least one of the positioning unit and the sensing unit. The control unit provides an electrical signal to the sensing unit. The control unit monitors changes in the at least one parameter as the sensing unit moves past the plurality of edges. The control unit employs the changes in the at least one parameter to effect the evaluating.

APPARATUS AND METHOD FOR EVALUATING LAYERS IN A MULTI-LAYER STRUCTURE

TECHNICAL FIELD

The present invention is directed to material testing apparatuses and methods, and especially to apparatuses and methods for evaluating layers, including interlayer gaps, in a multi-layer structure.

BACKGROUND

In evaluating multi-layer materials one may need to know information relating to layers of the structure, including the sizes of any gaps between layers of the structure. By way of example and not by way of limitation, one may need to know the size of a gap to analyze whether excessive stress exists between layers. Measuring or evaluating layers in a multi-layer structure may be carried out at an edge of the multi-layer structure at which edges of the various layers may be presented. Alternatively, edge evaluation or measurement may be carried out within an aperture that traverses the structure or traverses at least some layers of the structure. Such an aperture may be created for the express purpose of service as a test aperture, or an existing fastener aperture may be employed for measuring or evaluating.

Measurement or other evaluation of layers in a multi-layer structure is not easily carried out if one does not know the thicknesses of various layers in the structure. Access to a free edge of the multi-layer structure may render the evaluating or measuring process easier.

However, in situations in which one is not aware to a certainty of the various thicknesses of layers in a multi-layer structure and especially where no free edge of the structure is presented, there is a need for an apparatus, system and method for measuring or otherwise evaluating layers of a multi-layer structure.

There is a need for an apparatus, system and method for evaluating interlayer gaps in a multi-layer structure.

SUMMARY

An apparatus for evaluating layers, including interlayer gaps, in a multi-layer structure; the multi-layer structure presenting a plurality of edges generally aligned athwart an axis; the apparatus includes: (a) a sensing unit configured for sensing at least one parameter; (b) a positioning unit coupled with the sensing unit; the positioning unit being configured to effect moving the sensing unit generally along the axis; and (c) a control unit coupled with at least one of the positioning unit and the sensing unit. The control unit provides an electrical signal to the sensing unit. In an alternate configuration, the control unit may provide an electrical signal to the sensing unit during the moving. The control unit monitors changes in the at least one parameter as the sensing unit moves past the plurality of edges. The control unit employs the changes in the at least one parameter to effect the evaluating.

A system for determining thicknesses of differing material layers generally along an axis in a multi-layer structure; the thicknesses being bound by a plurality of edges substantially in register crossingly arranged with respect to the axis. For purposes of this disclosure the term "crossingly" may be taken to mean that the edges are not coincident with or parallel with the axis. The system includes: (a) an electromagnetic sensor unit configured for sensing at least one electromagnetic parameter; (b) a positioning unit coupled with the sensor unit; the positioning unit effecting movement of the sensor unit generally along the axis; and (c) a monitoring unit coupled with at least one of the sensor unit and the positioning unit. The monitoring unit provides an electrical input signal to the sensor unit and receives indications of changes in the at least one electromagnetic parameter from the sensor unit as the sensor unit moves along the axis past the plurality of edges. The monitoring unit employs the changes in the at least one electromagnetic parameter to effect the determining.

A method for evaluating layers, including interlayer gaps, in a multi-layer structure to generate a map representing the evaluating; the multi-layer structure presenting a plurality of edges generally aligned athwart an axis; the method including: (a) in no particular order: (**1**) providing a sensing unit configured for sensing at least one parameter; (**2**) providing a positioning unit coupled with the sensing unit; the positioning

unit being configured to effect moving the sensing unit generally parallel with the axis; and (3) providing a control unit coupled with at least one of the positioning unit and the sensing unit; (b) operating the control unit to provide an electrical signal to the sensing unit during the moving; (c) operating the control unit to monitor changes in the at least one parameter as the sensing unit moves past the plurality of edges; (d) operating the control unit to employ the changes in the at least one parameter to effect the evaluating; and (e) employing the evaluating to generate the map.

The present disclosure may provide an apparatus, system and method for measuring or otherwise evaluating layers of a multi-layer structure.

The present disclosure may provide an apparatus, system and method for evaluating interlayer gaps in a multi-layer structure.

The disclosure also describes an apparatus for measuring thicknesses of interlayer gaps in a multi-layer structure, the multi-layer structure presenting a plurality of edges generally aligned athwart an axis and that substantially surround an aperture traversing at least a portion of the multilayer structure generally parallel with the axis. The apparatus includes (a) a sensing unit configured for sensing at least one parameter and (b) a positioning unit coupled with the sensing unit. The positioning unit includes a positioning frame selectively coupled to the multi-layer structure such that the positioning frame substantially circumscribes the aperture when coupled to the multi-layer structure and such that the sensing unit is substantially co-axial with the axis. The positioning unit is also configured to effect movement of the sensing unit past the plurality of edges in a direction generally along the axis. The apparatus also includes (c) a control unit coupled with at least one of the positioning unit and the sensing unit. The control unit is configured to provide an electrical signal to the sensing unit, is configured to monitor changes in the at least one parameter as the sensing unit moves along the axis past the plurality of edges, and is configured to employ the changes in the at least one parameter to effect the measuring.

The positioning unit may be further configured to indicate displacement of the sensing unit effected by the positioning unit and the control unit may be further configured to employ the indicated displacement in the measuring.

The positioning unit may be embodied in a micrometer unit.

The sensing unit may include an eddy current coil unit.

The at least one parameter may be impedance experienced by the eddy current coil unit.

The positioning unit may be configured to effect movement of the sensing unit past the plurality of edges by being configured to effect movement of the sensing unit with a clearance between the sensing unit and the multi-layer structure.

The control unit may be further configured to employ the changes in the at least one parameter to effect measuring of a distance between adjacent layers of the multi-layer structure and a thickness of layers of the multi-layer structure.

The positioning unit may be configured to effect rotation of the sensing unit about the axis.

The control unit may be configured to monitor the changes in the at least one parameter as the sensing unit moves past the plurality of edges and as the sensing unit rotates within the aperture.

