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(54) CLOTHESPIN TYPE HEAT DISSIPATING APPARATUS FOR SEMICONDUCTOR MODULE

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(52) **U.S. Cl.** **165/80.1**

(57) **ABSTRACT**

Some embodiments of the invention include two heat exchange members, which are arranged facing each other with a semiconductor module therebetween, the semiconductor module including a plurality of packages; a connection member formed in the middle of each of the heat exchange members to hinge join the heat exchange members such that portions of the heat exchange members protrude above the semiconductor module inserted between the heat exchange members; and an elastic member disposed between the heat exchange members to provide a force pushing portions of the heat exchange members below the connection member toward the packages of the semiconductor module. Other embodiments of the invention are described in the claims.

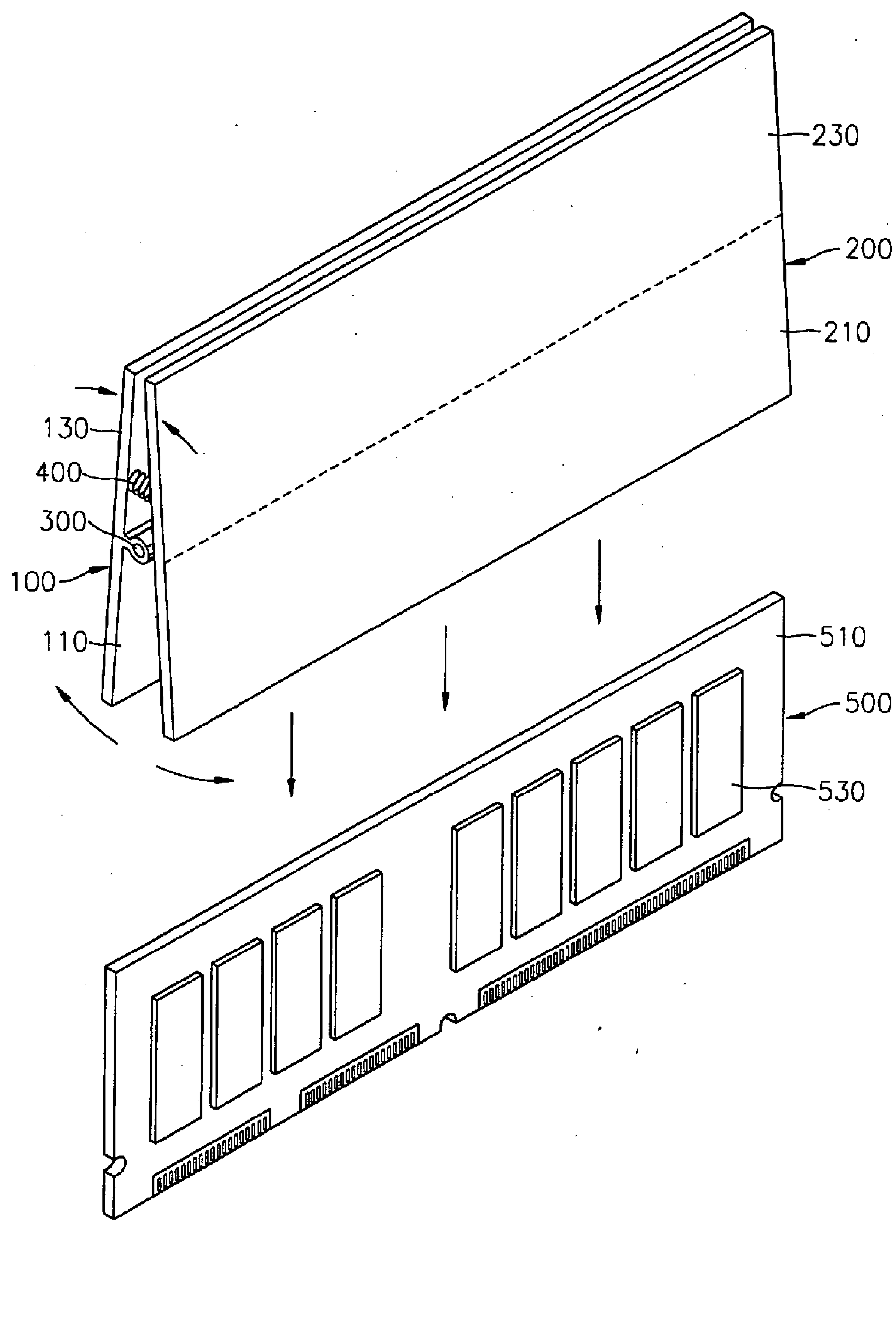


FIG. 1 (PRIOR ART)

