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(71) Applicant(s)
Kingsdown, Inc.

(72) Inventor(s)
Scott, David B.;Carrier, Joshua A.;Schmoeller, Joe W.;Oexman, Robert D.

(74) Agent / Attorney
Spruson & Ferguson, L 35 St Martins Tower 31 Market St, Sydney, NSW, 2000

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(71) Applicant *(for all designated States except US)*: **KINGSDOWN, INC.** [US/US]; 126 West Holt Street, Mebane, North Carolina 27302 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **SCHMOELLER, Joe W.** [US/US]; c/o KINGSDOWN, INC., 126 West Holt Street, Mebane, North Carolina 27302 (US). **SCOTT, David B.** [US/US]; c/o KINGSDOWN, INC., 126 West Holt Street, Mebane, North Carolina 27302 (US). **OEXMAN, Robert D.** [US/US]; c/o KINGSDOWN, INC., 126 West Holt Street, Mebane, North Carolina 27302 (US). **CARRIER, Joshua A.** [US/US]; c/o KINGSDOWN, INC., 126 West Holt Street, Mebane, North Carolina 27302 (US).

(74) Agents: **TASKA, Andrew J.** et al.; Sughrue Mion, PLLC, 2100 Pennsylvania Avenue, NW, Suite 800, Washington, District Of Columbia 20037-3213 (US).

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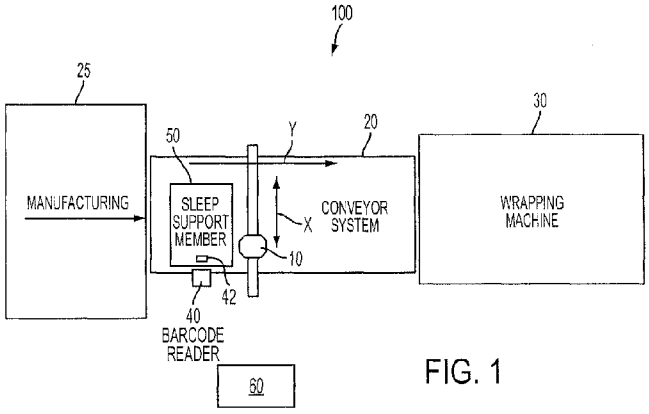

FIG. 1

(57) **Abstract**: A method of testing a sleep support member, the method including: identifying the sleep support member; determining a tested comfort/support value for the identified sleep support member before the identified sleep support member is provided to a customer; and determining whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member. An apparatus for testing a sleep support member, the apparatus including: an identification unit configured to identify the sleep support member; a comfort/support testing unit configured to determine a tested comfort/support value for the identified sleep support member before the identified sleep support member is provided to a customer; and an analysis unit configured to determine whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member.

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METHODS AND APPARATUSES FOR COMFORT/SUPPORT ANALYSIS OF A SLEEP SUPPORT MEMBER

CROSS-REFERENCE TO RELATED PATENT APPLICATION

[01] This application claims priority from U.S. Provisional Patent Application No. 61/075,796, filed on June 26, 2008, in the U.S. Patent and Trademark Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[02] Methods and apparatuses consistent with the present invention relate to comfort/support analysis of a sleep support member and to determining whether the firmness of an identified sleep support member is acceptable. Among other things, methods and apparatuses consistent with the present invention relate to testing a sleep support member's firmness after the sleep support member is manufactured, but before the sleep support member leaves the manufacturing line. These methods and apparatuses also relate to determining whether customized sleep support members, which have been custom-manufactured to provide optimal support and comfort characteristics for a particular person(s), have been manufactured to desired specifications.

2. Description of the Related Art

[03] A wide variety of different sleep systems are currently available. Such sleep systems may comprise all aspects of a bedding assembly including, but not limited to, mattresses, box springs, foundation units, bed frames, pillows, mattress pads, linens and, more generally, to any type of sleep product that influences a person's sleep. However, each respective sleep system may be suitable for some persons but not suitable for others persons.