The disclosure also describes a system for determining thicknesses of differing material layers generally along an axis in a multi-layer structure, the thicknesses being bound by a plurality of edges substantially in register crossingly arranged with respect to the axis and that substantially surround an aperture traversing at least a portion of the multilayer structure generally parallel with the axis. The system includes (a) an electromagnetic sensor unit configured for sensing at least one electromagnetic parameter and (b) a positioning unit coupled with the electromagnetic sensor unit. The positioning unit includes a positioning frame selectively coupled to the multi-layer structure such that the positioning frame substantially circumscribes the aperture when coupled to the multilayer structure and such that the electromagnetic sensor unit is aligned substantially coaxially with the axis. The positioning unit is also configured to effect movement of the electromagnetic sensor unit past the plurality of edges in a direction generally along the axis. The system also includes (c) a monitoring unit coupled with at least one of the electromagnetic sensor unit and the positioning unit. The monitoring unit is configured to provide an electrical input signal to the electromagnetic sensor unit and to receive indications of changes in the at least one electromagnetic parameter from the electromagnetic sensor unit as the electromagnetic sensor unit moves along the axis past the plurality of edges. The monitoring unit is also configured to employ the changes in the at least one electromagnetic parameter to effect the determining.

The positioning unit may be further configured to indicate displacement of the electromagnetic sensor unit effected by the positioning unit and the monitoring unit may be further configured to employ the indicated displacement in the determining.

The positioning unit may be embodied in a micrometer unit.

The electromagnetic sensor unit may include an eddy current coil unit.

The at least one electromagnetic parameter may be impedance experienced by the eddy current coil unit.

The positioning unit may be configured to effect movement of the electromagnetic sensor unit past the plurality of edges by being configured to effect movement of the electromagnetic sensor unit past the plurality of edges with a clearance between the electromagnetic sensor unit and the multi-layer structure.

The monitoring unit may be configured to employ the changes in the at least one electromagnetic parameter to effect determining of a distance between adjacent differing material layers of the multi-layer structure and the determining of the thicknesses of the differing material layers of the multi-layer structure.

The positioning unit may be configured to effect rotation of the electromagnetic sensor unit about the axis.

The monitoring unit may be configured to receive the indications of the changes in the at least one electromagnetic parameter as the electromagnetic sensor unit moves past the plurality of edges and as the electromagnetic sensor unit rotates within the aperture.

The disclosure also describes a method for measuring thicknesses of interlayer gaps in a multi-layer structure to generate a map representing the measuring, the multi-layer structure presenting a plurality of edges generally aligned athwart an axis and that substantially surround an aperture traversing at least a portion of the multilayer structure generally parallel with the axis. The method involves (a) causing a positioning unit including a positioning frame substantially circumscribing the aperture to align a sensing unit configured for sensing at least one parameter substantially coaxially with the axis, (b) causing the positioning unit to effect movement of the sensing unit past the plurality of edges in a direction generally parallel with the axis through the aperture, (c) causing a control unit to provide an electrical signal to the sensing unit and to monitor changes in the least one parameter as the sensing unit moves along the axis past the plurality of edges, (d) causing the control unit to employ the changes in the at least one parameter to effect the measuring, and (e) causing the control unit to employ the measuring to generate the map.

The method may further involve causing the positioning unit to measure displacement of the sensing unit effected by the positioning unit and causing the control unit to employ the measured displacement in the measuring of thicknesses.

The positioning unit may be a micrometer unit.

The sensing unit may include an eddy current coil unit.

The at least one parameter may be impedance experienced by the eddy current coil unit.

Causing the positioning unit to effect movement of the sensing unit past the plurality of edges may involve causing the positioning unit to effect movement of the sensing unit past the plurality of edges with a clearance between the sensing unit and the multi-layer structure.

The method may further involve causing the control unit to employ the changes in the at least one parameter to effect measuring of a distance between adjacent layers of the multi-layer structure and a thickness of layers of the multi-layer structure.

The method may further involve causing the positioning unit to effect rotation of the sensing unit about the axis.

Causing the control unit to monitor the changes in the at least one parameter may involve causing the control unit to monitor the changes in the at least one parameter as the sensing unit moves past the plurality of edges and as the sensing unit rotates within the aperture.

Further features of the present disclosure will be apparent from the following specification and claims when considered in connection with the accompanying drawings, in which like elements are labeled using like reference numerals in the various figures, illustrating the preferred embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partial section plan view of an exemplary apparatus and system for evaluating layers of a multi-layer structure according to the teachings of the present disclosure.

FIG. **2** is a schematic diagram illustrating employment of the present disclosure to evaluate layers of a multi-layer structure.

FIG. **3** is a schematic diagram illustrating employment of the present disclosure to evaluate layers of a multi-layer structure at different clock positions around an aperture.

FIG. **4** is a flow diagram illustrating the method of the present disclosure.

DETAILED DESCRIPTION

The terms “coupled” and “connected”, along with their derivatives, may be used herein. It should be understood that these terms are not intended as synonyms for each other. Rather, in particular embodiments, "connected" may be used to indicate that two or more elements are in direct physical or electrical contact with each other. "Coupled" may be used to indicated that two or more elements are in either direct or indirect (with other intervening elements between them) physical or electrical contact with each other, or that the two or more elements co-operate or interact with each other (e.g. as in a cause and effect relationship).

FIG. **1** is a partial section plan view of an exemplary apparatus and system for evaluating layers of a multi-layer structure according to the teachings of the present disclosure. As used herein, the term "exemplary" indicates an example and not necessarily an ideal. In FIG. **1**, an apparatus **10** for evaluating interlayer gaps in a multi-layer structure may include a sensing unit **12**, a positioning unit **14** and a control unit **16**.

Positioning unit **14** may include a positioning frame **20** (shown in section in FIG. **1**) and a moving unit **22**. Positioning frame **20** may present an aperture **24** communicating with a well **26**. Aperture **24** and well **26** may be substantially symmetrically oriented about an axis **27**.