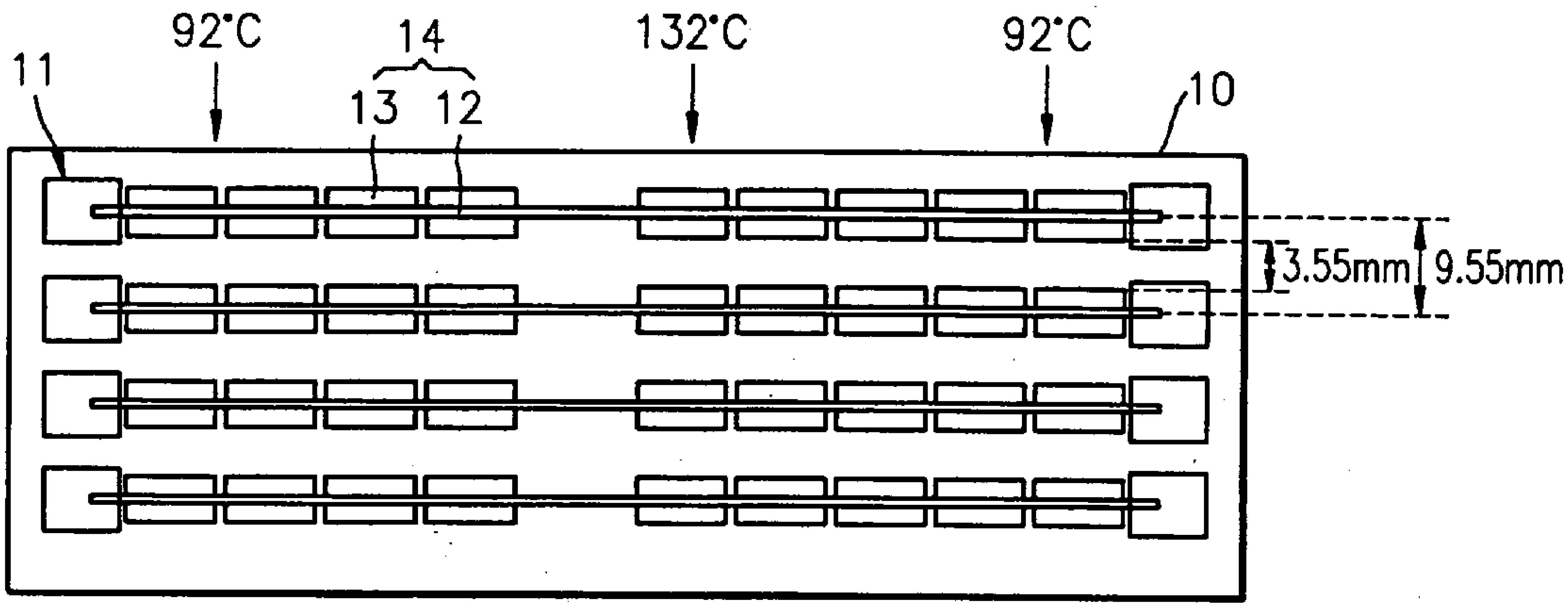


FIG. 2

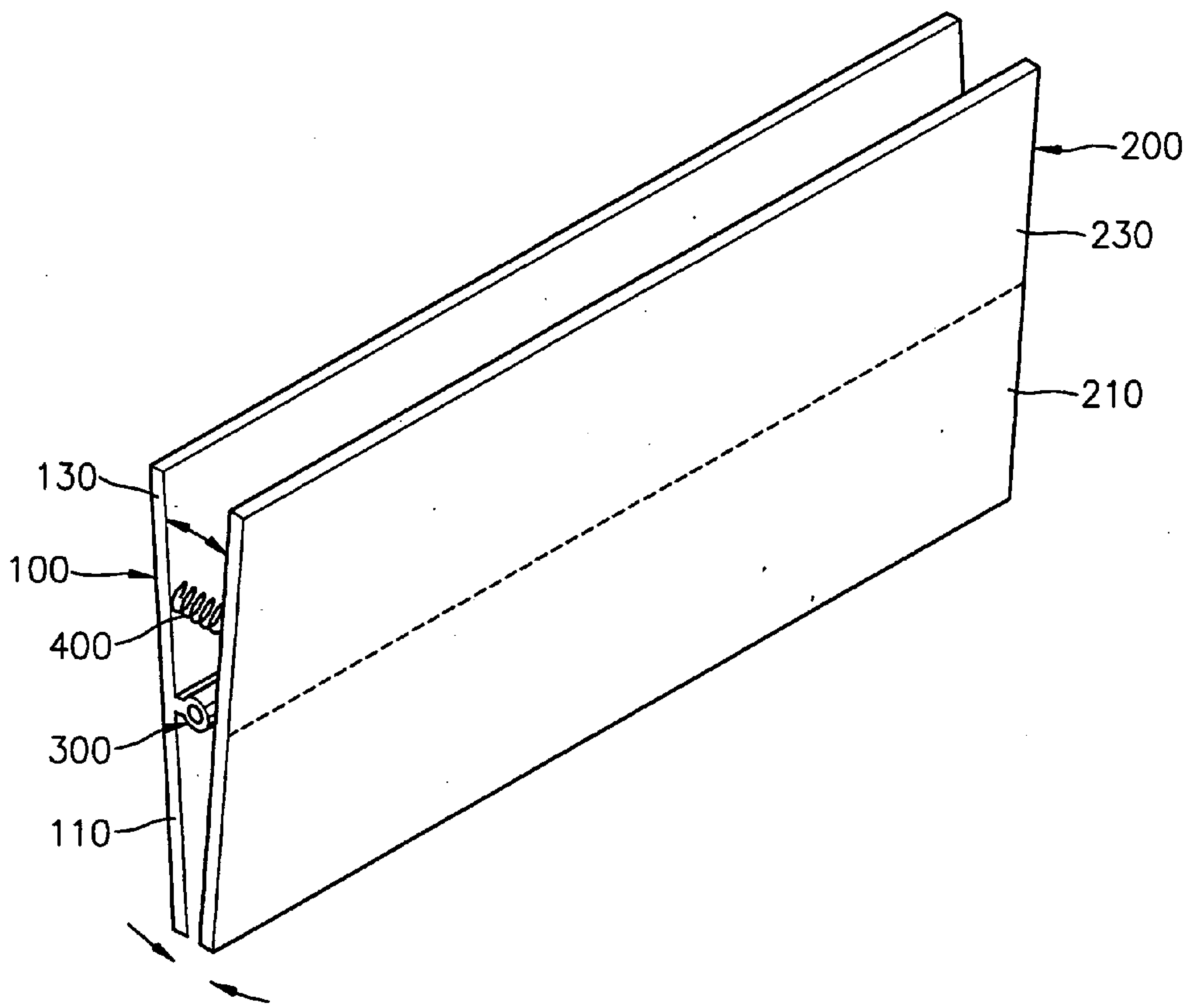


FIG. 3

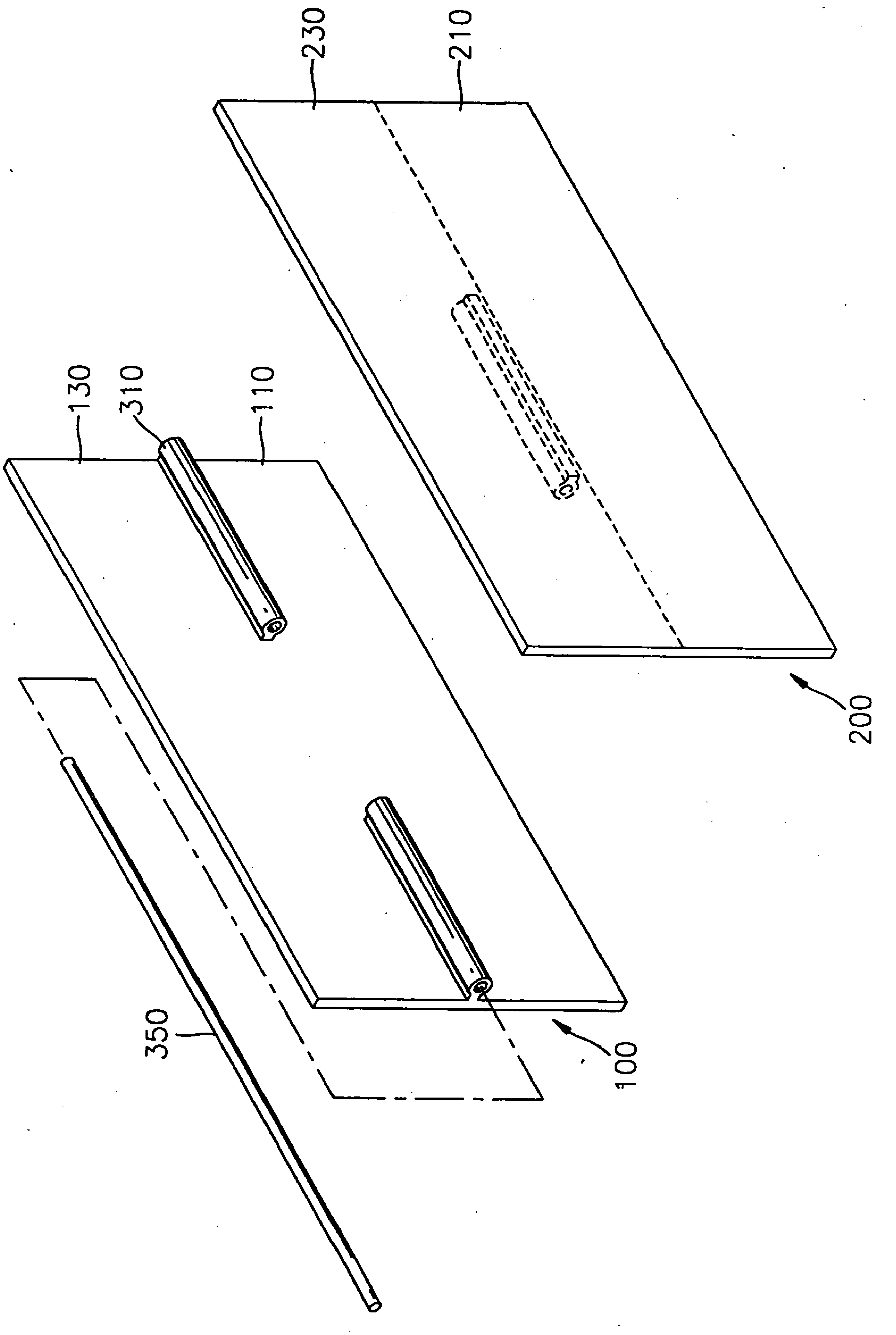


FIG. 4

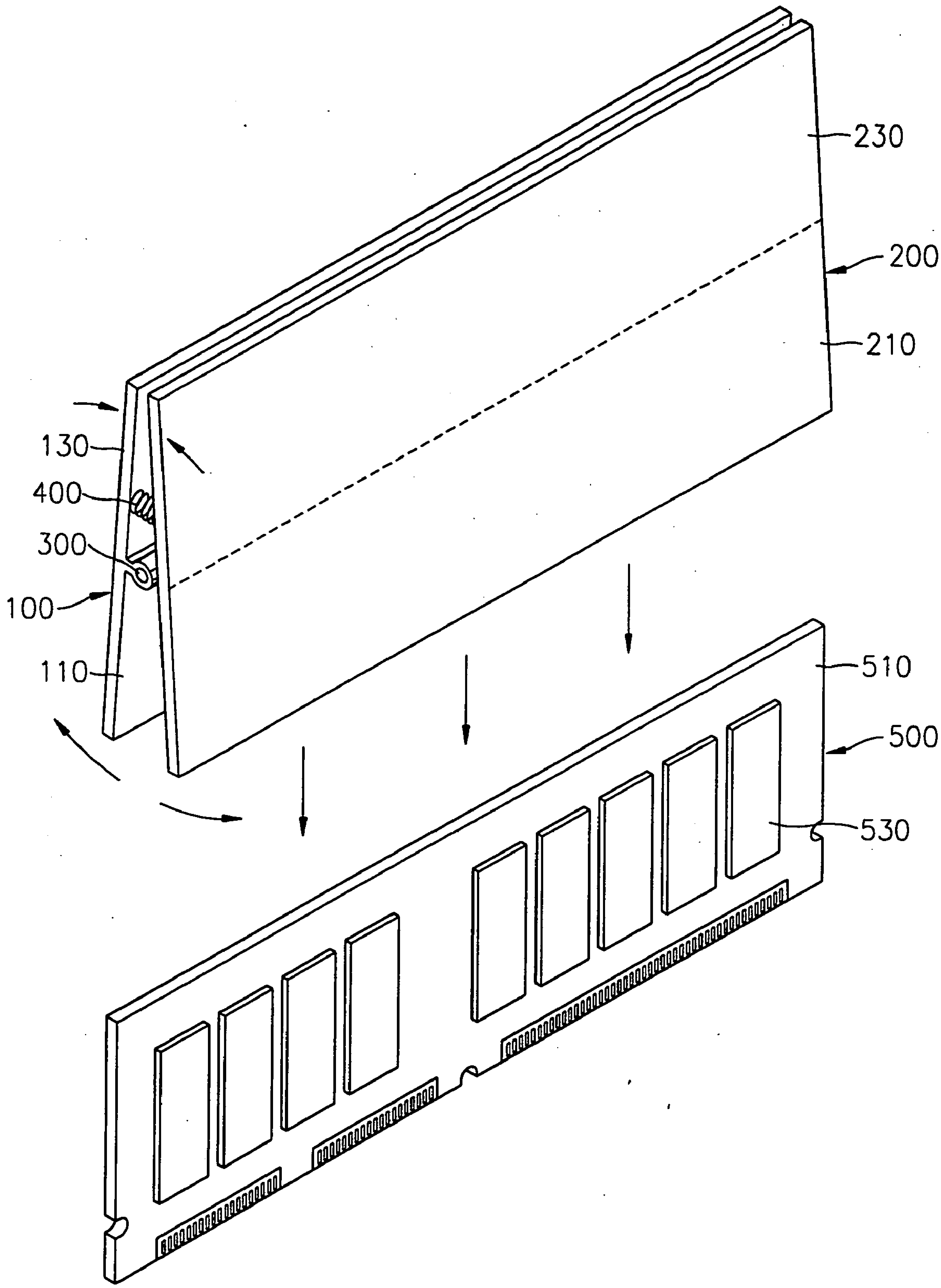


FIG. 5

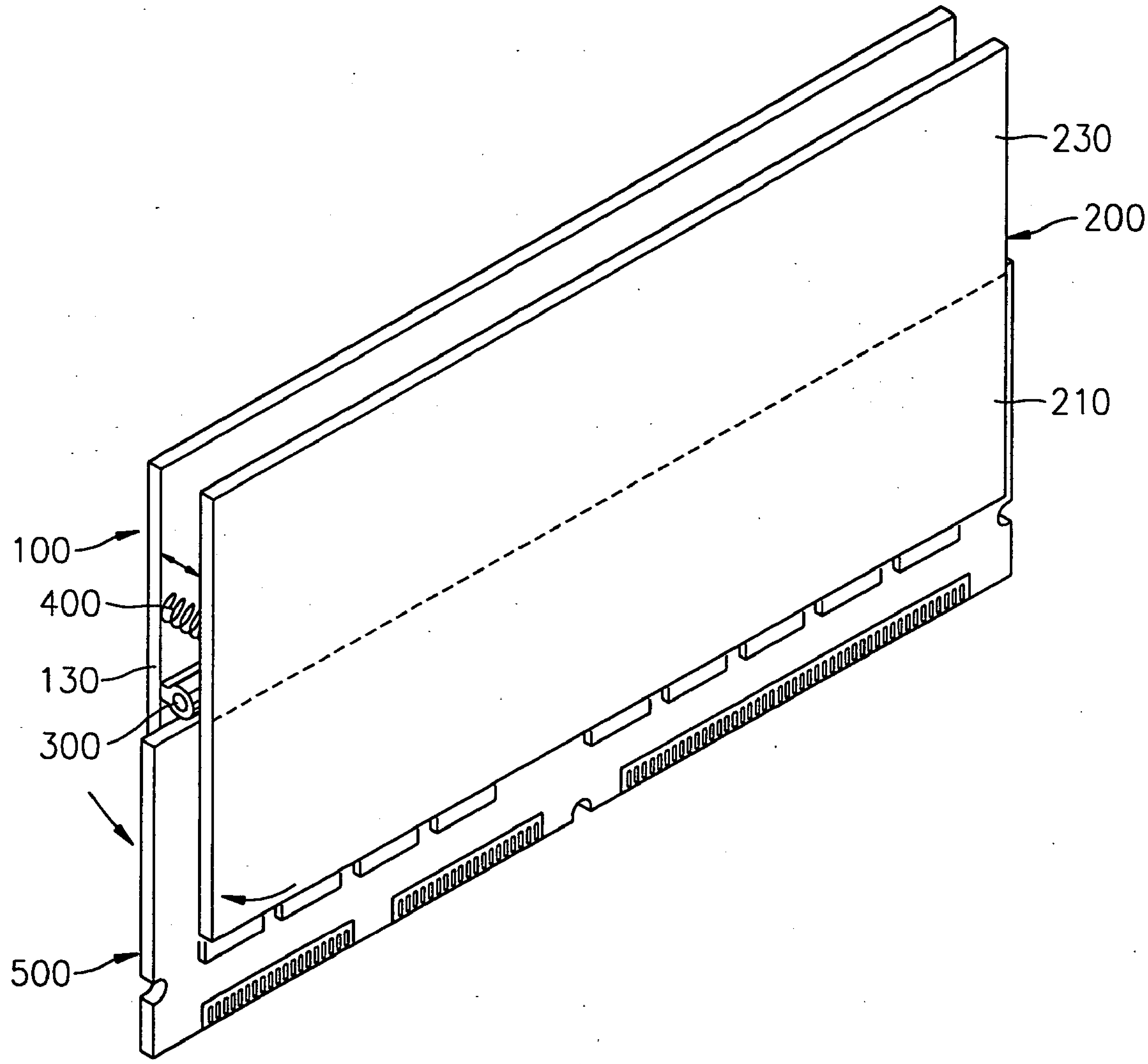


FIG. 6