[04] It is particularly important for a mattress and/or a foundation unit to provide proper comfort and support for a person using the mattress and/or foundation unit. For example, a mattress may deliver support through the resistance provided by innersprings to the downward force applied due to the person's body weight.

[05] However, conventional manufacturing methods cannot guarantee that a manufactured mattress will provide comfort and support characteristics for a purchaser within acceptable tolerances. Further, there is no way for a purchaser to know that a mattress that is delivered to the purchaser's home exhibits the same comfort and support characteristics as the mattress that the purchaser tested in the store. Thus, there is a need for an objective way for a consumer to determine whether a purchased mattress is acceptable.

[06] Whether or not a mattress will provide proper comfort and/or support for an individual person can be determined by subjecting the mattress to a firmness test. This can be accomplished by using, for example, an Indention/Load/Deflection ("ILD") test machine. An ILD test machine is a conventional device that tests the firmness of a mattress or a foundation unit by determining how far the surface of the mattress or foundation unit deflects when subjected to a certain force (i.e., load). Conventional ILD test machines take measurements at regular intervals (e.g., ½ inch or one inch).

[07] Although such conventional ILD test machines are sometimes used to approximate the firmness of a batch of mattresses or foundation units by testing one mattress or foundation unit from the batch at the design stage, there is no conventional system that allows testing of whether the firmness of each and every mattress or foundation unit that is produced in a manufacturing line is acceptable as each mattress or foundation unit is manufactured. Thus, there is a need for an in-manufacturing-line comfort/support analysis system. Such a system would (among other advantages) help to address the problem of ensuring that a customized mattress and/or foundation unit (i.e., a mattress and/or foundation unit that is custom manufactured to meet the specific characteristics of the intended user(s)) is suitable for use by

the user(s). There is also a need for an improved comfort/support analysis system for research and development purposes.

[08] Conventional ILD test machines have failed to address these problems and the prior art has failed to appreciate the aforementioned advantages. Indeed, conventional ILD test machines have not been employed in a manufacturing line for testing mattresses, much less for every mattress that is manufactured. Moreover, conventional ILD test machines are typically only used to determine a firmness value for a specific deflection and there is generally no comparison performed using the entire ILD curve (i.e., various loads vs. deflection values). However, mattresses and foundation units frequently do not exhibit a linear ILD curve (i.e., they do not behave with a constant force per unit length according to Hooke's Law $F = -k \cdot x$).

[09] Instead, the ILD curve of many mattresses and foundation units is more complex because many mattresses or foundation units are made of multiple components and layers that provide varying levels of firmness. For instance, the top portion of a mattress typically comprises comfort materials such as foam and fiber materials that exhibit a different ILD curve than the support layers comprising inner-springs that are disposed underneath the comfort layers.

[10] Accordingly, an in-manufacturing-line comfort/support analysis system would be useful to manufacturers for warranty and quality assurance purposes and would allow manufacturers to ensure that manufacturing methods are correct. For example, an in-manufacturing-line comfort/support analysis system would allow manufacturers to guarantee that every manufactured mattress will provide comfort and support characteristics for a purchaser within acceptable tolerances. Such an in-manufacturing-line comfort/support analysis system would also provide customers with an objective way to distinguish mattresses.

[11] Additionally, a comfort/support analysis system that employs a comfort/support analysis curve, instead of a single point of measurement, would provide a more accurate

assessment of the sleep support member's characteristics. Moreover, measuring the comfort/support analysis curve while removing the testing platen from the mattress, in addition to measuring the comfort/support analysis curve while the testing platen is deflecting into the mattress, would allow analysis of the sleep support member's material recovery characteristics.

Object of the Invention

[11a] It is the object of the present invention to substantially overcome or at least provide a useful alternative over one or more of the above disadvantages.