Sensing unit **12** may include a sensor unit **30** mounted with a sensor carrier **32**. Sensor carrier **32** may be slidingly received within aperture **24** and bear against moving unit **22**. A bearing element **34** may provide substantially all contact between moving unit **22** and sensor carrier **32**. By way of example and not by way of limitation, bearing element **34** may be embodied in a ball bearing nestingly engaged with one of moving unit **22** and sensor carrier **32** or bearing element **34** may be embodied in an integrally formed protuberance extending from one of moving unit **22** and sensor carrier **32**. Sensor unit **30** may be coupled with control unit **16** such as, by way of example and not by way of limitation, via an electrical connecting conductor **36**. Control unit **16** may also be coupled with moving unit **22** such as, by way of example and not by way of limitation, via an electrical connecting conductor **37**. Control unit **16** may provide an electrical signal to sensor unit **30**. In an alternate configuration, control unit **16** may provide an electrical signal to sensor unit **30** during a moving of moving unit **22**. The electrical signal may be an eddy current. Sensor unit **30** may be embodied in an eddy current coil unit. Such an eddy current coil unit is known to those skilled in the art of sensor unit design and is therefore not illustrated in detail in FIG. **1**.

A bias member **38** may be located between a shoulder portion **33** of sensor carrier **32** and a stop **35** associated with positioning frame **20**. Stop **35** may be, by way of example and not by way of limitation, integrally formed within well **26**, affixed within well **26** or otherwise substantially immovably located to provide a stop for bias member **38**. Bias member **38** may be oriented to urge sensor carrier **32** toward an at-rest orientation. In the exemplary embodiment illustrated in FIG. **1**, bias member **38** may be understood to be embodied in a helical compression spring urging sensor carrier **32** upward in FIG. **1** to reduce the extension "e" by sensor unit **30** beyond positioning frame **20**.

Moving unit **22** may be embodied, by way of example and not by way of limitation, in a depth gauge or a micrometer unit. Moving unit **22** may be advanced within well **26** against a bias force provided by bias unit **38** to effect advancing sensor carrier **32** substantially along axis **27** in a manner to increase extension "e" by sensor unit **30**. Details regarding interaction among positioning unit **22**, sensor unit **30** and a multi-layer structure are described in further detail in connection with FIG. **2**.

FIG. **2** is a schematic diagram illustrating employment of the present disclosure to evaluate layers of a multi-layer structure. In FIG. **2**, an apparatus **10** configured generally as described in connection with FIG. **1** is illustrated in an installed orientation for evaluating a multi-layer structure **40**.

Multi-layer structure **40** may include a first layer **42** extending a depth d_1 from a top surface **41**. A second layer **44** may extend between a distance d_2 and a distance d_3 from top surface **41**. A third layer **46** may extend between a distance d_4 and a distance d_5 from top surface **41**. A fourth layer **48** may extend between a distance d_6 and a distance d_7 from top surface **41**.

Layers **42**, **44** may establish a gap **43** between distance d_1 and distance d_2 from top surface **41**. Layers **44**, **46** may establish an interlayer **45** between distance d_3 and distance d_4 from top surface **41**. Layers **46**, **48** may establish an interlayer **47** between distance d_5 and distance d_6 from top surface **41**. Interlayers **45**, **47** may be embodied in different materials than adjacent layers **44**, **46**, **48**. Interlayers **45**, **47** and layers **44**, **46**, **48** may each be embodied in a different material.

Multi-layer structure **40** may present an aperture **50** substantially oriented about an axis **52**. Layers **44**, **46**, **48** may thus present a plurality of edges generally aligned athwart axis **52**. The plurality of edges may be substantially in register crossingly arranged with respect to axis **52**.

To carry out an evaluation of multi-layer structure **40** a user may advance the moving unit associated with apparatus **10** (not visible in FIG. **2**; see moving unit **22**, FIG **1**) to move sensor unit **54** generally parallel with axis **52** in directions indicated by arrows **56** to vary extension e from layer **42**.

As sensor unit **54** may be moved to traverse multi-layer structure **40**, sensor unit **54** may be oriented adjacent to differing materials exhibiting differing characteristics sensed by sensor unit **54**. By way of example and not by way of limitation, sensor unit **54** may be configured to cooperate with a control unit (not visible in FIG. **2**; see control unit **16**, FIG **1**) to measure differences in impedance. This arrangement may be effected by configuring sensor unit **54** substantially as a type of a Wheatstone bridge with at least one portion of the bridge adjacent to the materials being evaluated. A Wheatstone bridge may be employed to measure an unknown electrical resistance or impedance by balancing two portions or legs of a bridge circuit, one portion of which includes the unknown impedance. Details of such a Wheatstone bridge are not described here but are within the understanding of one skilled in the art of sensor design.

As sensor unit **54** traverses multi-layer structure **40** via aperture **50**, a change in impedance may be sensed by sensor unit **54** as sensor unit **54** passes each of layers **42**, **44**, **46**, **48**, gap **43** and interlayers **45**, **47**. By noting the depth to which apparatus **10** extends sensor unit **54** into aperture **50** as impedance sensed by sensor unit **54** varies, one may ascertain the thickness of each layer **42**, **44**, **46**, **48**, gap **43** and each interlayer **45**, **47**.

Sensor unit **54** may be configured for sensing another parameter than impedance such as, by way of further example and not by way of limitation, magnetic flux or capacitance. The size such as, by way of example and not by way of limitation, cross-section of sensor unit **54** taken along a plane substantially parallel with axis **52** may affect the resolution of changes that may be determinable by sensor unit **54**. It may be that a smaller cross-section may permit finer discrimination of locations where changes in a measured parameter may occur, such as a transition from a material in a layer **44** to an air gap **43** as at distance d_1 from upper surface **41**.

One skilled in the art of sensor design may also understand that apparatus **10** may operate substantially as described in connection with FIG. **2** in a situation where an exposed edge of multi-layer structure **40** is presented for evaluation rather than the interior surrounding edge of an aperture traversing multi-layer structure **40**.

FIG. **3** is a schematic diagram illustrating employment of the present disclosure to evaluate layers of a multi-layer structure at different clock positions around an aperture. In FIG. **3**, a multi-layer structure **60** may include material layers **62**, **64** separated by an air gap **63**. An aperture **71** substantially symmetrical about an axis **72** may traverse multi-layer structure **60**.