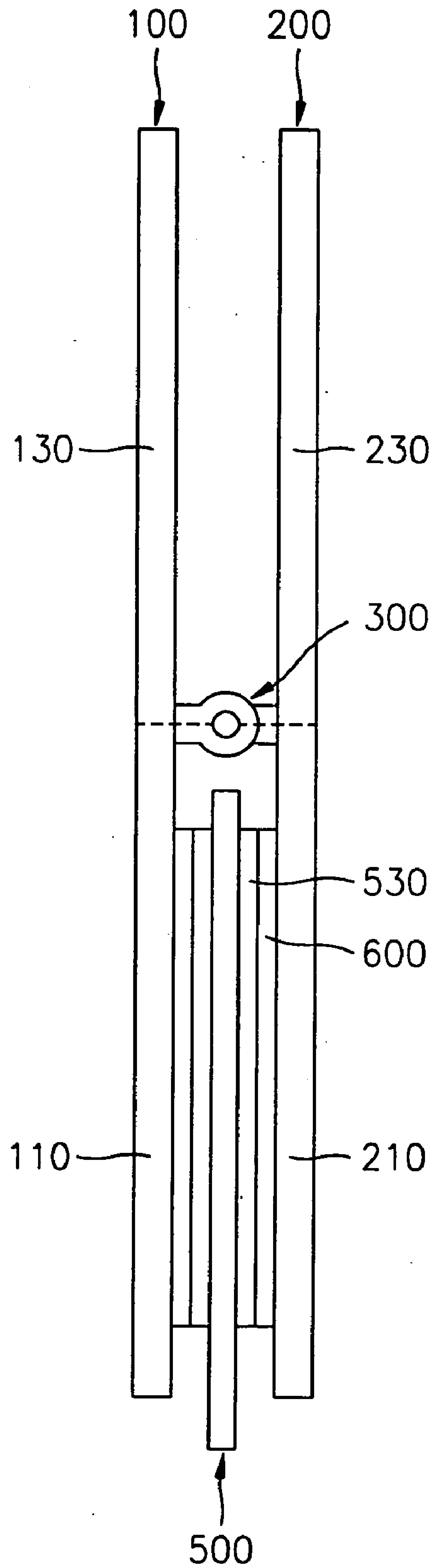


FIG. 7

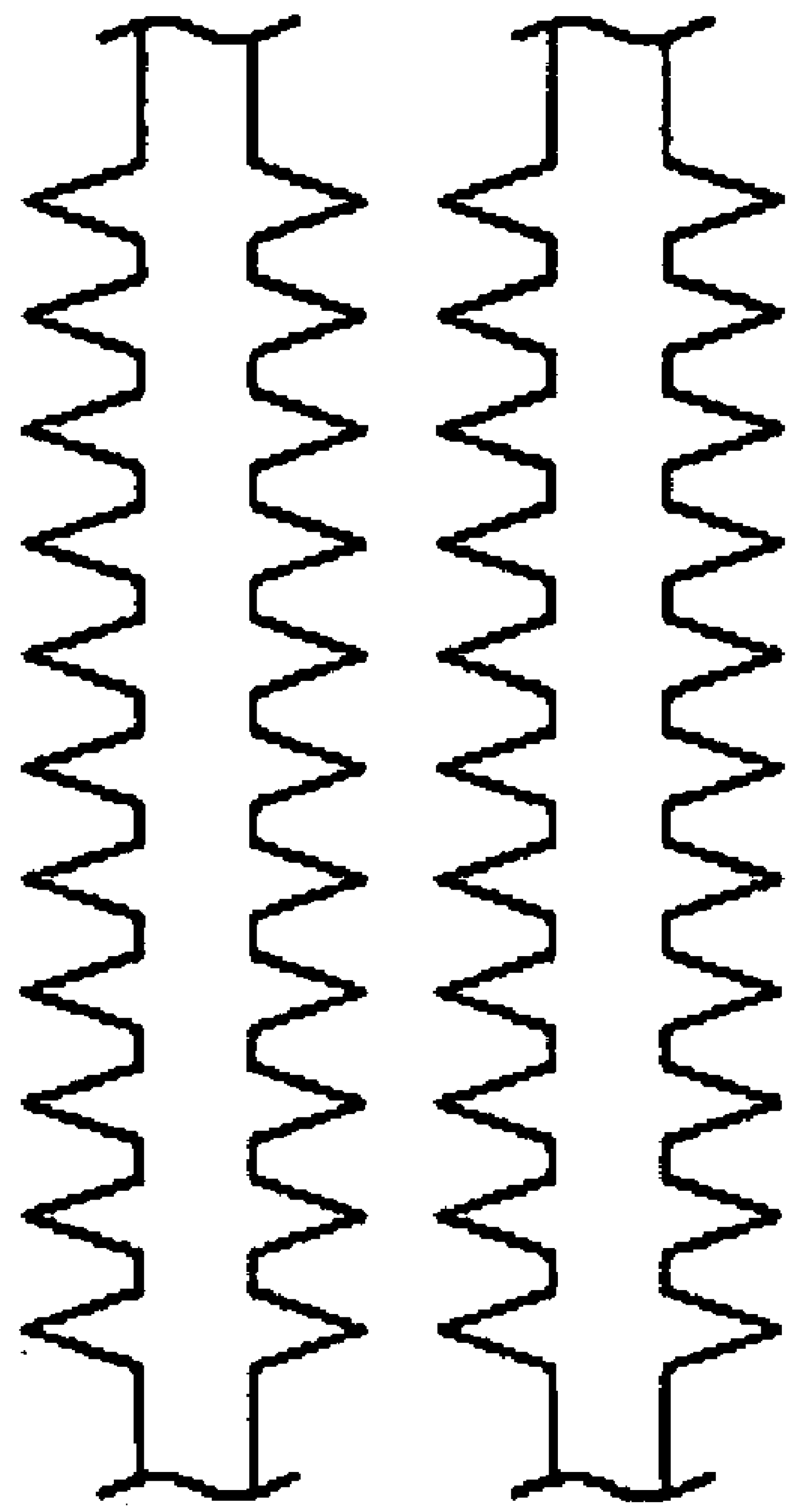


FIG. 8

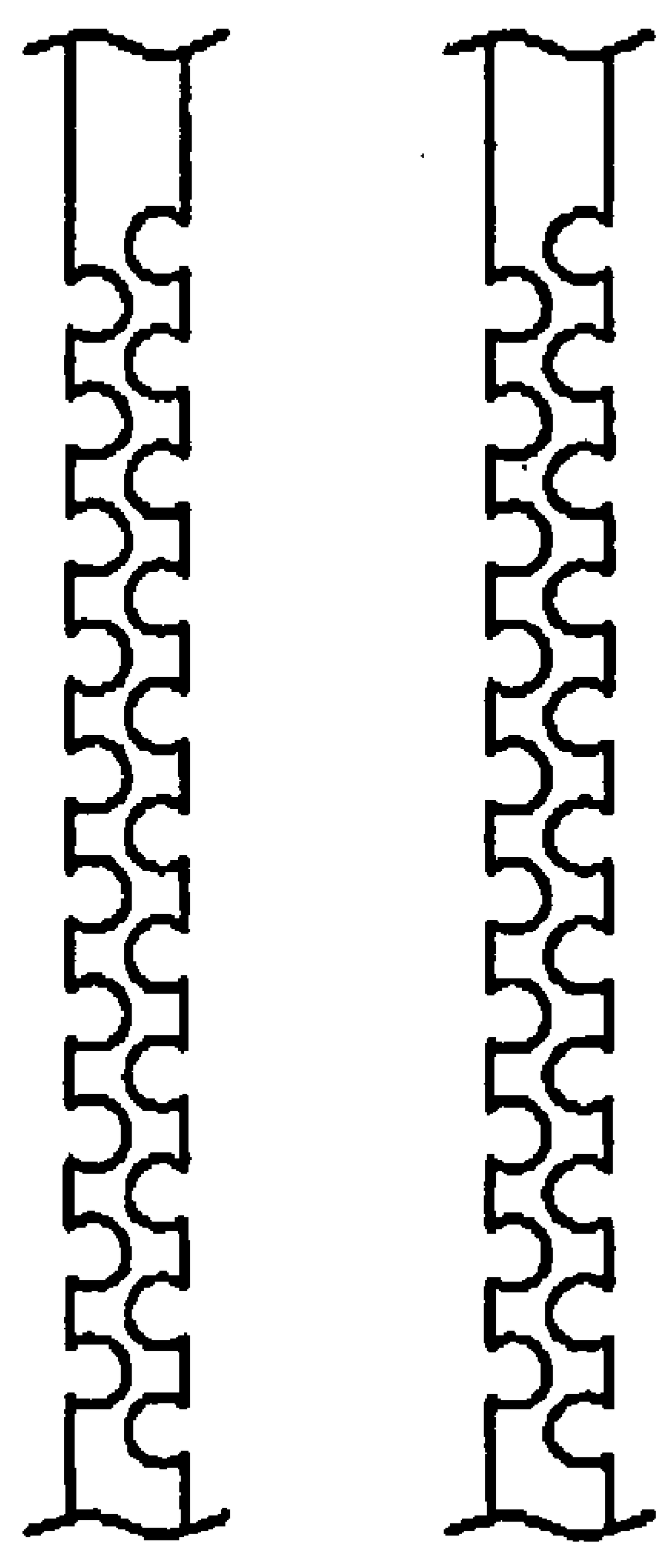


FIG. 9

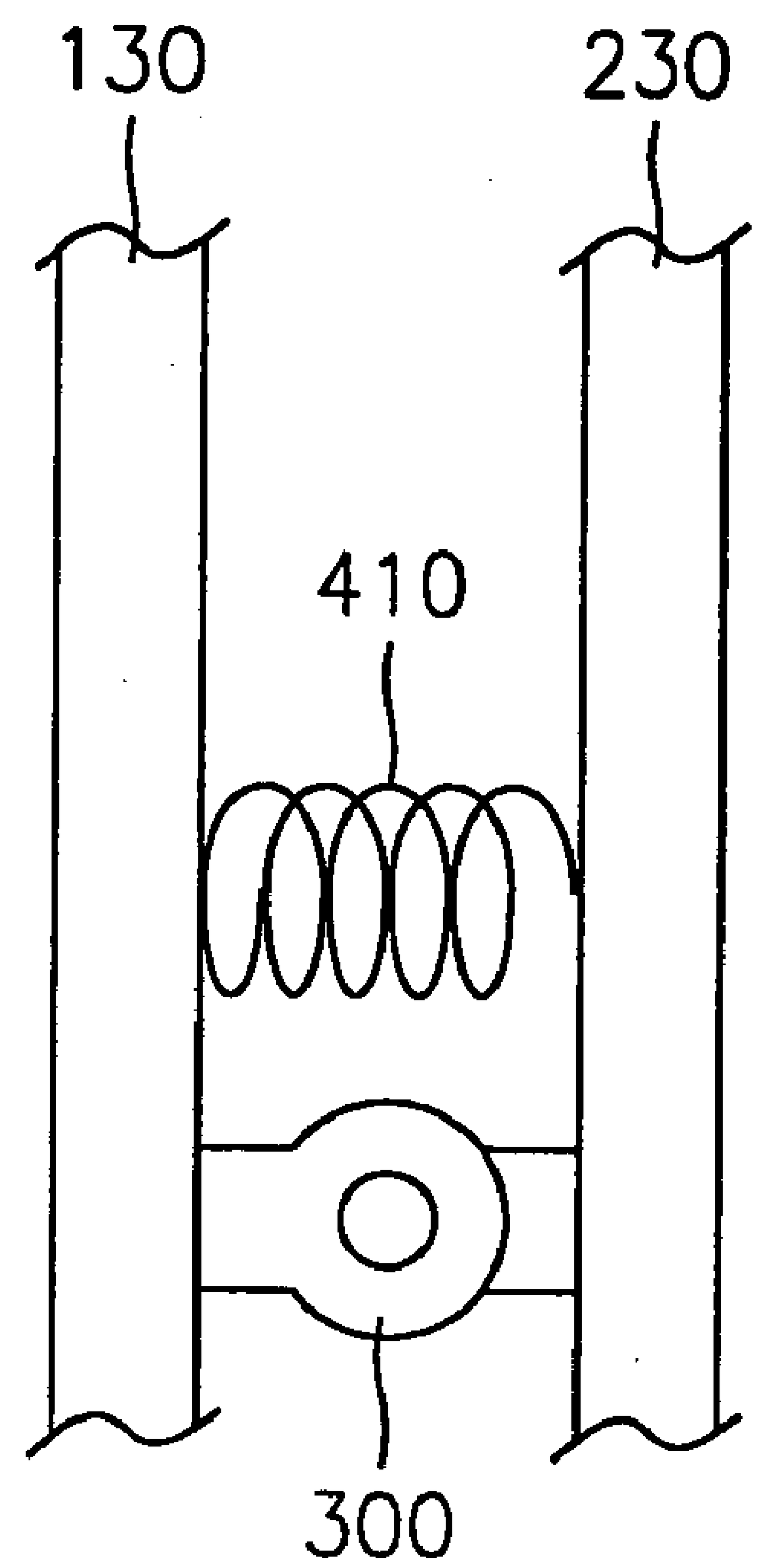


FIG. 10

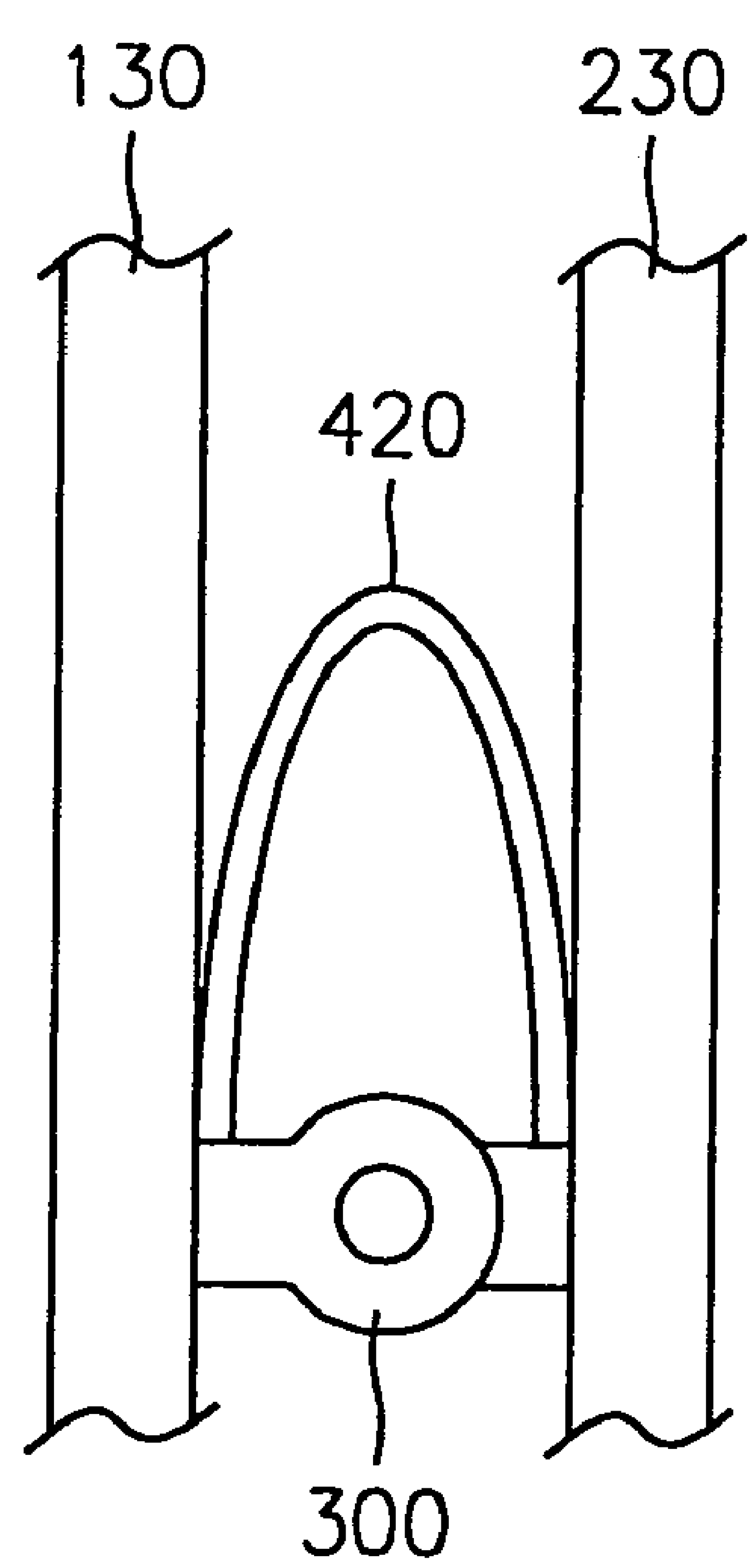


FIG. 11