Summary of the Invention

[12] Methods and apparatuses are described for comfort/support analysis of a sleep support member. An aspect of the present invention provides a method of testing a sleep support member, the method comprising: identifying by an identification unit, the sleep support member; determining, by a testing unit, a tested comfort/support value for the identified sleep support member before the identified sleep support member is provided to a customer; and determining, by an analysis unit, whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member.

[13] Another aspect of the present invention provides an apparatus for testing a sleep support member, the apparatus comprising: an identification unit configured to identify the sleep support member; a comfort/support testing unit configured to determine a tested comfort/support value for the identified sleep support member before the identified sleep support member is provided to a customer; and an analysis unit configured to determine whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member.

[14] Another aspect of the present invention provides a method of testing a sleep support member, the method comprising: identifying the sleep support member; determining a tested comfort/support value for the identified sleep support member; and determining whether the tested comfort/support value is within a predetermined tolerance level of a goal

comfort/support value for the identified sleep support member; wherein the goal comfort/support value comprises at least one goal Indention/Load/Deflection ("ILD") curve.

BRIEF DESCRIPTION OF THE DRAWINGS

[15] The above and other aspects will become more apparent by describing in detail illustrative embodiments thereof with reference to the attached drawings in which:

[16] FIG. 1 is a schematic view of a comfort/support analysis system for a sleep support member according to an illustrative embodiment of the present invention; and

[17] FIG. 2 is a schematic view of a first comfort/support analysis system and a second comfort/support analysis system configured to test two opposing sides of a sleep support member according to an illustrative embodiment of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[18] Hereinafter, illustrative embodiments of the present invention will be described in detail with reference to the attached drawings.

[19] FIG. 1 shows a sleep support member manufacturing line 100 according to an illustrative embodiment of the present invention. The illustrative sleep support member manufacturing line 100 includes a manufacturing area 25 for manufacturing a sleep support member 50. The sleep support member 50 may comprise a wide variety of sleep system components including, but not limited to, a mattress and/or foundation unit.

[20] According to the illustrative embodiment shown in FIG. 1, each manufactured sleep support member 50 is brought to a conveyor system 20 that conveys the sleep support member 50 from the manufacturing area 25 to a wrapping machine 30 that prepares the sleep support member 50 for shipment by wrapping the sleep support member 50.

[21] While the sleep support member 50 is on the conveyor system 20, the identity of the sleep support member 50 is determined by a reader 40 based on an identifier 42 provided on or in the sleep support member 50. The identifier 42 can include, but is not limited to, a bar

code or a Radio Frequency Identification Device (RFID) tag, while the reader 40 can include, but is not limited to, for example, a bar code reader or an RFID reader. However, the invention is not limited in the aforementioned illustrative configurations and other identifiers/readers can be used consistent with the present invention.

[22] According to an illustrative embodiment, the identifier 42 can include a wide variety of information relating to the sleep support member 50 including, but not limited to, goal specifications, goal comfort/support analysis curves, goal tolerance levels, sleep support member type, identifiers regarding the plant in which the sleep support member was manufactured, date of manufacture, information regarding manufacturing materials, customer information, etc. According to one illustrative embodiment, the identifier 42 comprises reference information relating to a database, data file, or the like, wherein the database data file, or the like stores goal specifications, goal comfort/support analysis curves, goal tolerance levels, sleep support member type, identifiers regarding the plant in which the sleep support member was manufactured, date of manufacture, information regarding manufacturing materials, customer information, etc.

[23] The firmness of the sleep support member 50 can be tested by a comfort/support analysis system 10. However, the invention is not limited in this respect. The comfort/support analysis system 10 can be disposed in a manufacturing line, or can be used outside of a manufacturing line for research and development purposes. The comfort/support analysis system 10 can include a contact surface that applies a load to the sleep support member 50 at a specific location and a strain gauge that measures the deflection of the sleep support member 50, but the invention is not limited to these structures. As the load applied to the sleep support member 50 at the specific location is increased, the sleep support member 50 will deflect a larger amount.