An apparatus configured substantially similarly to apparatus **10** (not shown in FIG. **3**; see FIGs. **1** and **2**) may be installed in an aperture **71** in a manner similar to the installation illustrated in FIG. **2** with respect to aperture **50**. A series of evaluations may be performed by the inserted apparatus **10** generally as described in connection with FIG. **2**. However, more than one series of evaluations may be performed in order to gain a more thorough evaluation of the extent of air gap **62**. Such a more thorough evaluation maybe carried out by performing a series of evaluative readings of an electrical parameter, such as impedance, at several positions around the perimeter of aperture **71**. By way of example and not by way of limitation, one may perform a series of evaluative readings at a twelve o'clock position **72**. After completing evaluations at twelve o'clock position **72**, apparatus **10** may be rotated to permit performance of a series of evaluative readings at another clock position, such as at three o'clock position **74**. Alternatively, a portion of apparatus **10** such as moving unit **22** or sensing unit **12** may be rotated to permit evaluation at three o'clock position **74**. After completing evaluations at three o'clock position **74**, apparatus **10** may be rotated to permit performance of a series of evaluative readings at another clock position, such as at eight o'clock position **76**. Performing such a series of evaluations at different clock positions about aperture **71** may permit one to ascertain whether separation of air gap **63** from layers **62**, **64** is not uniform about aperture **71**, as is the case illustrated in FIG. **3**.

FIG. **4** is a flow diagram illustrating the method of the present disclosure. In FIG. **4**, a method **100** for evaluating interlayer gaps in a multi-layer structure to generate a map representing said evaluating begins at a START locus **102**. The multi-layer structure presents a plurality of edges generally aligned athwart an axis.

Method **100** continues with, in no particular order: (**1**) providing a sensing unit configured for sensing at least one parameter, as indicated by a block **104**; (**2**) providing a positioning unit coupled with the sensing unit, as indicated by a block **106**; the positioning unit may be configured to effect moving the sensing unit generally parallel with the axis; and (**3**) providing a control unit coupled with at least one of the positioning unit and the sensing unit, as indicated by a block **108**.

Method **100** continues with operating the control unit to provide an electrical signal to the sensing unit, as indicated by a block **110**. Alternatively, the electrical signal may be provided to the sensing unit during the moving of the sensing unit.

Method **100** continues with operating the control unit to monitor changes in the at least one parameter as the sensing unit moves past the plurality of edges, as indicated by a block **112**.

Method **100** continues with operating the control unit to employ the changes in the at least one parameter to effect the evaluating, as indicated by a block **114**.

Method **100** continues with employing the evaluating to generate the map, as indicated by a block **116**. The map may be in the form of a graphic display, a tabular representation of a graphic display or another format useful to a user. The map may be stored in a storage unit for later use or evaluation.

Method **100** terminates at an END locus **118**.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.

THE SUBJECT-MATTER OF THE INVENTION FOR WHICH AN EXCLUSIVE PRIVILEGE OR PROPERTY IS CLAIMED IS DEFINED AS FOLLOWS:

1. An apparatus for measuring thicknesses of interlayer gaps in a multi-layer structure, the multi-layer structure presenting a plurality of edges generally aligned athwart an axis and that substantially surround an aperture traversing at least a portion of the multilayer structure generally parallel with the axis, the apparatus comprising:

    (a) a sensing unit configured for sensing at least one parameter;

    (b) a positioning unit coupled with said sensing unit; said positioning unit comprising a positioning frame selectively coupled to the multi-layer structure such that said positioning frame substantially circumscribes the aperture when coupled to the multi-layer structure and such that said sensing unit is substantially co-axial with the axis; and said positioning unit configured to effect movement of said sensing unit past the plurality of edges in a direction generally along the axis; and

    (c) a control unit coupled with at least one of said positioning unit and said sensing unit; said control unit configured to provide an electrical signal to said sensing unit, configured to monitor changes in the at least one parameter as said sensing unit moves along the axis past the plurality of edges, and configured to employ the changes in the at least one parameter to effect said measuring.

2. The apparatus of Claim **1** wherein said positioning unit is further configured to indicate displacement of said sensing unit effected by said positioning unit and said control unit is further configured to employ the indicated displacement in said measuring.

3. The apparatus of Claim **1** or **2** wherein said positioning unit is embodied in a micrometer unit.

4. The apparatus of Claim **1**, **2**, or **3** wherein the sensing unit includes an eddy current coil unit.

5. The apparatus of Claim **4** wherein the at least one parameter is impedance experienced by said eddy current coil unit.

6. The apparatus of any one of claims **1** to **5** wherein said positioning unit configured to effect movement of said sensing unit past said plurality of edges comprises said positioning unit configured to effect movement of said sensing unit with a clearance between said sensing unit and the multi-layer structure.

7. The apparatus of any one of claims **1** to **6** wherein said control unit is further configured to employ the changes in the at least one parameter to effect measuring of a distance between adjacent layers of the multi-layer structure and a thickness of layers of the multi-layer structure.

8. The apparatus of any one of claims **1** to **7** wherein said positioning unit is configured to effect rotation of said sensing unit about the axis.

9. The apparatus of claim **8** wherein said control unit is configured to monitor the changes in the at least one parameter as said sensing unit moves past the plurality of edges and as said sensing unit rotates within the aperture.

10. A system for determining thicknesses of differing material layers generally along an axis in a multi-layer structure, said thicknesses being bound by a plurality of edges substantially in register crossingly arranged with respect to the axis and that substantially surround an aperture traversing at least a portion of the multilayer structure generally parallel with the axis, the system comprising:

(a) an electromagnetic sensor unit configured for sensing at least one electromagnetic parameter;

(b) a positioning unit coupled with said electromagnetic sensor unit; said positioning unit comprising a positioning frame selectively coupled to the multi-layer structure such that said positioning frame substantially circumscribes the aperture when coupled to the multilayer structure and such that said electromagnetic sensor unit is aligned substantially coaxially with the axis; and said positioning unit configured to effect movement of said electromagnetic sensor unit past the plurality of edges in a direction generally along the axis; and

(c) a monitoring unit coupled with at least one of said electromagnetic sensor unit and said positioning unit; said monitoring unit configured to provide an electrical input signal to said electromagnetic sensor unit and to receive indications of changes in the at least one electromagnetic parameter from said electromagnetic sensor unit as said electromagnetic sensor unit moves along the axis past the plurality of edges; said monitoring unit configured to employ the changes in the at least one electromagnetic parameter to effect said determining.