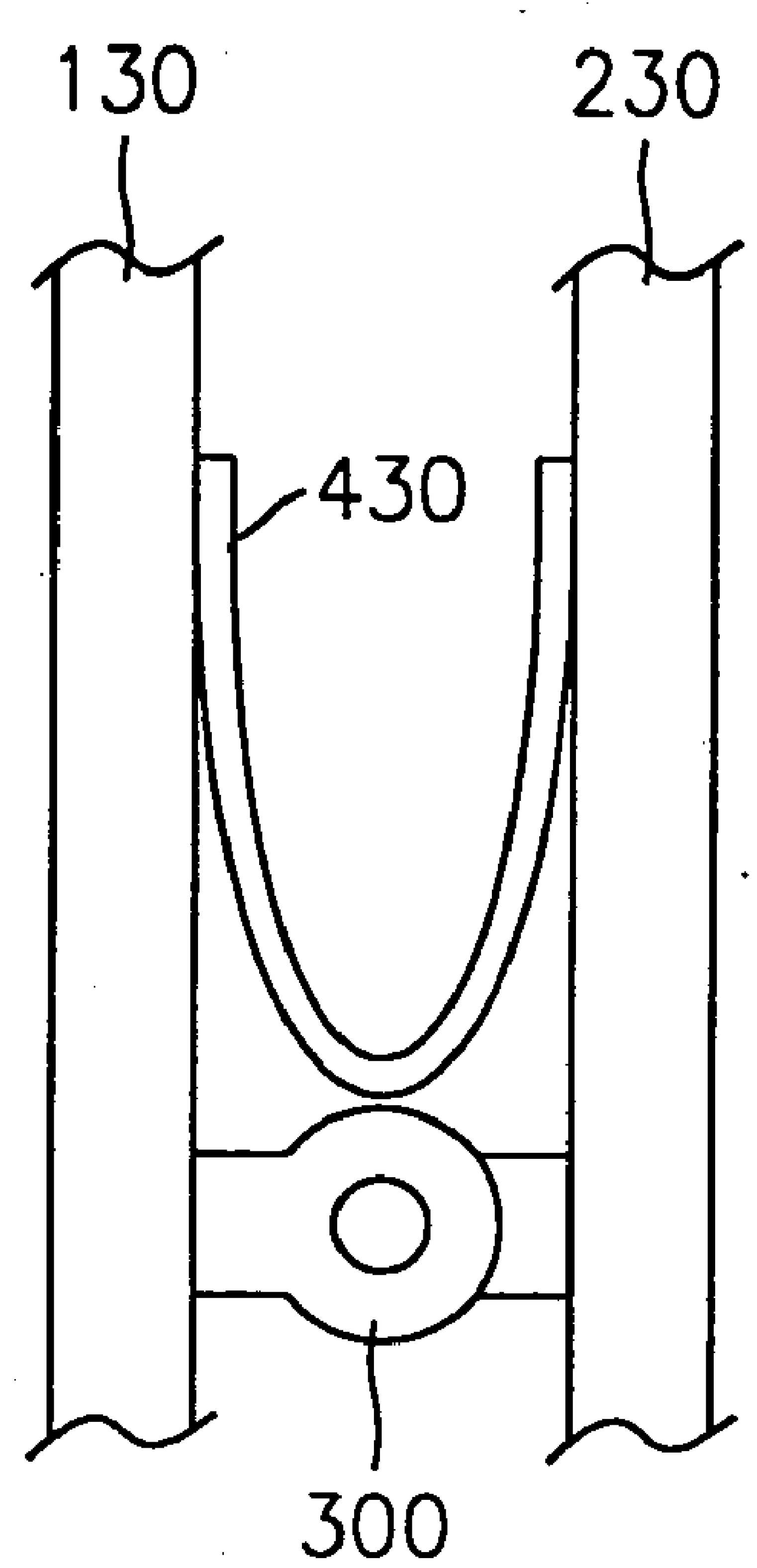


FIG. 12

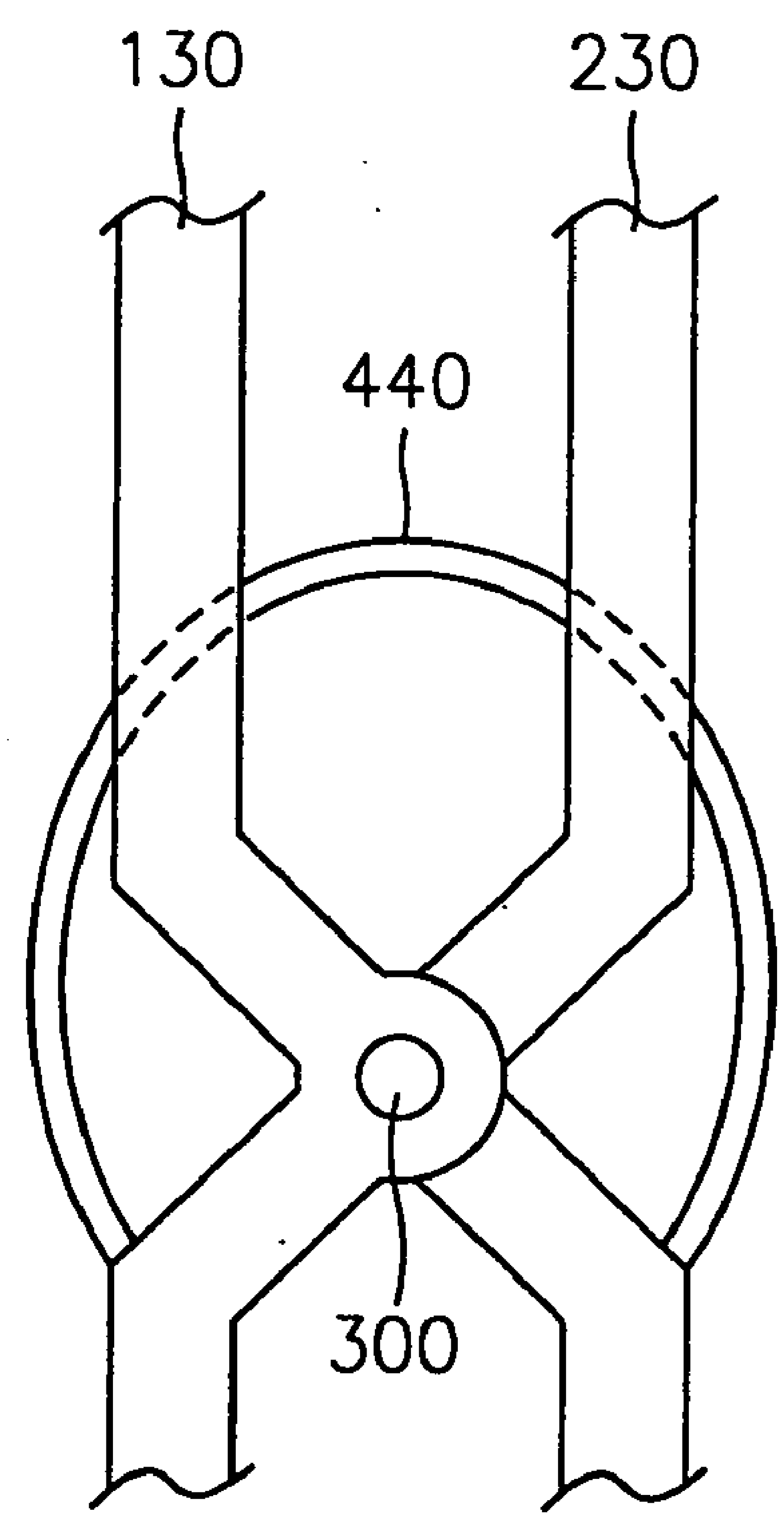


FIG. 13

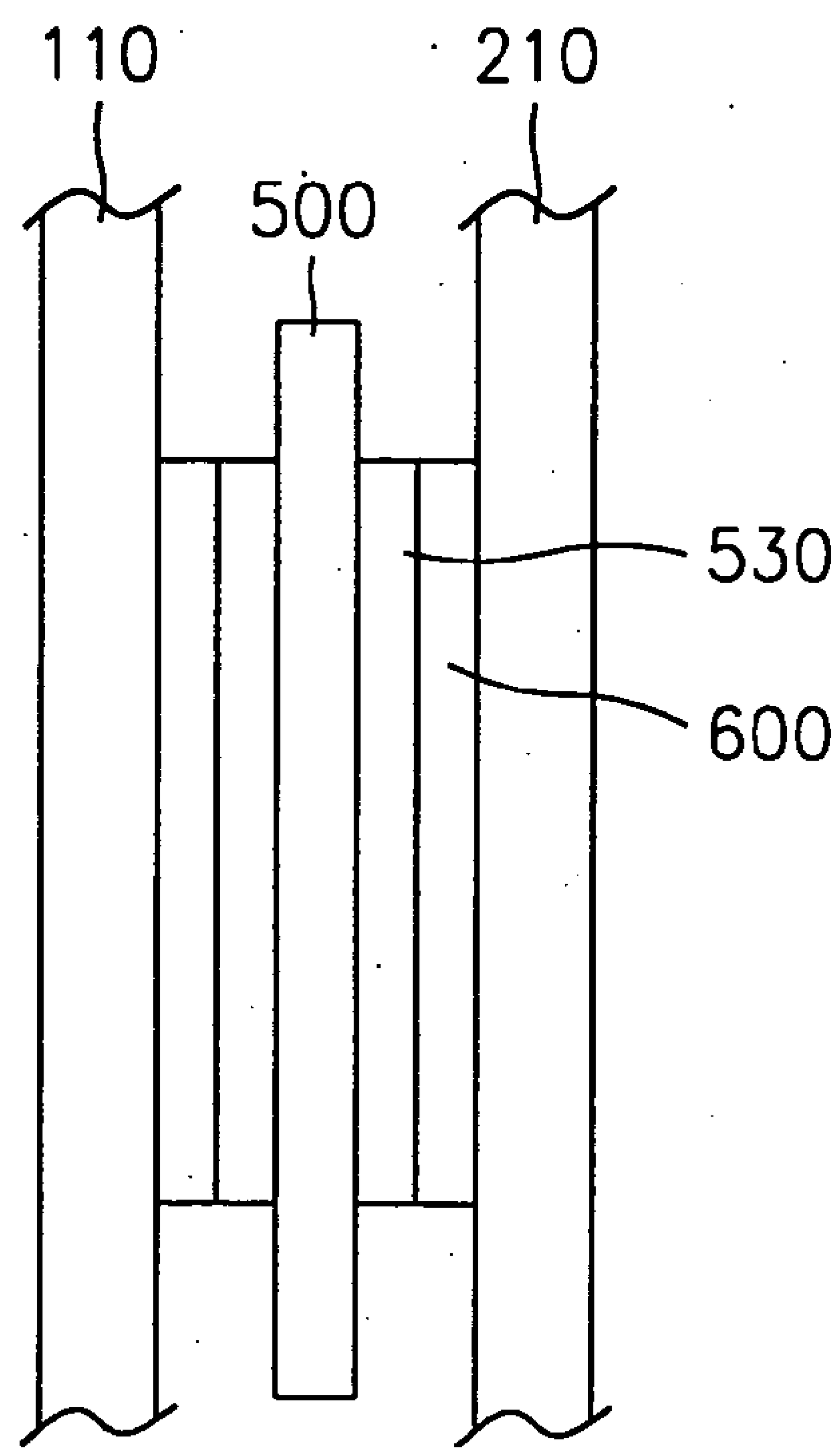


FIG. 14

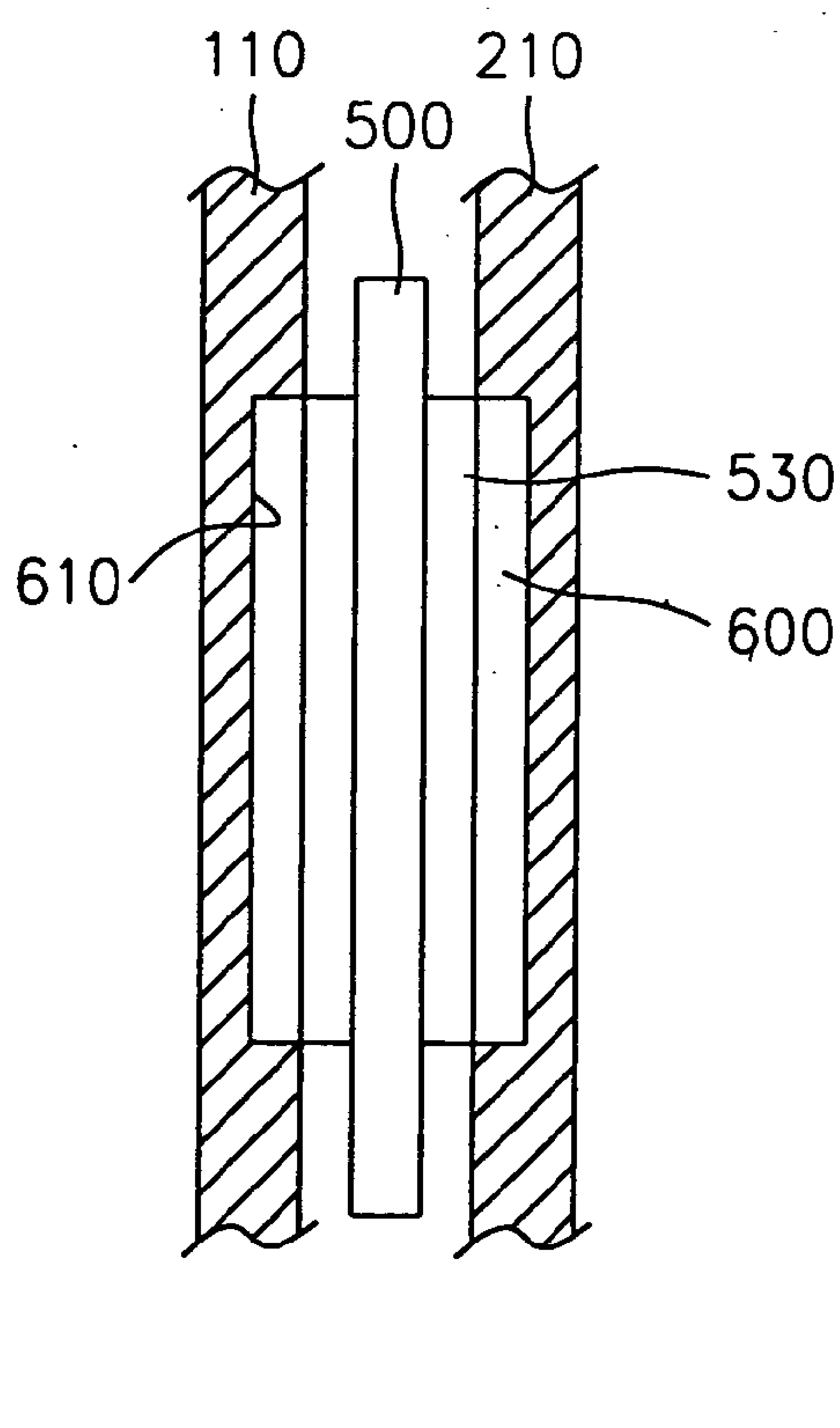


FIG. 15

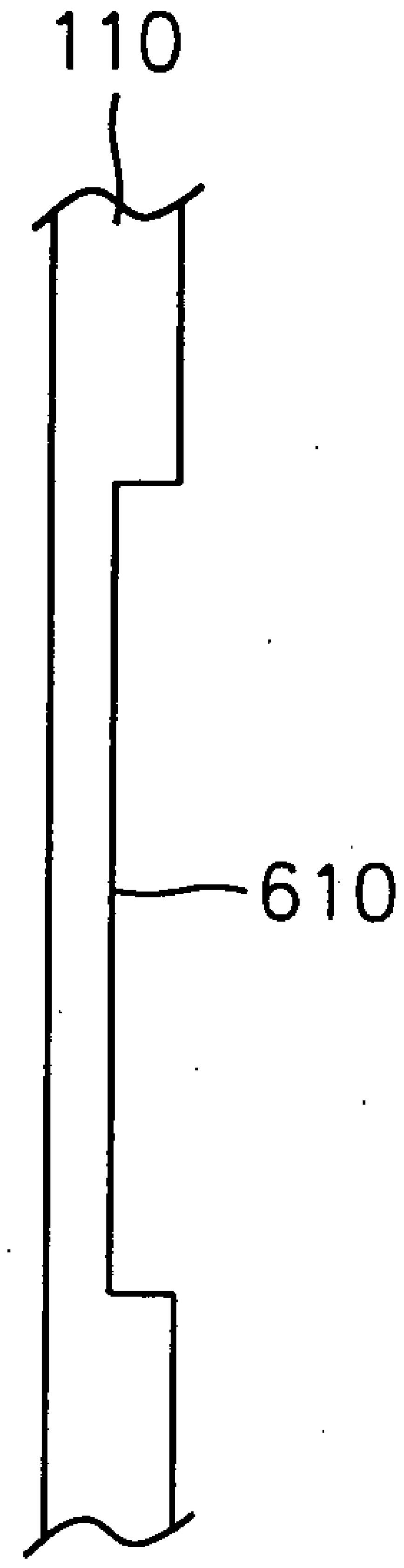


FIG. 16

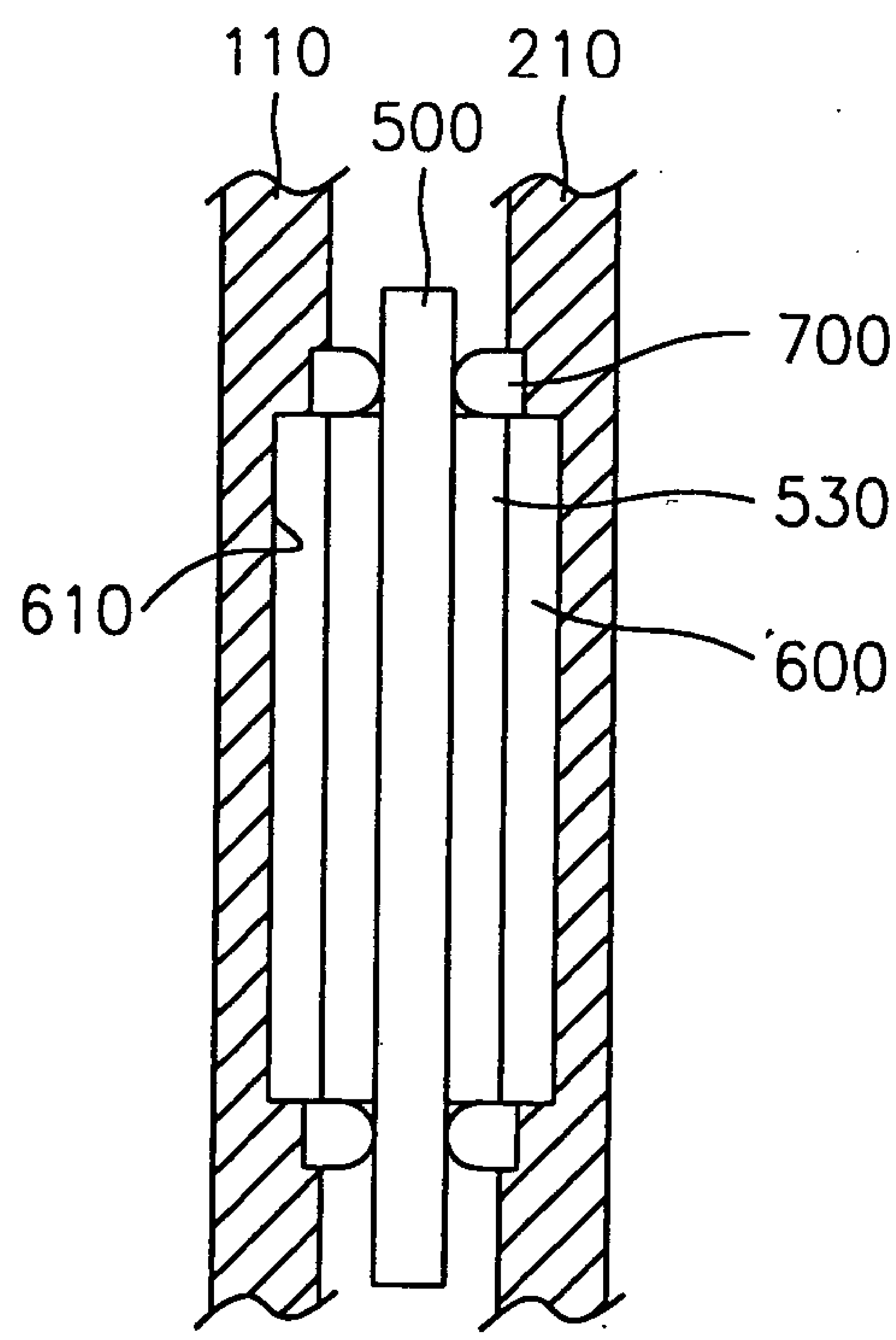


