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Ratzlaff

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[54] **VARIABLE RESISTOR ASSEMBLY**

[75] Inventor: **Harold J. Ratzlaff**, Morrison, Ill.

[73] Assignee: **General Electric Company**, Fort Wayne, Ind.

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[52] **U.S. Cl.** **338/89**; 338/161; 338/167; 338/202; 338/283

[51] **Int. Cl.²** **H01C 9/02**

[58] **Field of Search** 338/89, 90, 138, 142, 160, 338/162, 165, 170, 217, 292, 333, 283, 287, 293, 316, 161, 167, 169, 184, 202

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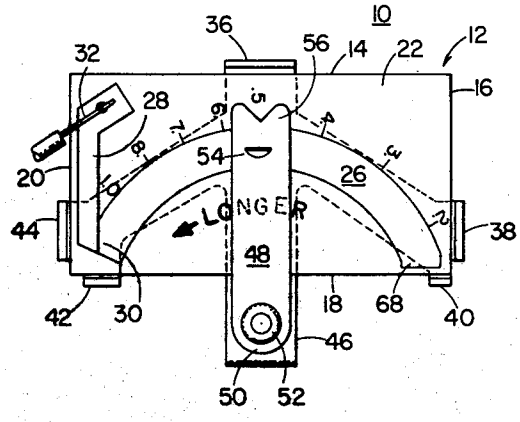
Primary Examiner—Bruce A. Reynolds
Attorney, Agent, or Firm—Joseph E. Papin

[57] **ABSTRACT**

A variable resistor assembly which may be used as a preheat resistor for a room thermostat. The resistor comprises a substrate member having an elongate, arcuate strip of resistance material coated thereon, the substrate member being engaged by a support member. An elongate leaf spring wiper element is pivotally mounted on the support member and has a contact element engaging the resistance strip and traversing the same in an arcuate path, the wiper element resiliently maintaining the substrate member on the support member. Equally spaced, transversely extending slots are alternately formed in the opposite side edges of the strip which are progressively deeper from one end of the strip to the other and some of which cross the contact element path thereby varying the resistance along the path in a logarithmic function.