11. The system of Claim **10** wherein said positioning unit is further configured to indicate displacement of said electromagnetic sensor unit effected by said positioning unit and said monitoring unit is further configured to employ the indicated displacement in said determining.

12. The system of Claim **10** or **11** wherein said positioning unit is embodied in a micrometer unit.

13. The system of Claim **10**, **11**, or **12** wherein said electromagnetic sensor unit includes an eddy current coil unit.

14. The system of Claim **13** wherein the at least one electromagnetic parameter is impedance experienced by said eddy current coil unit.

15. The system of any one of claims **10** to **14** wherein said positioning unit configured to effect movement of said electromagnetic sensor unit past the plurality of edges comprises said positioning unit configured to effect movement of said electromagnetic sensor unit past the plurality of edges with a clearance between said electromagnetic sensor unit and the multi-layer structure.

16. The system of any one of claims **10** to **15** wherein said monitoring unit is configured to employ the changes in the at least one electromagnetic parameter to effect determining of a distance between adjacent differing material layers of the multi-layer structure and said determining of the thicknesses of the differing material layers of said multi-layer structure.

17. The system of any one of claims **10** to **16** wherein said positioning unit is configured to effect rotation of said electromagnetic sensor unit about the axis.

18. The system of claim **17** wherein said monitoring unit is configured to receive the indications of the changes in the at least one electromagnetic parameter as said electromagnetic sensor unit moves past the plurality of edges and as said electromagnetic sensor unit rotates within the aperture.

19. A method for measuring thicknesses of interlayer gaps in a multi-layer structure to generate a map representing said measuring, said multi-layer structure presenting a plurality of edges generally aligned athwart an axis and that substantially surround an aperture traversing at least a portion of said multilayer structure generally parallel with said axis, the method comprising:

(a) causing a positioning unit comprising a positioning frame substantially circumscribing the aperture to align a sensing unit configured for sensing at least one parameter substantially coaxially with the axis;

(b) causing said positioning unit to effect movement of the sensing unit past the plurality of edges in a direction generally parallel with the axis through the aperture;

(c) causing a control unit to provide an electrical signal to the sensing unit and to monitor changes in the least one parameter as the sensing unit moves along the axis past the plurality of edges;

(d) causing said control unit to employ the changes in the at least one parameter to effect said measuring; and

(e) causing said control unit to employ said measuring to generate the map.

20. The method of Claim **19** further comprising causing said positioning unit to measure displacement of said sensing unit effected by said positioning unit and causing said control unit to employ the measured displacement in said measuring of thicknesses.

21. The method of claim **20** wherein said positioning unit is a micrometer unit.

22. The method of Claim **19**, **20**, or **21** wherein said sensing unit includes an eddy current coil unit.

23. The method of Claim **22** wherein the at least one parameter is impedance experienced by said eddy current coil unit.

24. The method of any one of claims **19** to **23** wherein causing said positioning unit to effect movement of said sensing unit past the plurality of edges comprises causing said positioning unit to effect movement of said sensing unit past the plurality of edges with a clearance between said sensing unit and the multi-layer structure.

25. The method of any one of claims **19** to **24** further comprising causing said control unit to employ the changes in the at least one parameter to effect measuring of a distance between adjacent layers of the multi-layer structure and a thickness of layers of the multi-layer structure.

26. The method of any one of claims **19** to **25** further comprising causing said positioning unit to effect rotation of said sensing unit about the axis.

27. The method of claim **26** wherein causing said control unit to monitor the changes in the at least one parameter comprises causing said control unit to monitor the changes in the at least one parameter as said sensing unit moves past the plurality of edges and as said sensing unit rotates within the aperture.