FIG. 17

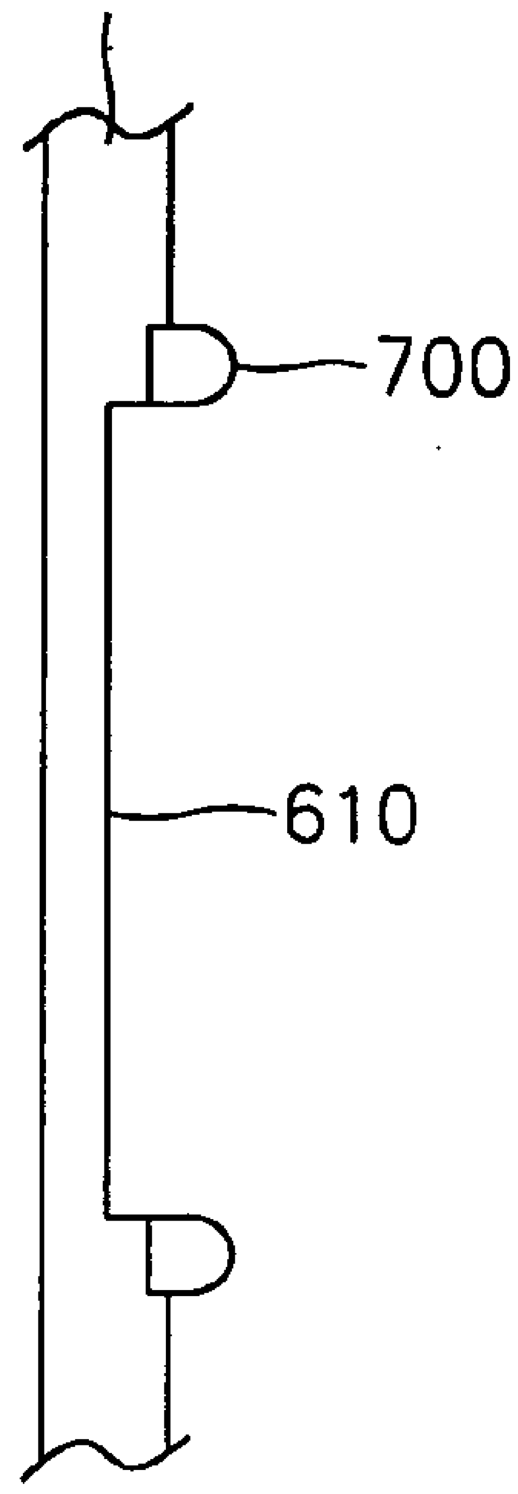

110
700
610

FIG. 18

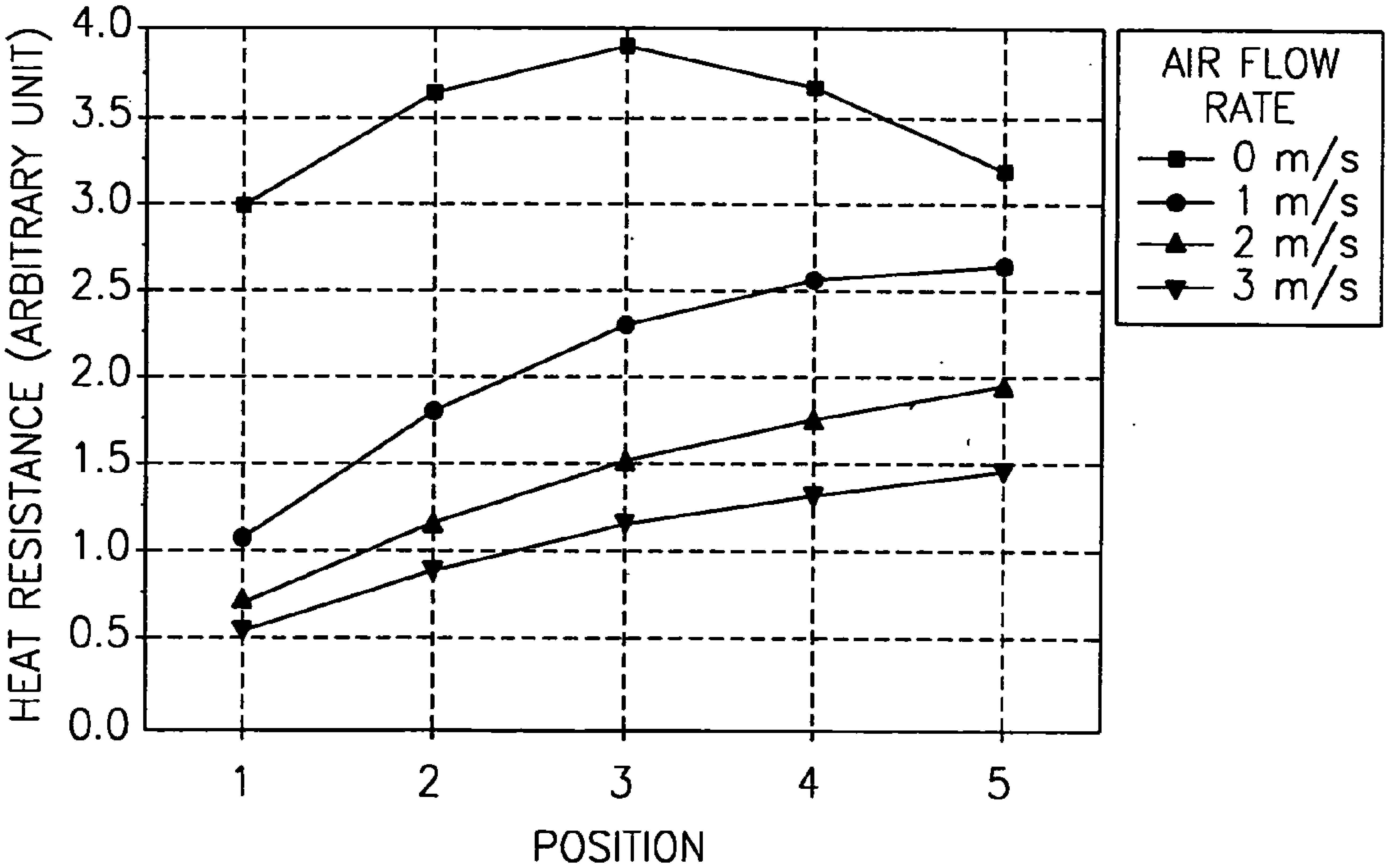

HEAT RESISTANCE (ARBITRARY UNIT)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
POSITION
AIR FLOW RATE
0 m/s
1 m/s
2 m/s
3 m/s