[24] According to an illustrative embodiment, the contact surface is pressed a specified distance into the sleep support member 50 at a specific location and the corresponding force

applied to the sleep support member 50 is analyzed. For example, measurements of corresponding forces taken within a distance from the top surface of the sleep support member 50 to a depth of approximately two inches from the surface of the sleep support member 50 could provide an approximation of the typical thickness of comfort materials in a mattress and could be used to calculate a comfort score. Further, measurements of corresponding forces taken within a distance from a depth of two inches from the surface of the sleep support member 50 to a depth of approximately seven inches from the surface of the sleep support member 50 could provide an approximation of the typical thickness of support materials in a mattress and could be used to calculate a support score. However, the present invention is not limited to the aforementioned illustrative embodiment and a wide variety of different measurement depths can be employed to calculate a comfort score and a support score since the thickness of comfort materials and support materials in a mattress can vary and the aforementioned embodiment only employs general approximations of these materials. Morover, according to one illustrative embodiment, measurements of corresponding forces taken at a top portion of the sleep support member 50 can provide an approximation of the typical thickness of comfort materials in a mattress and could be used to calculate a comfort score, and measurements of corresponding forces taken at a bottom portion of the sleep support member 50 could be used to calculate a support score.

[25] According to another illustrative embodiment, the contact surface is pressed into the sleep support member 50 at a specific location until a specified force applied to the sleep support member 50 is measured and the corresponding distance that the contact surface is pressed into the sleep support member 50 is measured. The aforementioned specified force may, for instance, correlate to anthropometric data to measurements acquired for a specific person.

[26] According to an illustrative embodiment, the reader 40 reads the identifier 42 of the sleep support member 50 to acquire goal specifications comprising goal comfort/support

analysis curves, for each sleep support member 50 that has been manufactured. The use of comfort/support analysis curves rather than just a single measurement point provides a more accurate comfort/support analysis of the sleep support member 50. For example, when a very broad shouldered person is sleeping on his/her side, the load on the sleep support member 50 at a specific location will be much greater than when the broad shoulder person is sleeping on his/her back, where the load is spread out to more locations on the sleep support member 50. By using goal comfort/support analysis curves rather than single goal ILD point, a sleep support member 50 can be tested to ensure (among other things) that it has the appropriate firmness for each sleeping position.

[27] In addition, according to an illustrative embodiment of the present invention, the comfort/support analysis system 10 includes a contact surface that applies a load to the sleep support member 50 at a specific location and that measures the comfort/support analysis curve while removing the contact surface from the sleep support member 50. In such a manner, the material recovery characteristics of the sleep support member 50 can be analyzed.

[28] Once the goal specifications for the manufactured sleep support member 50 are acquired, the comfort/support analysis system 10 then measures a comfort/support analysis curve at one or more locations on the identified sleep support member 50 by proceeding through a programmed test for the identified sleep support member 50. The testing is controlled, for example, by a controller 60, which includes a processor and a memory. Consistent with the present invention, it is possible for the comfort/support analysis system 10 to comprise multiple testing units, for example, to test both sides of a custom-manufactured sleep support member, wherein each side of the custom-manufactured sleep support member exhibits different characteristics.

[29] If more than one location is to be used, then the comfort/support analysis system 10 is moved in the X and/or Y-directions, as shown in FIG. 1, from one appropriate location over the identified sleep support member 50 to the next appropriate location over the identified

sleep support member 50. At each location, the load applied to the sleep support member 50 is gradually increased, while the comfort/support analysis system 10 determines the amount that the sleep support member 50 deflects. The measured comfort/support analysis curve is determined based on the respective deflection values for each of the different loads.