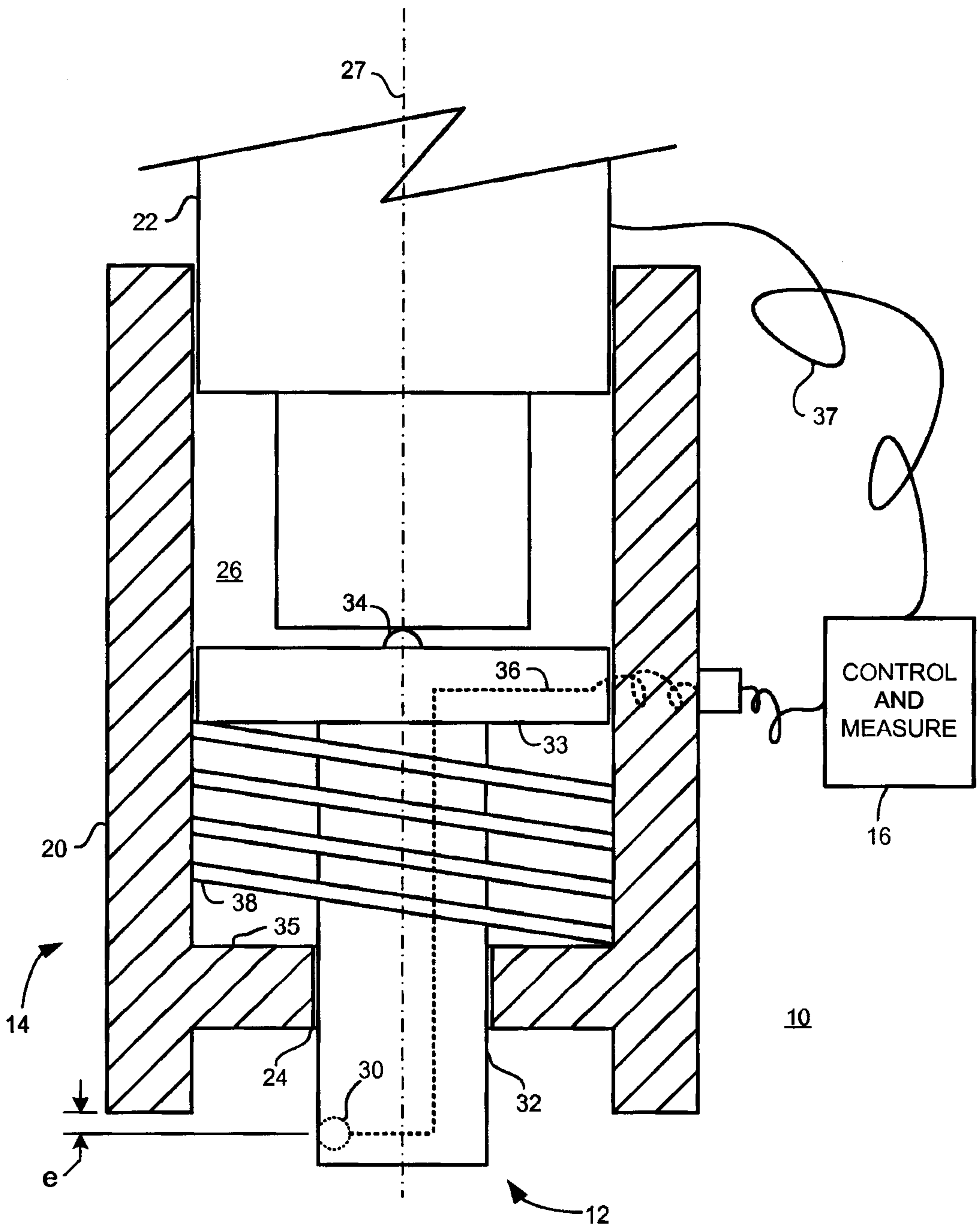

27
22
37
26
34
36
33
CONTROL AND MEASURE
16
20
38
35
14
10
24
30
32
e
12

FIG. 1

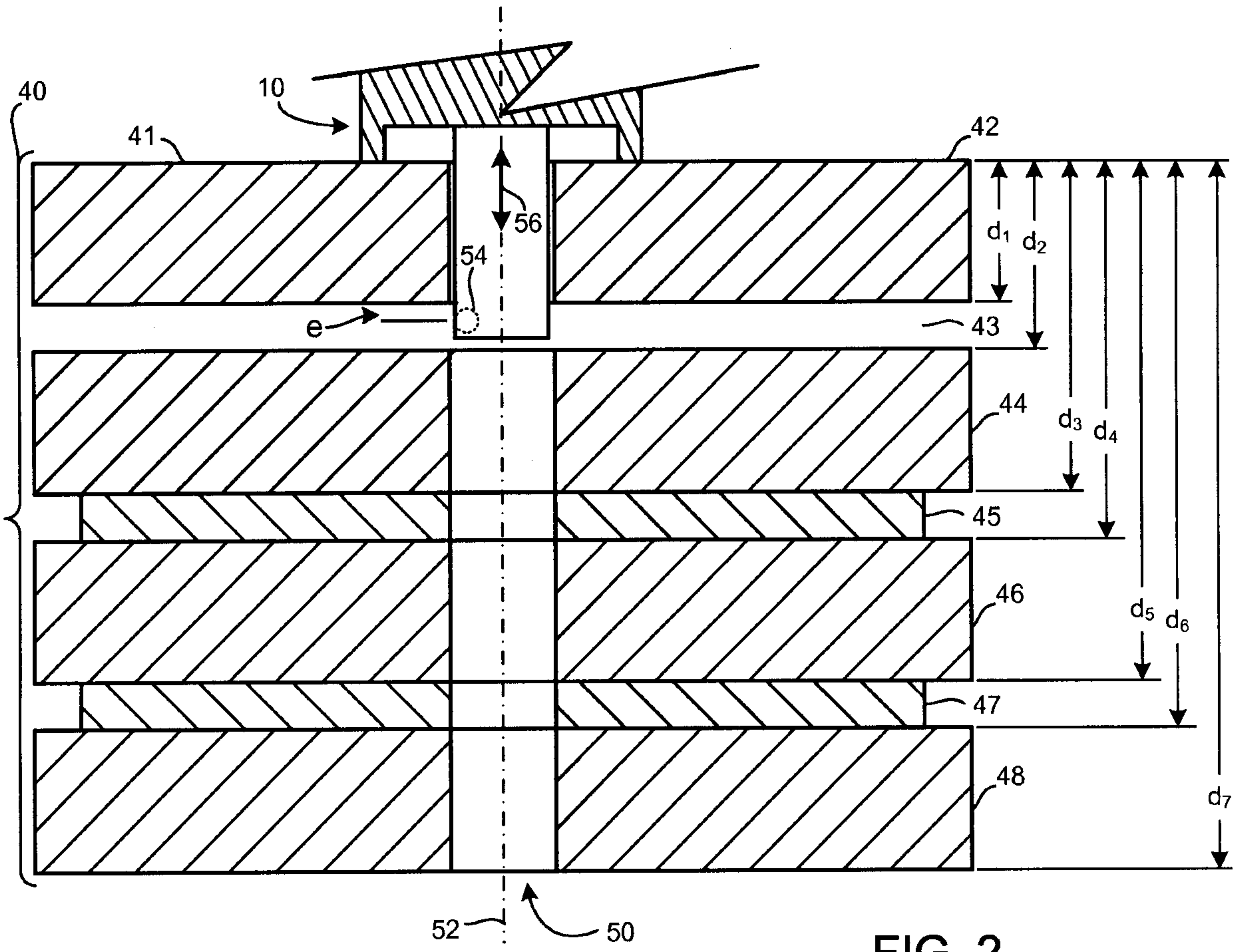

40
10
41
42
56
54
e
43
44
45
46
47
48
52
50
d1
d2
d3
d4
d5
d6
d7

FIG. 2

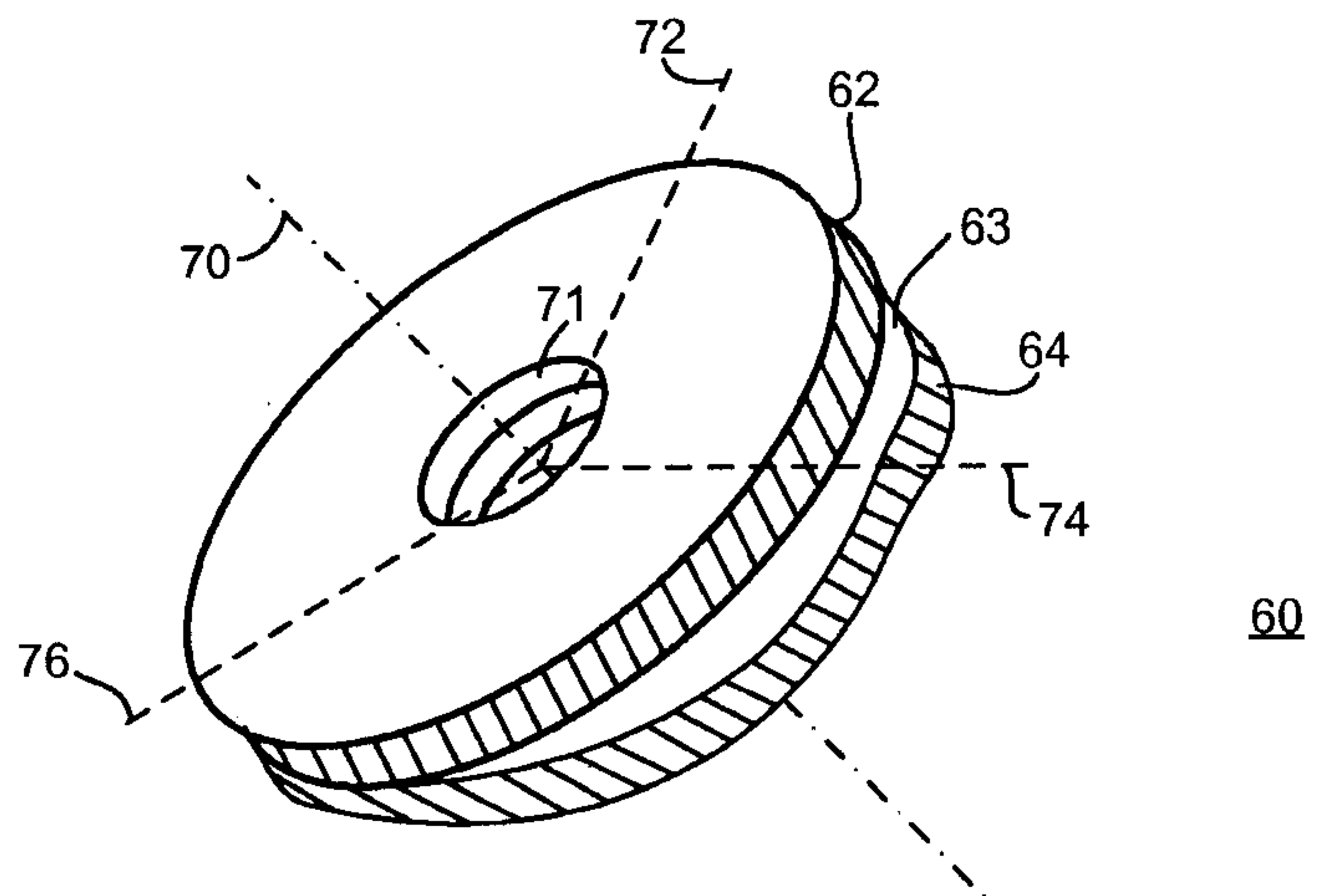

72
62
70
71
63