FIG. 19 (PRIOR ART)

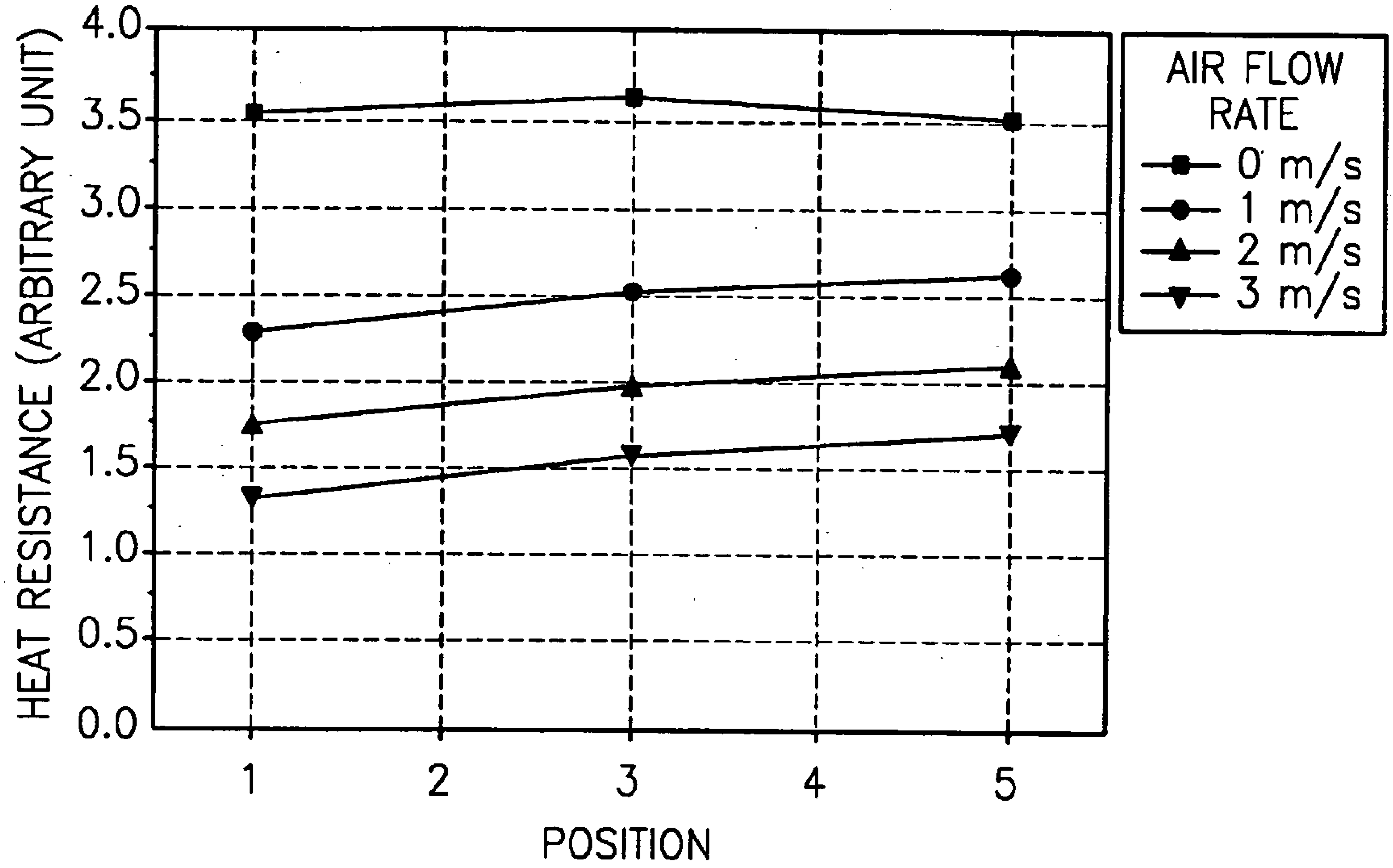
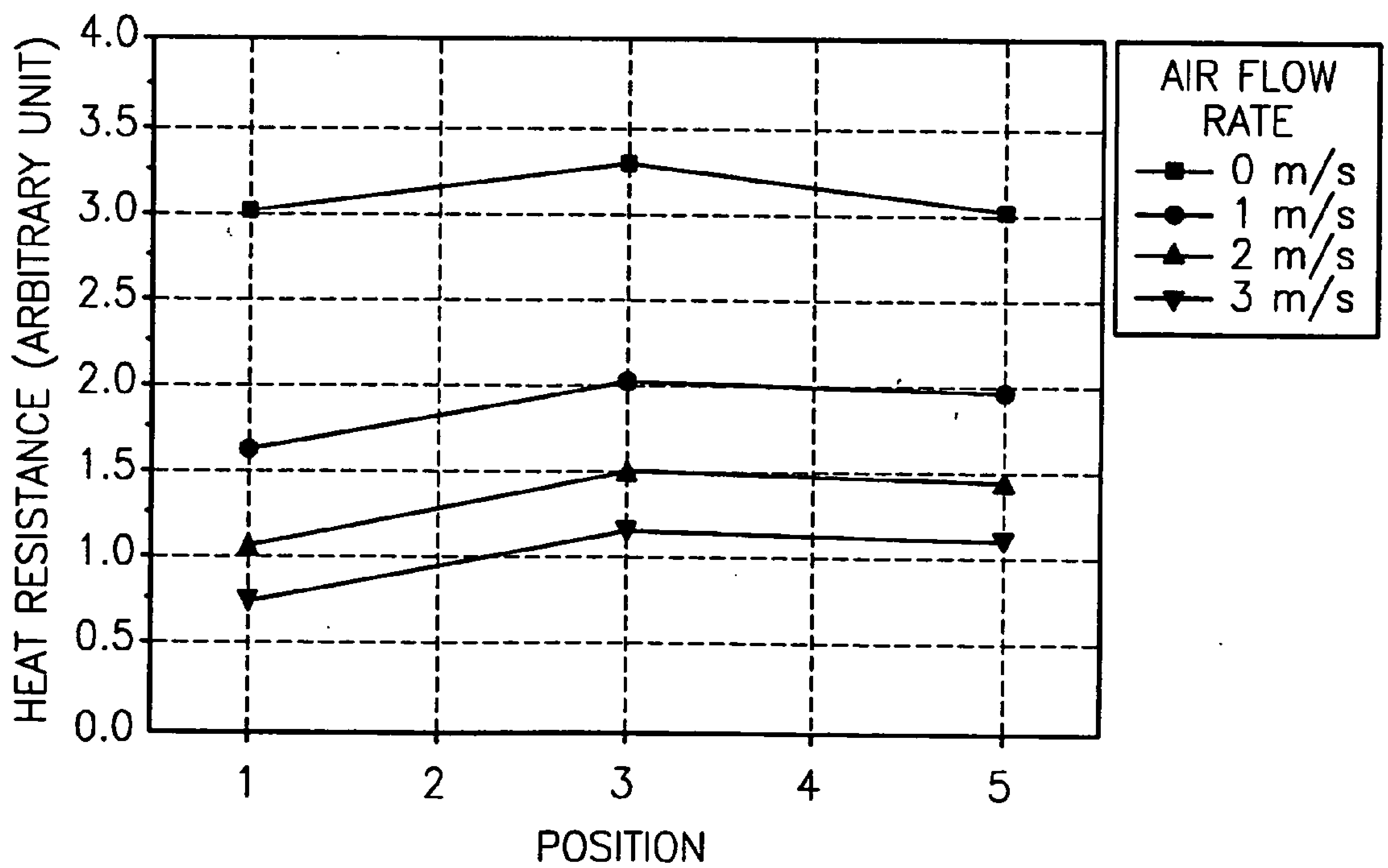


FIG. 20



CLOTHESPIN TYPE HEAT DISSIPATING APPARATUS FOR SEMICONDUCTOR MODULE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from Korean Patent Application No. **2003-8450**, filed on Feb. 11, 2003, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This disclosure relates to a semiconductor module, and more particularly, to a clothespin type heat dissipating apparatus that can effectively dissipate heat generated by a device mounted on a semiconductor module and which can be easily attached to and detached from the semiconductor module.

[0004] 2. Description of the Related Art

[0005] Recently, the thermal issue of semiconductor modules, such as, high density memory modules, becomes more critical. Along with the concerns about increasing power consumption and heat generation, which have arisen from the expectation that the capacity of memory modules will increase by up to 2 GB or more, there has been a need for a solution to the thermal issues associated with such memory modules.

[0006] As the rate of data transmission between a central processing unit (CPU) and peripheral devices becomes faster, the operating current of memory products becomes greater. To raise the capacity of memory modules, stacking more individual electronic components upon one another has been suggested. However, stacked memory modules result in poor thermal resistance.

[0007] A higher temperature of modules leads to a lower operation rate, poor refresh properties, and a shorter life span. For example, the data retention time (tREF) of Dynamic Random Access Memory (DRAMs) is a very critical factor. When the temperature, i.e., the device junction temperature (Tj), of a module rises 10° C., the data retention time is reduced by about 30%. As the temperature of memory modules increases, the yield decreases. Therefore, there is a need to keep the device junction temperature (Tj) constant without raising thermal problems.

[0008] Such a memory module is mounted in a slot of a mother board in a (personal) computer system, as shown in **FIG. 1**.

[0009] **FIG. 1** is a diagram illustrating conventional memory modules mounted on a printed circuit board. Referring to **FIG. 1**, individual devices **13**, which generally have a package form, are integrated on a module board **10** to form a memory module **14**. The memory module **14** is inserted in a slot **11**. About three or four slots **11** are spaced a distance of, for example, about 9.55 mm apart from one another, and a plurality of memory modules **14** are inserted in the slots **11** parallel to each other.

[0010] The temperature of the memory modules **14** varies depending on the positions of the devices **13** therein. The temperature of a memory module **14** at both end portions thereof is about 92° C., whereas the temperature of the memory module **14** at the center portion is about 132° C. This is because a larger amount of air flows at the end portions to facilitate thermal convection, whereas the air flows more slowly at the center portion and hot air flows towards the center portion from the front portion.

[0011] Such a rise in the temperature of the memory module **14** becomes more serious when the interval between a plurality of memory modules **14** inserted into the slots **11** is narrower. In particular, when each memory device **13** mounted in a limited area of the memory model **14** is highly integrated with more stacks, the problem of temperature rise is at its worst. This is because the interval between the modules **14** becomes narrower as the package has more stacks. For the double-side stacked memory module **14** as shown in **FIG. 1**, the interval between the modules is only 3.55 mm, which leads to more serious rises in temperature.

[0012] To compensate for the rise in temperature in such memory modules, various kinds of heat dissipating apparatus, for example, a heat sink or a heat spreader, have been attached to memory modules.

[0013] For example, for RAMBUS DRAMs, heat spreaders are disposed with a module therebetween and bound together by rebating. However, the heat spreaders rather hinder airflow and thermal convection when the modules are narrowly spaced with highly stacked packages and fail to dissipate or distribute heat.

[0014] In U.S. Pat. No. 5,966,287, entitled "Clip-on Heat Exchanger for a Memory Module and Assembly Method," two parts, each of which includes a heat spreader and a heat sink, are arranged with a memory module therebetween and bound together using a clip.

[0015] However, with the above methods of coupling the heat dissipating apparatuses to a memory module by rebating or clipping, attaching or detaching the heat spreader or heat sink to/from the memory module is a complicated process.

[0016] The following are considerations required when attaching a heat sink or heat spreader to memory modules. First, the heat spreader or heatsink must tightly contact the individual components, i.e., the packages, of the memory module to lower contact resistance and more effectively transfer heat. Second, it must be easy to attach a heat spreader to or detach it from a memory module. Third, heat spreaders must be designed to induce more effective thermal convection.

[0017] However, as described above, the conventional coupling methods are complicated and do not allow tight binding between the heat spreader and the chip packages of the module. Therefore, a more effective heat dissipating apparatus that may be conveniently attached or detached from memory modules is required.

[0018] Embodiments of the invention address these and other limitations of the prior art.

SUMMARY OF THE INVENTION

[0019] The present invention provides a heat dissipating apparatus that can be easily attached to and detached from a semiconductor module and which can effectively dissipate heat generated by components (packages) of the semiconductor module to prevent a rise in the temperature of the semiconductor module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The above and other features and advantages of the invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings.

[0021] **FIG. 1** is a diagram illustrating conventional memory modules mounted on a mother board.

[0022] **FIG. 2** is a diagram illustrating a clothespin type heat dissipating apparatus for memory modules according to an embodiment of the invention.

[0023] **FIG. 3** is an exploded perspective diagram of the heat dissipating apparatus shown in **FIG. 2**.

[0024] **FIG. 4** is a perspective diagram illustrating a process of installing the heat dissipating apparatus of **FIG. 2** on a memory module.

[0025] **FIG. 5** is a perspective diagram illustrating the heat dissipating apparatus of **FIG. 2** installed on a memory module.

[0026] **FIG. 6** is a cross-sectional diagram of **FIG. 5**.

[0027] **FIGS. 7 and 8** are cross-sectional diagrams illustrating examples of heat dissipating portions for the heat dissipating apparatus according to some embodiments of the invention.

[0028] **FIGS. 9, 10, 11**, and **12** are cross-sectional diagrams illustrating examples of a biasing member for the heat dissipating apparatus according to some embodiments of the invention.