24 Claims, 3 Drawing Figures



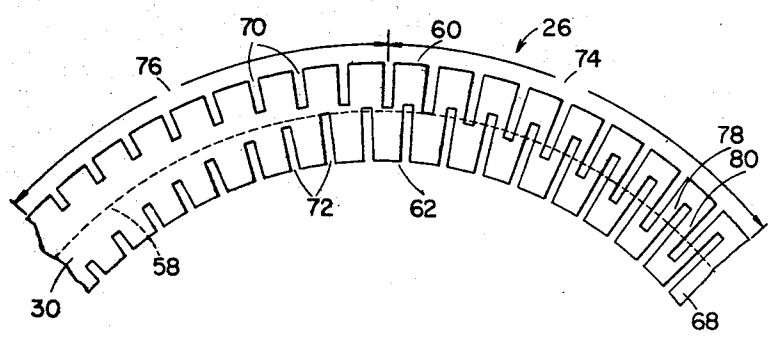


FIG. 1

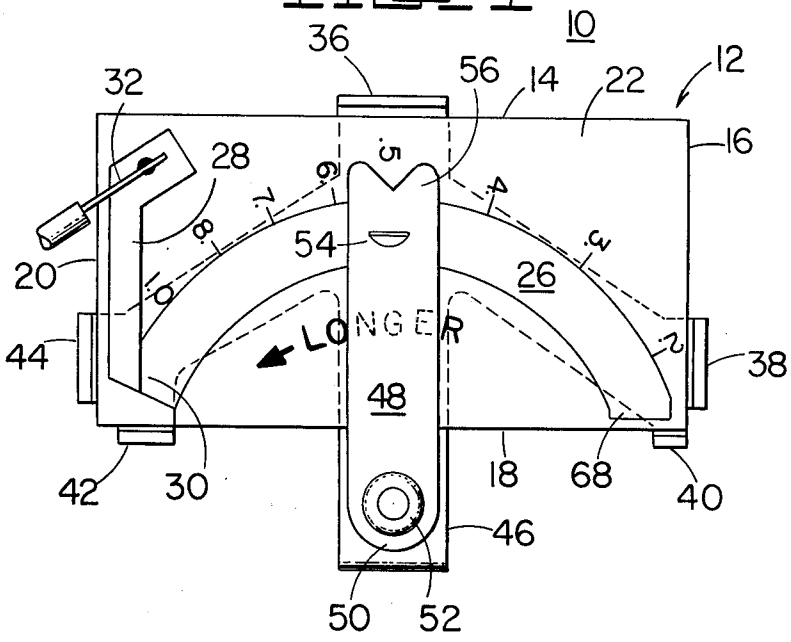


FIG. 2

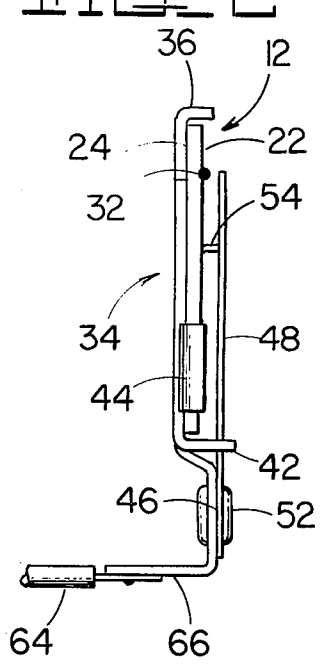
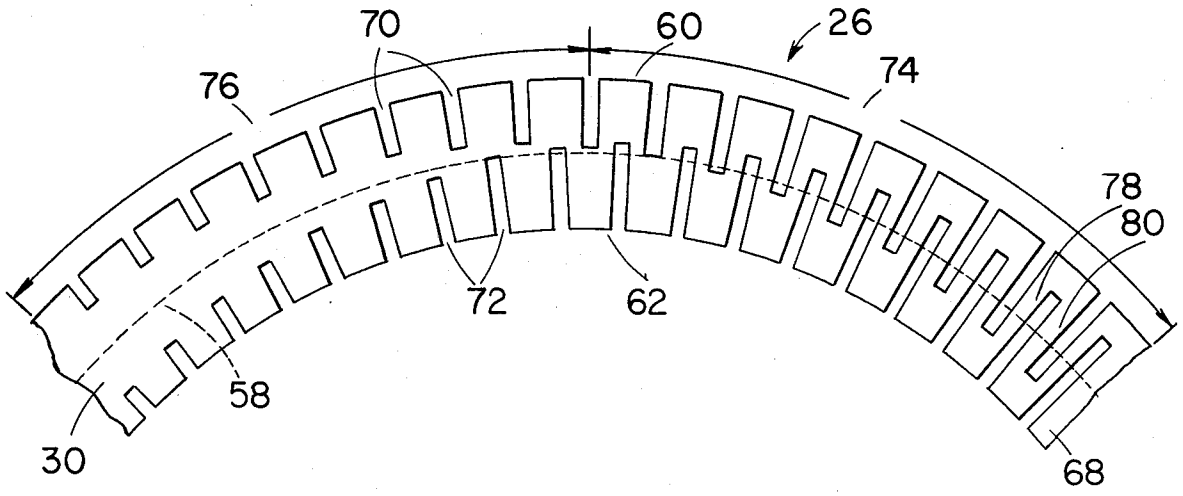


FIG. 3



VARIABLE RESISTOR ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to variable resistor assemblies of the type having a resistance strip deposited on a substrate member, and more particularly to such a variable resistor assembly wherein a wiper element maintains the substrate member on a support member and wherein slots are formed in the strip thereby to vary the resistance along the path of movement of the wiper in a logarithmic function.

2. Description of the Prior Art

Variable resistors or potentiometers have been provided comprising an elongate strip of resistance material coated on an insulative substrate with a wiper contact being selectively movable along the strip.

The provision of slots in a strip of resistance material coated on an insulative substrate in order to vary the resistance along the path of a wiper contact in accordance with a predetermined function is disclosed in U.S. Pat. No. 2,597,674 assigned to the assignee of the present application.

It is desirable to provide an improved, simplified variable resistor assembly of the type employing a strip of resistance material coated on an insulative substrate, and also to provide for variation of the resistance in accordance with a logarithmic function thereby rendering the resistor assembly particularly useful as a preheat resistor for room thermostats.