64
74
60
76

FIG. 3

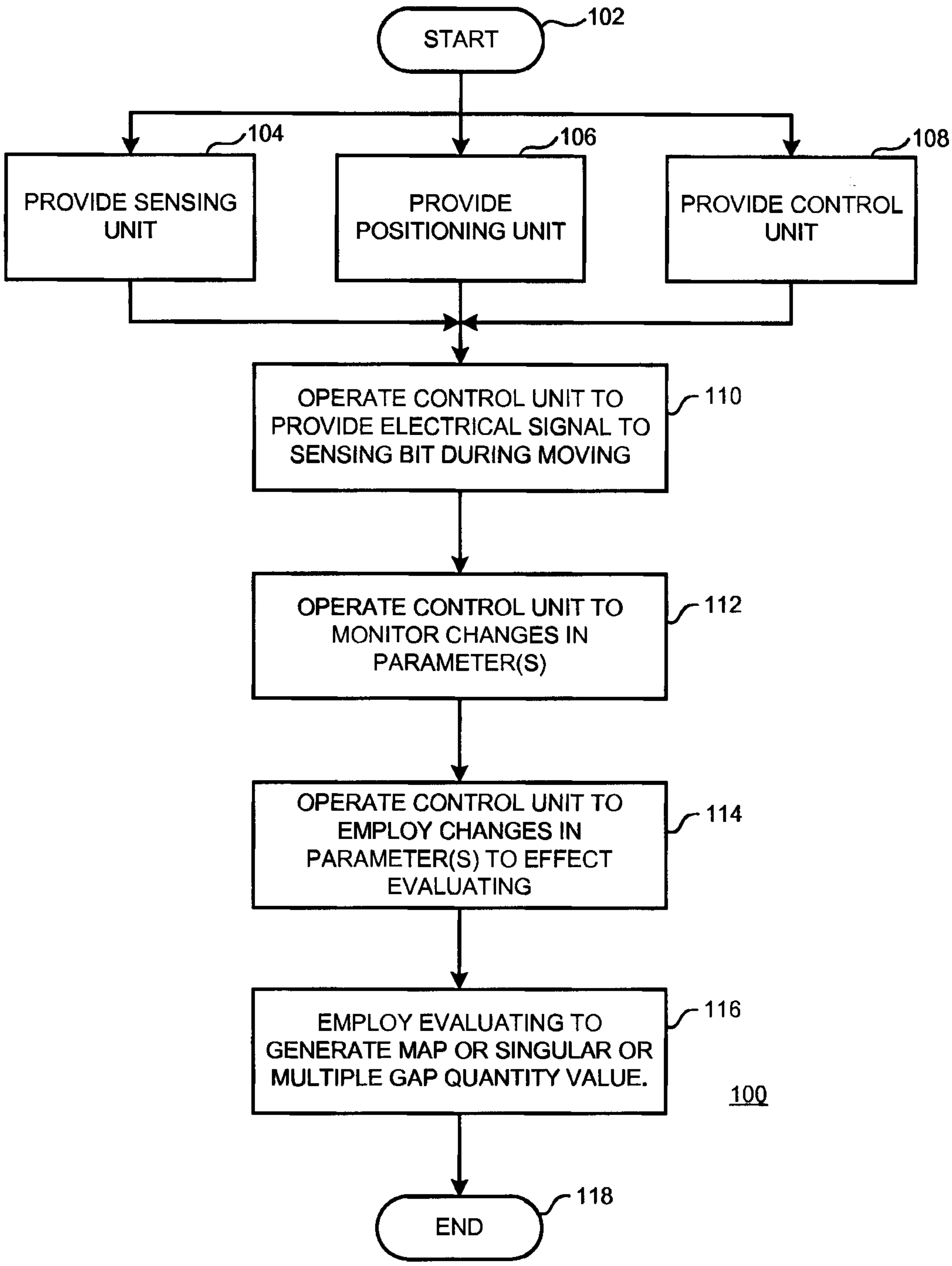
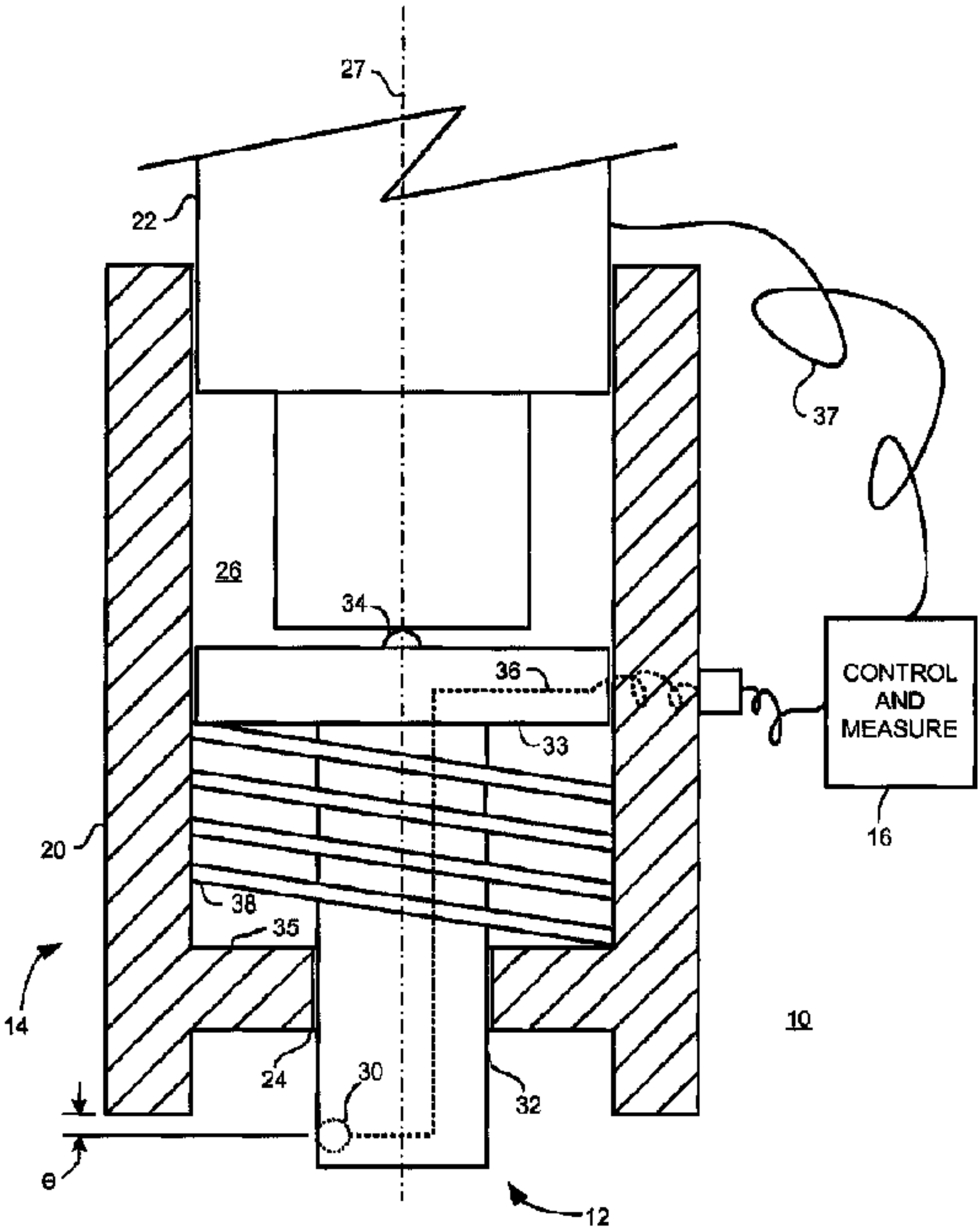

START
102
PROVIDE SENSING UNIT
104
PROVIDE POSITIONING UNIT
106
PROVIDE CONTROL UNIT
108
OPERATE CONTROL UNIT TO PROVIDE ELECTRICAL SIGNAL TO SENSING BIT DURING MOVING
110
OPERATE CONTROL UNIT TO MONITOR CHANGES IN PARAMETER(S)
112
OPERATE CONTROL UNIT TO EMPLOY CHANGES IN PARAMETER(S) TO EFFECT EVALUATING
114
EMPLOY EVALUATING TO GENERATE MAP OR SINGULAR OR MULTIPLE GAP QUANTITY VALUE.
116
100
END
118

FIG. 4


27
22
37
26
34
36
CONTROL
AND
MEASURE
33
20
16
38
35
14
10
30
24
32
θ
12