[0029] **FIGS. 13, 14, 15, 16**, and **17** are cross-sectional diagrams illustrating examples of thermal interface material layers that may be formed in the heat dissipating apparatus according to some embodiments of the invention.

[0030] **FIGS. 18, 19**, and **20** are graphs of heat resistance vs. position for various airflow rates that illustrate the effectiveness of embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0031] Embodiments of the invention will be described with reference to the appended drawings. The invention may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the concept of the invention to those skilled in the art. It is also noted that like reference numerals may be used to designate identical or corresponding parts throughout the several views.

[0032] In the following embodiments according to the invention, a clothespin type heat dissipating apparatus is described that effectively dissipates heat generated by packages of a semiconductor memory module to prevent a rise in the temperature of the semiconductor memory module.

[0033] A clothespin type heat dissipating apparatus according to an embodiment of the invention includes two heat exchanger members, which are substantially symmetrical, disposed with a memory module therebetween. Each of the heat exchanger members may act as a heat sink and a heat spreader. These two heat exchanger members are hinged by a connection member for pivot movability. The connection member is positioned between the heat exchange members. In particular, each heat exchange member includes a contacting portion, which contacts the memory module, and a heat dissipating portion, which extends like a fin above the memory module. The connection member is positioned between the heat dissipating portion and the contacting portion. As such, the two heat exchange members can clip the memory module while being hinged about the connection member.

[0034] To provide a force pushing the heat exchange members closer the packages mounted on a board of the memory module, a biasing member, for example, a spring may be inserted between the heat exchange members.

[0035] The contacting portion of each heat exchange member, which contacts the packages of the memory module, acts as a heat sink. The heat dissipating portions extending from the contacting portions, respectively, above the memory module inserted between the contacting portions effectively dissipate heat transmitted via the contacting portions into air by thermal convection.

[0036] Each of the contacting portions may include a heat transfer layer made of a thermal interface material (TIM) to ensure more effective heat transfer between the contacting portion of the heat exchange member and the packages of the memory module. A recess that will be filled with TIM may be formed in each of the contacting portions for tighter contact with the memory module. To provide against a case where the TIM is changed into liquid phase by the heat generated by the packages, either a packing member or a barrier may be formed around the TIM material layer to prevent it from running out of the recess.

[0037] The clothespin type heat dissipating apparatus according to embodiments of the invention may be easily attached to and detached from a memory module by simple clipping. In addition, due to the biasing force or tension applied by the biasing member, tight contact between the heat exchange members and the memory module is ensured, thereby maximizing the efficiency of transmitting heat from the package to the heat exchange members.

[0038] The heat transmitted from the packages is transmitted to the heat dissipating portions of the heat dissipating apparatus. Since the heat dissipating portions protrude above the memory module inserted between the contacting portions to induce thermal convection, it can quickly dissipate the heat transferred from the packages into air. As a result, a rise in the temperature of the memory module can be effectively prevented.

[0039] **FIG. 2** is a diagram illustrating a clothespin-type, heat-dissipating apparatus for memory modules according to an embodiment of the invention. **FIG. 3** is an exploded perspective diagram of the heat dissipating apparatus shown in **FIG. 2**. **FIG. 4** is a perspective diagram illustrating a process of installing the heat dissipating apparatus of **FIG. 2** on a memory module. **FIG. 5** is a perspective diagram illustrating the heat dissipating apparatus of **FIG. 2** installed on a memory module, and **FIG. 6** is a cross-sectional diagram of **FIG. 5**.

[**0040**] Referring to **FIGS. 2 and 6**, a clothespin type heat dissipating apparatus according to an embodiment of the invention includes two heat exchange members **100** and **200**, which are hinge jointed together for clipping, like a clothespin.

[**0041**] In particular, a first heat exchange member **100** and a second heat exchange member **200** may be formed to be substantially the same, for example, to be flat, although other shapes may be used depending on the operating environment. The first heat exchange member **100** includes a first contacting portion **110** and a first heat dissipating portion **130** extending from the first contacting portion **110**. Likewise, the second heat exchange member **200**, which corresponds to the first heat exchange member **100**, includes a second contacting portion **210** and a second heat dissipating portion **230** extending from the second contacting portion **210**. The first contacting portion **110** is thermally connected to the first heat dissipating portion **130**, and the second contacting portion **210** is thermally connected to the second heat dissipating portion **240**.

[**0042**] The first contacting portion **110** substantially contacts a package **530** (see **FIG. 4**), which is an electronic part, on a semiconductor memory module **500**. The second contacting portion **210** does the same for an electronic part on the other side of the memory module **500**. As shown in **FIGS. 5 and 6**, the semiconductor memory module **500** is inserted between the first and second contacting portions **110** and **210** so that the surfaces of the package **530** on a board **510** of the semiconductor memory module **500** contact the first and second contacting portions **110** and **210**, as shown in **FIGS. 4 and 6**.

[**0043**] The first contacting portion **110** and/or the second contacting portion **210** contact the surface of the package **530** so that heat generated by the package **530** when the memory module **500** is operated in a computer is transferred to the first and second contacting portions **110** and **210**. The first and second contacting portions **110** and **210** act as heat sinks. A TIM layer **600** (see **FIG. 6**), which will be described later, is formed on an inner surface of each of the first and second contacting portions **110** and **210** for tighter and closer contact between the first and/or second contacting portions **110** and **210** and the package **530**.

[**0044**] The first heat dissipating portion **130**, which extends from the first contacting portion **110** and is thermally connected thereto, is positioned to protrude above the memory module **500** that is clamped between heat dissipating apparatus, as shown in **FIGS. 5 and 6**. When the heat dissipating apparatus is coupled to the memory module **500**, as shown in **FIG. 5**, the outer surfaces of the first and second heat dissipating portions **130** and **230** are exposed to the air so that they can effectively dissipate into air the heat transmitted from the first and/or second contacting portions **110** and **210**. In other words, there is no blockage of airflow between the first and second heat dissipating portions **130** and **230**, thereby allowing smooth thermal convection. As a result, heat can be effectively dissipated through the first and second heat dissipating portions **130** and **230**. As such, the first and second heat dissipating portions **130** and **230** substantially act as effective heat spreaders.

[**0045**] The first and second heat dissipating portions **130** and **230**, which protrude, like fins, above the memory module **500**, may be designed to have a relatively large surface area for effective heat dissipating or heat transfer into air. To this end, the first and second heat dissipating portions **130** and **320** may have uneven surfaces, as shown in **FIGS. 7 and 8**. Alternatively, the first and second heat dissipating portions **130** and **320** may be formed of a metal plate, for example, aluminum, with porous surfaces.

[**0046**] The heat dissipating apparatus according to embodiments of the invention can effectively cool the package **530** by maximizing a thermal convection effect and can be easily attached to or detached from the semiconductor memory module **500** by simple clipping.

[**0047**] Referring back to **FIGS. 2 through 6**, the first and second heat exchange members **100** and **200** are hinge joined together by a connection portion **300**. The connection portion **300** may include a hinge **310** and a pin **350**, which is passed through the hinge **310**. The first and second heat exchange members **100** and **200** can do hinging movements about the connection portion **300**. When inserting the semiconductor memory module **500** between the first and second contacting portions **110** and **210** of the heat exchange members **100** and **200**, the first and second contacting portions **110** and **210** are opened wide, as shown in **FIG. 4**, the memory module **500** is inserted between the first and second contacting portions **110** and **210**, and the first and second contacting portions **110** and **210** are closed, as shown in **FIG. 5**.

[**0048**] To keep the first and second contacting portions **110** and **210** in contact with the memory module **500**, as shown in **FIG. 6**, a biasing member **400** (see **FIGS. 4 and 5**) is disposed between the first and second heat dissipating portions **130** and **230**. The biasing force **400** between the first and second heat dissipating portions **130** and **230** provides a force pushing the first and second contacting portions **110** and **210** toward the memory module **500**, due to the hinged structure of the heat dissipating apparatus.

[**0049**] For example, a spring may be installed between the first and second heat dissipating portions **130** and **230** as the biasing member **400**, as shown in **FIG. 2**. The spring provides a force pushing the first and second heat dissipating portions **130** and **230** outward, as indicated by arrows in **FIG. 2**. At the same time, the first and second contacting portions **110** and **210** are pushed inward by the force of the spring due to the hinged structure of the first and second heat exchange members **100** connected by the connection portion **300**.

[**0050**] In other words, when the first and second heat dissipating portions **130** and **230** are pushed in the directions indicated by arrows in **FIG. 4**, the first and second contacting portions **110** and **210** are opened to allow for the semiconductor memory module **500** to be inserted therebetween. When the first and second heat dissipating portions **130** and **230** are released from the force after the semiconductor memory module **500** has been inserted between the first and second contacting portions **110** and **210**, the first and second heat dissipating portions **130** and **230** are pushed apart by the restoring force of the biasing member **400**, as indicated by arrows in **FIG. 5**. This force is transmitted to the first and second contacting portions **110** and **210** via the connection portion **300** so that they become tightly affixed to the memory module **500**.

[0051] **FIGS. 9, 10, 11**, and **12** are cross-sectional diagrams illustrating examples of a biasing member for the heat dissipating apparatus according to some embodiments of the invention.

[0052] The biasing member **400** may have various shapes, as shown in **FIGS. 9 through 12**. For example, a spring **410** may be used for the biasing member **400**, as shown in **FIG. 9**. A plate spring **420** or **430** may be used for the biasing member **400**, as shown in **FIGS. 10 and 11**.

[0053] Alternatively, a C-shaped spring **440** may be used, as shown in **FIG. 12**. In this case, the ends of the C-shaped spring **440** may be connected to the external surfaces of the first and second contacting portions **110** and **210** and the C-shaped spring **440** is oriented such that the connection portion **300** is included in the space formed by the C-shaped spring **440**.

[0054] The heat dissipating apparatus according to embodiments of the invention is structured like a clip and utilizes the elastic force of the elastic member **400** to attach the first and second contacting portions **110** and **210** to the memory module **500**. A heat dissipating apparatus having such a structure may be conveniently attached or detached from the memory module **500** by simple clipping.

[0055] Referring to **FIG. 6**, for tighter contact between the contacting portions **110** and **210** and the packages **530** and effective heat transmission from the package **530**, TIM layers **600** may be formed between the package **530** and the first and second contacting portions **110** and **210**, as described above. Examples of a material for the TIM layers **600** include thermal tape, thermal grease, a thermal epoxy, and a phase change material, for instance.

[0056] **FIGS. 13, 14, 15, 16**, and **17** are cross-sectional diagrams illustrating examples of thermal interface material layers that may be formed in the heat dissipating apparatus according to some embodiments of the invention.

[0057] As shown in **FIG. 13**, the TIM layers **600** may be formed on surfaces of the first and second contacting portions **110** and **210** that face the package **530**. As shown in **FIGS. 14 and 15**, to raise the efficiency of heat transmission from the package **530**, a recess **610** may be formed in the surface of each of the first and second contacting portions **110** and **130**, and the recess **610** filled with the TIM layer **600**. The recess **610** filled with the TIM layer **600** provides more stable adhesion to the package **530**.

[0058] Alternatively, as shown in **FIGS. 16 and 17**, a barrier or a packing member **700** may be provided adjacent to the TIM layer **600**. The barrier or packing member **700** may be made of rubber, or other acceptable material. The barrier or packing member **700**, which bounds the TIM layer **600** filling the recess **610**, prevents the TIM layer **600** from dripping down the sides of the apparatus. When the TIM layer **600** is in liquid form or is made of a PCM that changes into a liquid at an elevated temperature, or when the temperature of the package **530** is raised, the TIM layer **600** could otherwise drip down the sides of the apparatus. The barrier or the packing member **700** prevents this problem.

[0059] The surfaces of the first and second contacting portions **110** and **210** that face the package **530** may be processed to be rough or to increase the surface area to maximize the adhesion to the semiconductor memory module **500**. To this end, the surfaces of the first and second contacting portions **110** and **210** may be processed by etching, sputtering, coating, etc.

[0060] As described above, the temperature of semiconductor memory modules can be effectively maintained at a lower temperature using the above heat dissipating apparatus according to embodiments of the invention.

[0061] **FIGS. 18, 19**, and **20** are graphs of heat resistance vs. position for various airflow rates that illustrate the effectiveness of embodiments of the invention. **FIG. 18** is derived from the case where no heat dissipation apparatus is used on a semiconductor memory module. **FIG. 19** is derived from the case where a conventional rebated heat spreader is used on a semiconductor memory module, and **FIG. 20** is derived from the case where an embodiment of the invention was used to dissipate heat from a semiconductor memory module.

[0062] The semiconductor memory module **500**, in which nine packages **530** are mounted, as shown in **FIG. 4**, was used to obtain each set of results shown in **FIGS. 18-20**. Positions **1**, **2**, **3**, **4**, and **5** denote the first, third, fifth, seventh, and ninth package from the left end of the semiconductor memory module **500**, respectively. In other words, positions **1** and **5** correspond to the leftmost package and the rightmost package, respectively, and position **3** corresponds to the middle package. Thermal resistance was measured at different air flow rates, in which the airflow moved in a direction from position **1** towards position **5**.

[0063] A smaller value of heat resistance implies a greater cooling effect. Comparing the results in **FIG. 20** to the results in **FIGS. 18 and 19**, it is apparent that the heat dissipating apparatus according to embodiments of the invention can effectively lower the temperature of memory modules and can evenly distribute the temperature of memory modules.