It is accordingly an object of the invention to provide an improved variable resistor assembly.

Another object of the invention is to provide an improved variable resistor assembly of the type incorporating a strip of resistance material coated on an insulative substrate.

A further object of the invention is to provide an improved variable resistor wherein the resistance is varied in accordance with a logarithmic function.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings.

In general, a variable resistor assembly in one form of the invention has a generally planar substrate member and a resistance material defining a resistance path on the substrate member. Means for supporting the substrate member includes means for maintaining the substrate member against displacement generally in its plane on the supporting means and also means movable on the supporting means and generally along the resistance path in contacting engagement with the resistance material for varying its resistance and for maintaining the substrate member against displacement generally from its plane on the supporting means.

Also in general and in one form of the invention, a variable resistor assembly has a substrate member having at least one marginal edge, and a resistance material defining a resistance path is provided on the substrate member. Means is provided for supporting the substrate member, and means is adjustably movable in contacting engagement with the resistance material generally along its path for varying its resistance and for urging the substrate member toward the supporting means. The supporting means includes means engaged

with the at least one marginal edge for generally retaining the substrate member against displacement on the supporting means upon the adjusting movement of the varying and urging means along the path of the resistance material in the contacting engagement therewith.

Further in general, a variable resistor assembly in one form of the invention has a substrate member with at least a pair of generally opposite marginal edges. A resistance material on the substrate member defines a resistance path in accordance with a predetermined function, and means is movable on the support and in contacting engagement with the resistance material generally along its path for varying its resistance and for urging the substrate toward seating engagement with the support. The support includes at least a pair of means for respective abutment with the at least pair of marginal edges to generally prevent movement of the substrate member on the support in response to the movement varying and urging means in its contacting engagement with the resistance material along the path thereof.

Still further and in general, a variable resistor assembly in one form of the invention has a substrate member having opposite surfaces and side edges intersecting therewith. A resistance material is disposed on one of the opposite surfaces, and the resistance material defines a generally serpentine path having a plurality of adjacent legs consecutively interconnected in accordance with a predetermined mathematical relation. Means is provided for supporting the other of the opposite surfaces, and means on the supporting means engages at least some of the side edges thereby to generally prevent displacement movement of the substrate member generally in the plane of the one opposite surface supported on the supporting means. Means is movably mounted on the supporting means for contacting the resistance material in abutting engagement therewith, and the abutting engagement of the contacting means with the resistance material urges the other opposite surface toward the supporting means for maintaining the substrate member against displacement therefrom. The contacting means is selectively movable into engagement between adjacent ones of the legs for varying the resistance along the generally serpentine path in accordance with the predetermined mathematical relation.

Also in general and in one form of the invention, a variable resistor assembly has a generally planar substrate member including first and second pairs of opposite side edges, and first and second opposite surfaces respectively intersecting with the first and second side edge pairs. At least a strip of resistance material is disposed on the first surface generally between the first side edge pair and generally constituting a resistance path in accordance with a predetermined mathematical function. A support for the substrate member includes: a seat for engagement with the second surface; first and second pairs of means respectively embracing the first and second side edge pairs to generally restrain the substrate member against displacement generally in its plane on the seat; and an arm movably mounted to the support adjacent one of the side edges of the second side edges pair and having at least a resiliently loaded portion adjustably movable along the resistance material strip in contacting engagement therewith for varying its resistance and for generally restraining the substrate member against displacement of its second surface from the seat on the support.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view showing the improved variable resistor assembly of the invention;

FIG. 2 is a side view of the variable resistor assembly of FIG. 1; and

FIG. 3 is a fragmentary, enlarged view of the resistance strip of the variable resistance of FIGS. 1 and 2.

Corresponding referenced characters indicate corresponding parts throughout the several views of the drawings.