[0064] In conclusion, a clothespin type heat dissipating apparatus according to embodiments of the invention can easily be attached to or detached from a semiconductor memory module by simple clipping. The heat dissipating apparatus has fin-like heat dissipating portions that protrude above the semiconductor memory module, so that it can effectively dissipate heat into air by convection.

[0065] The heat dissipating apparatus according to some embodiments of the invention has recesses in the contacting portions thereof and packing members, so that a TIM material that changes into liquid by heat absorption can be effectively applied to the heat dissipating apparatus. Therefore, a rise in the temperature of semiconductor memory modules can be effectively prevented using the heat dissipating apparatus.

[0066] Furthermore, embodiments of the invention evenly control the distribution of temperature over the semiconductor memory module, without uneven rises in the temperature of a particular package of the semiconductor memory module.

[0067] Particular embodiments of the invention will now be described, but those embodiments shall not be considered to limit the invention nor prohibit the invention from operating in a different manner.

[0068] Some embodiments of the invention provide a clothespin type heat dissipating apparatus for semiconductor modules, the apparatus including: two heat exchange members, which are arranged facing each other with a semiconductor module therebetween, the semiconductor module including a plurality of packages; a connection member formed in the middle of each of the heat exchange members to hinge join the heat exchange members such that portions of the heat exchange members protrude above the semiconductor module inserted between the heat exchange members; and a biasing member disposed between the heat exchange members to provide a force pushing portions of the heat exchange members below the connection member toward the packages of the semiconductor module.

[0069] Other embodiments of the invention provide a clothespin type heat dissipating apparatus for semiconductor modules, including: a first heat exchange member including a first contacting portion, which is arranged in contact with a surface of a semiconductor module to absorb heat generated by the semiconductor module, and a first heat dissipating portion, which is thermally connected to the first contacting portion to dissipate the heat absorbed by the first contacting portion; a second heat exchange member including a second contacting portion, which is arranged in contact with the other surface of the semiconductor module to absorb the heat generated by the semiconductor module, and a second heat dissipating portion, which is thermally connected to the second contacting portion to dissipate the heat absorbed by the second contacting portion; and an elastic member providing a force pushing the first and second contacting portions toward the surfaces of the semiconductor module inserted between the first and second contacting portions.

[0070] In some embodiments of the invention, the portions of the heat exchange members that protrude above the semiconductor module may have uneven surfaces. In alternative embodiments of the invention, the portions of the heat exchange members that protrude above the semiconductor module may be made of a metal plate, for example, aluminum, with a porous surface.

[0071] The biasing member may be a C-shaped spring whose both ends go through the first and second heat dissipating portions and are connected to external surfaces of the first and second contacting portions and which is oriented such that the connection portion is included in the space formed by the C-shaped spring.

[0072] Embodiments of the invention may further include a connection member, which hinge joins the first and second heat exchange members such that the first and second heat dissipating portions protrude above the semiconductor module inserted between the heat exchange members, wherein the biasing member may be one of a spring, a plate spring, and a C-shaped spring, which is disposed between the first and second heat dissipating portions and provides the force pushing the first and second contacting portions toward the surfaces of the semiconductor module inserted between the first and second contacting portions due to the force of the biasing member being exerted outward on the first and second heat dissipating portions.

[0073] Embodiments of the invention may further include a thermal interface material layer on the portions of the heat exchange portions below the connection member, which contact the surfaces of the packages. In alternative embodiments of the invention, the thermal interface material layer may be made of one selected from the group consisting of a thermal tape, a thermal grease, a thermal epoxy, and a phase change material.

[0074] In some embodiments of the invention, the portions of the heat exchange portions below the connection member, which contact the surfaces of the packages, are subjected to surface processing selected from the group consisting of etching, sputtering, and coating, to enhance the adhesion to the semiconductor module.

[0075] Other embodiments of the invention provide a clothespin type heat dissipating apparatus for semiconductor modules, including: a first heat exchange member including a first contacting portion, which is arranged in contact with a surface of a semiconductor module to absorb heat generated by the semiconductor module, and a first heat dissipating portion with uneven surfaces, the first heat dissipating portion being thermally connected to the first contacting portion to dissipate the heat absorbed by the first contacting portion; a second heat exchange member including a second contacting portion, which is arranged in contact with the other surface of the semiconductor module to absorb the heat generated by the semiconductor module, and a second heat dissipating portion with uneven surface, the second heat dissipating portion being thermally connected to the second contacting portion to dissipate the heat absorbed by the second contacting portion; a connection member, which hinge joins the first and second heat exchange units such that the first and second heat dissipating portions protrude above the semiconductor module inserted between the first and second heat exchange members; and an elastic member disposed between the first and second heat exchange members to provide a force pushing the first and second contacting portions toward the surfaces of the semiconductor module inserted between the first and second contacting portions.

[0076] Other embodiments of the invention provide a clothespin type heat dissipating apparatus for semiconductor modules, including: a first heat exchange member including a first contacting portion, which is arranged in contact with a surface of a semiconductor module to absorb heat generated by the semiconductor module, and a first heat dissipating portion, which is thermally connected to the first contacting portion to dissipate the heat absorbed by the first contacting portion; a second heat exchange member including a second contacting portion, which is arranged in contact with the other surface of the semiconductor module to absorb the heat generated by the semiconductor module, and a second heat dissipating portion, which is thermally connected to the second contacting portion to dissipate the heat absorbed by the second contacting portion; a connection member, which hinge joins the first and second heat exchange units such that the first and second heat dissipating portions protrude above the semiconductor module inserted between the heat exchange members; an elastic member disposed between the first and second heat exchange members to provide a force pushing the first and second contacting portions toward the surfaces of the semiconductor module inserted between the first and second contacting portions; thermal interface material layers formed between the surfaces of the semiconductor module and facing surfaces of the first and second contacting portions; and packing members bounding the thermal interface material layers formed on the first and second contacting portions, respectively, to prevent the thermal interface material layers from running down the facing surfaces of the first and second contacting portions if the thermal interface material reaches a liquid or semi-liquid state.

[0077] In some embodiments of the invention, the packing members may be made of rubber. The facing surfaces of the first and second contacting portions may include a recess filled with the corresponding thermal interface material layer. Each of the packing members may be disposed around the corresponding recess.

[0078] As described above, embodiments of the invention have heat dissipating portions that protrude above a semiconductor module, and can effectively dissipate heat generated by the semiconductor module. In addition, embodiments of the invention can be easily attached to and detached from the semiconductor module by a simple clipping process.

[0079] While the invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

We claim:

1. An apparatus comprising:

two heat exchange members configured to be placed on both sides of a semiconductor module, the semiconductor module including a plurality of packages;

a connection member between the two heat exchange members configured to movably join the two heat exchange members, wherein portions of the two heat exchange members are configured to protrude above the semiconductor module; and

a biasing member disposed between the two heat exchange members and configured to provide a force that holds the two heat exchange members against the packages of the semiconductor module.

2. The apparatus of claim 1, wherein the connection member comprises a hinge.

3. The apparatus of claim 1, wherein the portions of the two heat exchange members have uneven surfaces.

4. The apparatus of claim 1, wherein the portions of the two heat exchange members comprise:

a metal plate having a porous surface.

5. The apparatus of claim 4, wherein the metal plate comprises an aluminum plate.

6. The apparatus of claim 1, wherein the biasing member is disposed between the portions of the two heat exchange members that protrude above the semiconductor module and is chosen from the group consisting of a spring, a plate spring, and a C-shaped spring.

7. The apparatus of claim 1, further comprising:

a thermal interface material layer formed on at least one of the heat exchange members and configured to contact a surface of the packages.

8. The apparatus of claim 7, wherein the thermal interface material layer is selected from the group consisting of a thermal tape, a thermal grease, a thermal epoxy, and a phase change material.

9. The apparatus of claim 7, wherein at least one of the two heat exchange members comprise a recess filled with the thermal interface material layer.

10. The apparatus of claim 7, wherein at least one of the two heat exchange members comprise a packing member bounding the thermal interface material layer.

11. The apparatus of claim 1, wherein at least one of the heat exchange members is subjected to surface processing selected from the group consisting of etching, sputtering, and coating.

12. An apparatus comprising:

a first heat exchange member including a first contacting portion, the first contacting portion configured to contact a surface of a semiconductor module to absorb heat generated by the semiconductor module, and a first heat dissipating portion, which is thermally connected to the first contacting portion to dissipate the heat absorbed by the first contacting portion;

a second heat exchange member including a second contacting portion, the second contacting portion configured to contact another surface of the semiconductor module to absorb the heat generated by the semiconductor module, and a second heat dissipating portion, which is thermally connected to the second contacting portion to dissipate the heat absorbed by the second contacting portion; and

an elastic member structured to provide a force that draws the first and second contacting portions toward each other.

13. The apparatus of claim 12, wherein the elastic member is a C-shaped spring having ends going through the first and second heat dissipating portions, the apparatus and that are connected to external surfaces of the first and second contacting portions and which is oriented such that the connection portion is included in the space formed by the C-shaped spring.

14. The apparatus of claim 12, further comprising:

a connection member, which hinge joins the first and second heat exchange members such that the first and second heat dissipating portions protrude above the semiconductor module inserted between the heat exchange members, wherein the elastic member is chosen from the group consisting of a spring, a plate spring, and a C-shaped spring, and wherein the elastic member is disposed between the first and second heat dissipating portions.

15. The apparatus of claim 12, wherein the first and second contacting portions are subjected to surface processing selected from the group consisting of etching, sputtering, and coating, to increase the adhesion to the semiconductor module.

16. An apparatus comprising:

a first heat exchange member including a first contacting portion configured to contact a surface of a semiconductor module to absorb heat generated by the semiconductor module, and including a first heat dissipating portion with uneven surfaces, the first heat dissipating portion thermally connected to the first contacting portion to dissipate the heat absorbed by the first contacting portion, wherein the first heat dissipating portion is configured to protrude above the semiconductor module;

a second heat exchange member including a second contacting portion configured to contact another surface of the semiconductor module to absorb the heat generated by the semiconductor module, and including a second heat dissipating portion with uneven surface, the second heat dissipating portion thermally connected to the second contacting portion to dissipate the heat absorbed by the second contacting portion, the second heat dissipating portion configured to protrude above the semiconductor module;

a hinge that joins the first and second heat exchange members; and

a biasing member disposed between the first and second heat exchange members to provide a force that draws the first and second contacting portions toward the surface and the another surface of the semiconductor module that is inserted between the first and the second contacting portions.

17. The apparatus of claim 16, wherein the first and second heat dissipating portions are made of an aluminum plate with porous surfaces.

18. An apparatus comprising:

a first heat exchange member including a first contacting portion that is configured to contact a surface of a semiconductor module to absorb heat generated by the semiconductor module, and including a first heat dissipating portion that is thermally connected to the first contacting portion to dissipate the heat absorbed by the first contacting portion, wherein the first heat dissipating portion is configured to protrude above the semiconductor module;

a second heat exchange member including a second contacting portion that is configured to contact another surface of the semiconductor module to absorb the heat generated by the semiconductor module, and including a second heat dissipating portion that is thermally connected to the second contacting portion to dissipate the heat absorbed by the second contacting portion, wherein the second heat dissipating portion is configured to protrude above the semiconductor module;

a hinge that joins the first and second heat exchange units;

an elastic member disposed between the first and second heat exchange members to provide a force that draws the first and second contacting portions toward the surface and another surface of the semiconductor module inserted between the first and second contacting portions;

thermal interface material layers formed on the first and the second contacting portions; and

packing members bounding the thermal interface material layers.

19. The apparatus of claim 18, wherein the packing members comprise rubber packing members.

20. The apparatus of claim 18, wherein the first and second contacting portions comprise a recess filled with the corresponding thermal interface material layer.

21. The apparatus of claim 20, wherein each of the packing members is disposed around the corresponding recess.

22. A heat dissipater, comprising:

a relatively flat, elongated thermally conductive substrate; and

a clamp structured to hold a portion of the thermally conductive substrate adjacent to a top surface of one or more heat generating components that are attached to a circuit board.

23. The heat dissipater of claim 22, further comprising a second elongated thermally conductive substrate.

24. The heat dissipater of claim 23 wherein the clamp is structured to hold the first conductive substrate against a top surface of one or more heat generating components that are attached to a first side of the circuit board, and is structured to hold the second conductive substrate against a top surface of one or more heat generating components that are attached to a second side of the circuit board.

25. The heat dissipater of claim 23 wherein the clamp is a hinge clamp mounted between the first and second conductive substrates.

26. The heat dissipater of claim 22 wherein the clamp further comprises a biasing member.

27. The heat dissipater of claim 25 wherein the biasing member is one selected from the group of a spring, a plate spring, and a C-shaped spring.

28. The heat dissipater of claim 22 wherein the thermally conductive substrate is aluminum.

29. The heat dissipater of claim 22, further comprising a thermal interface material disposed on the thermally conductive substrate.

30. The heat dissipater of claim 28 wherein the thermal interface material is non-conductive.

31. A method of dissipating heat from two or more heat generating components mounted on opposite surfaces of a circuit board, the method comprising:

simultaneously clamping, to at least two opposed top surfaces of the heat generating components, portions of a first and a second elongated thermally conductive substrate, respectively.

32. The method of claim 31 wherein clamping comprises:

temporarily overcoming a normal biasing force to separate the first and second elongated substrates;

positioning portions of the first and second elongated substrates over the at least two opposed top surfaces, respectively; and

releasing the temporarily applied force to cause the normal biasing force to hold the first and second elongated substrates adjacent to the at least two opposed top surfaces, respectively.

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