The following examples illustrate the invention and are not to be construed as limiting in any manner.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2, an improved variable resistor assembly of the invention, generally indicated at **10**, comprises a generally rectangular substrate or generally planar substrate member **12** of suitable insulating material, such as a ceramic material or the like, having opposite side or marginal edges **14, 16, 18** and **20** interconnected between opposite generally planar surfaces **22, 24.** An arcuate strip **26** of suitable resistance material well known in the art is deposited or otherwise coated on surface **22** of substrate **12** for defining a resistance path thereon. A termination pad **28** formed of conductive material is also deposited or otherwise coated on surface **22** of substrate **12** and is electrically connected to an end **30** of resistance strip **26.** An electrical lead **32** may be suitably connected, as by soldering or the like, to termination pad **28.** Bottom surface **24** of substrate **12** is engaged and seated or supported by supporting means, such as a metal support member **34,** and a plurality of retaining, abutment or embracing means, such as ears or tabs **36, 38, 40, 42** and **44,** are integrally formed from the support member and engage side edges **14, 16, 18** and **20** of the substrate thereby to prevent movement or maintain the substrate member against displacement generally in its plane on the supporting means or generally in the plane of the engagement of substrate surface **24** and the support member.

Support member **34** has extension means, such as an elongate finger or tab portion **46,** extending therefrom, and means, such as leaf spring wiper arm **48,** is movable on the supporting means and generally along the resistance path of the resistance material of arcuate strip **26** in contacting engagement therewith for varying its resistance and for maintaining the substrate member **12** against displacement from its plane on the substrate member. Resiliently loaded or wiper arm **48** has its lower end **50** pivotally connected or movably mounted to tab portion **46** by a suitable means, such as a rivet **52.** A contact element or portion **54** is integrally formed from leaf spring wiper arm **48** adjacent its outer or upper end **56** and engages resistance strip **26,** contact element **54** being adjustably moved or traversed across resistance strip **26** in contacting engagement therewith in an arcuate path shown by the dashed line **58** (FIG. 3) which extends generally between the opposite ends **30, 68** of resistance strip **26** intermediate its side edges **60, 62.** In this manner, wiper arm **48** is generally constituted by means adjustably movable in contacting engagement with the resistance material of strip **26** generally along its resistance path for varying its resistance and for urging substrate member **24** toward its seating engagement with supporting means **12.** Tab portion **46** of support member **34** is bent upward slightly, as best seen in FIG. **2,** thereby to bias leaf spring wiper arm **48** toward substrate **12** so that the substrate is resiliently maintained on or urged toward the support member against displacement therefrom by contact element **54.**

Another electrical lead **64** is connected, as by soldering or the like, to an extension **66** of tab portion **46.** It will be readily understood that yet another electrical lead may be connected to the other or opposite end **68** of resistance strip **26** as by another termination pad similar to pad **28** or the like thereby providing a potentiometer connection.

A plurality of equally spaced, transversely extending slot means or grooves **70, 72** are provided in side edges **60, 62** of resistance strip **26,** slot means **70, 72** becoming progressively deeper from end **30** to end **68** of the resistance strip and crossing path **58** of contact element **54** in a segment **74** of the resistance strip. The resistance of strip **26** from end **32** to any given point on contact element path **58** is proportional to the length and inversely proportional to the width of that segment of the resistor. It will be seen that beginning at end **30** and progressing clockwise in segment **76,** the progressively increasing depth of slots **70, 72** progressively reduces the effective width of the resistor. In segment **74** progressing clockwise toward end **68,** the effective length of the resistor begins to increase more rapidly by reason of the progressively deeper slots **70, 72** and the effective width of the resistor becomes substantially constant. It will thus be seen that by virtue of the configuration and arrangement of slots **70, 72,** the resistance of strip **26** from end **30** to any point on contact element path **58** continuously and smoothly varies in accordance with a logarithmic function or other predetermined mathematical relation thus rendering variable resistor assembly **10** suitable for use as a preheat resistor in a room thermostat. It will be understood that other arrangements and configurations of slots may be employed in resistance strip **26** to provide any other continuous arbitrary function which may be desired for a particular application.

In a specific embodiment of the variable resistor assembly shown in the drawings intended for use as a preheat resistor employing a resistance strip **26** formed by depositing a blend of two conductor-type palladium silver materials of fired resistivity of 0.025 ohms and 0.060 ohms per square inch, respectively, a uniform log curve of resistance was obtained with a nominal ten percent increase of resistance per 2.75° rotation of wiper arm **48,** a nearly two decade change of resistance being achieved from approximately 0.04 ohms to approximately 4.0 ohms measured generally from termination pad **28** to contact element **54.** It will be seen that contact element **54** having a moderate radius readily bridges a pair of adjacent legs; such as legs **78, 80** of the generally serpentine pattern formed by slots **70, 72** in in segment **74** of resistance strip **26** thus avoiding loss of electrical continuity as contact element **54** is moved along path **58** in segment **74.**

It has been found that the heat transfer from resistance striip **26** is equal or superior to conventional wire-wound preheat resistors due to the compactness and low mass of the resistance assembly and the relatively high heat conductivity of ceramic substrate **12.** This construction permits disposition of an appropriate dial or other desired indicia (not shown) on substrate **12** in the same operation as the disposition of resistance element **26** thus eliminating the cost of a spearate dial.

It will be seen that assembly **10** comprises only four parts, i.e., substrate **12** with resistance strip **26** and termination pad **28** thereon, support element **34,** wiper arm **48** and rivet **52,** these four parts being readily and simply assembled and maintained in assembled relation by the simple expediency of attaching rivet **52** to wiper arm **48** and tab portion **46** of support member **34.** Thus, the invention provides a variable resistor assembly **10** particularly characterized by its simplicity and ease of assembly, and relatively low cost. It will be seen that resistor **10** is infinitely variable in segment **76** thereof and that the number of incremental steps in resistance provided in segment **74** is higher than that obtainable in a wire-wound resistor with tap electrodes. It will further be seen that resistance strip **26** may be sufficiently wide to accommodate a plurality of contact elements on wiper arm **48** and that, while an arcuate configuration is shown for resistance strip **26,** the resistance strip may be arranged to provide a straight line or any other desired configuration of contact element travel thereacross.

While there have been described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

What I claim as new and desire to secure by letters Patent of the United States is:

1. A variable resistor assembly comprising a substrate member having opposite surfaces and side edges intersecting therewith, a resistance material on one of the opposite surfaces, the resistance material defining a generally serpentine path having a plurality of adjacent legs consecutively interconnected in accordance with a predetermined mathematical relation, means for supporting the other of the opposite surfaces, means on the supporting means for engagement with at least some of the side edges thereby to generally prevent displacement movement of the substrate member generally in the plane of the one opposite surface supported on the supporting means, and means movably mounted on the supporting means for contacting the resistance material in abutting engagement therewith, the abutting engagement of the contacting means with the resistance material urging the other opposite surface toward the supporting means for maintaining the substrate member against displacement therefrom and the contacting means being selectively movable into engagement between adjacent ones of the legs for varying the resistance along the generally serpentine path in accordance with the predetermined mathematical relation.

2. A variable resistor assembly as set forth in claim **1,** comprising means for pivotally mounting the contacting means on the supporting means.

3. A variable resistor assembly as set forth in claim **1,** wherein the contacting means includes at least a resilient portion for establishing a force urging the contacting means into its engagement with the resistance means and the other opposite surface into engagement with the supporting means.

4. A variable resistor assembly as set forth in claim **1,** comprising means on the supporting means extending beyond one of the side edges and on which the contacting means is movably mounted.

5. A variable resistor assembly as set forth in claim **1,** wherein the resistance material comprises a strip having opposite sides between opposite ends thereof, the contacting means traversing the strip generally intermediate the sides and between the ends thereof, and a plurality of means in the strip respectively extending into the opposite sides and between the adjacent ones of the legs for varying the resistance of the strip along the serpentine path thereof in the mathematical relation.

6. A variable resistor assembly as set forth in claim **5,** wherein each of the resistance varying means is constituted by a slot and at least some of the slots extending across the path of the engagement of the contacting means with the strip.

7. A variable resistor assembly comprising a generally planar substrate member, a resistance material defining a resistance path on the substrate member, and means for supporting the substrate member including means for maintaining the substrate member against displacement generally in its plane on the supporting means, and means movable on the supporting means and generally along the resistance path in contacting engagement with the resistance material for varying its resistance and for maintaining the substrate member against displacement generally from its plane on the supporting means.

8. A variable resistor assembly as set forth in claim **7,** wherein the maintaining means comprises means extending generally across the plane of the substrate member for abutment with a portion thereof.

9. A variable resistor assembly as set forth in claim **8,** wherein the portion of the substrate member is constituted by at least one marginal edge.

10. A variable resistor assembly as set forth in claim **7,** wherein the varying and maintaining means includes means for pivotally mounting it to the supporting means.

11. A variable resistor assembly as set forth in claim **7,** wherein the varying and maintaining means comprises a resiliently loaded arm having a portion urged into the contacting engagement with the resistance material and another portion mounted to the supporting means for movement thereon.

12. A variable resistor assembly as set forth in claim **11,** further comprising means for pivotally mounting the other portion of the arm to the supporting means.

13. A variable resistor assembly comprising a substrate member having at least one marginal edge, a resistance material defining a resistance path on the substrate member, means for supporting the substrate member, means adjustably movable in contacting engagement with the resistance material generally along its path for varying its resistance and for urging the substrate member toward the supporting means, and the supporting means including means engaged with the at least one marginal edge for generally retaining the substrate member against displacement on the supporting means upon the adjusting movement of the varying and urging means along the path of the resistance material in the contacting engagement therewith.

14. A variable resistor assembly as set forth in claim **13,** wherein the varying and urging means includes means for movably mounting it to the supporting means.

15. A variable resistor assembly as set forth in claim **13,** wherein the varying and urging means comprises a generally resilient arm having a portion urged into the contacting engagement with the resistance material and another portion movably mounted to the supporting means.

16. A variable resistor assembly as set forth in claim 15, further comprising means for pivotally mounting the other portion of the arm to the supporting means.

17. A variable resistor assembly as set forth in claim 13, wherein the retaining means comprises at least one tab on the supporting means embracing the at least one marginal edge to prevent the displacement of the substrate member on the supporting means generally in the direction of the adjusting movement of the varying and urging means.

18. A variable resistor assembly comprising a substrate member having at least a pair of generally opposite marginal edges, a resistance material on the substrate member defining resistance path in accordance with a predetermined function, a support for seating the substrate member, means movable on the support and in contacting engagement with the resistance material generally along its path for varying its resistance and for urging the substrate toward seating engagement with the support, and the support including at least a pair of means for respective abutment with the at least pair of marginal edges to generally prevent movement of the substrate member on the support in response to the movement of the varying and urging means in its contacting engagement with the resistance material along the path thereof.

19. A variable resistor assembly as set forth in claim 18, wherein the substrate member includes a pair of generally opposite surfaces intersecting with the at least marginal edge pair, respectively, one of the opposite surfaces being disposed in seating engagement on the support and the resistance material being disposed on the other of the opposite surfaces, and the contacting engagement of the varying and urging means with the resistance material generally maintaining the one opposite surface against displacement from its seating engagement on the support.

20. A variable resistor assembly as set forth in claim 18, wherein the at least pair of abutment means comprises at least a pair of tabs integral with the support and extending therefrom so as to embrace the at least marginal edge pair.

21. A variable resistor assembly as set forth in claim 18, wherein the support further includes other means for embracing the substrate member to retain it against movement on the support so as to displace the at least marginal edge pair from between the at least abutment pair.

22. A variable resistor assembly as set forth in claim 18, wherein the varying and urging means comprises an arm having opposite ends, means associated with the arm adjacent one of the opposite ends for movably mounting it to the support, and the other of the opposite ends including means for effecting the contacting engagement with the resistance material.

23. A variable resistor assembly as set forth in claim 23, wherein the varying and urging means is generally constituted by a resiliently loaded arm.

24. A variable resistor assembly comprising a generally planar substrate member including first and second pairs of opposite side edges, and first and second opposite surfaces respectively intersecting with the first and second side edges pairs, at least a strip of resistance material disposed on the first surface generally between the first side edge pair and generally constituting a resistance path in accordance with a predetermined mathematical function, and a support for the substrate member including a seat for engagement with the second surface, first and second pairs of means respectively embracing the first and second side edge pairs to generally restrain the substrate member against displacement generally in its plane on the seat, and an arm movably mounted to the support adjacent one of the side edges of the second side edge pair and having at least a resiliently loaded portion adjustably movable along the resistance material strip in contacting engagement therewith for varying its resistance and for generally restraining the substrate member against displacement of its second surface from the seat on the support.

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