[30] In contrast to conventional ILD machines, which provide a weighted average ILD measurement, embodiments of the present invention provide both a comfort analysis measurement and a support analysis measurement. Indeed, one drawback (among other drawbacks) with using a conventional weighted average ILD measurement is that two sleep support members can have the same ILD weighted average, but have vastly different comfort / support characteristics (i.e., the two mattresses have completely different "feels").

[31] According to an illustrative embodiment, a plurality of analysis locations are used to replicate the physical attributes of the intended user(s) of the sleep support member 50. For example, a plurality of pressing structures may be arranged so that the location of each pressing structure replicates a part of the intended user's (or users') body (or bodies) depressed downwardly into the sleep support member 50 as described by the inventors of the present application, for example, in U.S. Patent No. 6,585,328, entitled "Customized Mattress Evaluation System" and in U.S. Provisional Application 61/028,599 entitled "Method and Apparatus for Testing a Mattress," both of which are incorporated herein by reference in their entirety. Such a plurality of pressing structures can employed, for instance, to measure comfort/support analysis curves relating to the amount that the sleep support member 50 deflects at a plurality of different locations deflected by each of the pressing structures, respectively. Additionally, such a plurality of pressing structures can be employed to deflect the sleep support member 50 at a number of locations until a certain force is reached and then the resulting deflection of the sleep support member 50 when the certain force is reached can be evaluated.

[32] Indeed, consistent with an illustrative embodiment of the present invention, a person could first be evaluated using the systems and methods described in U.S. Provisional Application 61/028,578, entitled "Apparatus and Methods for Evaluating a Person for a Sleep System," which is incorporated herein by reference in its entirety, so as to determine optimal support and comfort characteristics for the person. Then, a customized mattress could be manufactured for the person which exhibits the determined optimal support and comfort characteristics. Finally, illustrative embodiments of the present invention could be employed to evaluate whether the customized mattress accurately conforms to the determined optimal support and comfort characteristics within predetermined tolerance levels. For example, measurements relating to the consumer's body can be acquired in a sleep support member store using the systems and methods described in U.S. Provisional Application 61/028,578, and then such measurements can be transferred to the plurality of pressing structures arranged to replicate a part of the intended user's (or users') body (or bodies) depressed downwardly into the sleep support member 50 as described in U.S. Patent No. 6,585,328.

[33] The determinations provided by the comfort/support analysis system 10 are then compared with the goal comfort/support analysis curves. The identified sleep support member 50 is assigned a pass/fail value depending on whether the determined comfort/support analysis curves deviate from the goal curves by more than a predetermined tolerance level (e.g., $\pm 2\%$, $\pm 10\%$, $\pm 20\%$, etc.). According to an illustrative embodiment, the predetermined tolerance level is smaller for a highly customized sleep support member (i.e., a sleep support member designed precisely according to the user's specific physical attributes) than for a generically customized sleep support member (i.e., a sleep member generically designed for a plurality of users with similar physical attributes). In this way, the purchaser of a highly customized sleep support member can be assured that the mattress and/or box spring meets his/her precise specifications.

[34] According to an illustrative embodiment, each and every sleep support member 50 that is manufactured using a particular manufacturing line is subjected to testing by the comfort/support analysis system 10 to ensure that each sleep support member 50 meets desired specifications.

[35] In one embodiment, a sleep support member 50 that is assigned a fail value for goal comfort/support analysis curves of a specific product is discarded. However, in another embodiment, if a tested sleep support member 50 is assigned a fail value for goal comfort/support analysis curves of a specific product, then the measured comfort/support analysis curves of the tested sleep support member 50 are compared with the goal comfort/support analysis curves of various other products that are stored in a database within memory of the controller 60 or in an external database. If the measured comfort/support analysis curves of the tested sleep support member 50 match the goal comfort/support analysis curves of another product, within a required predetermined tolerance level, then the tested sleep support member 50 is re-assigned as the other product for which the tested sleep support member 50 exhibits a pass value and, thus, discarding of the mattress is avoided.

[36] Thereafter, the sleep support member 50 is sent to the wrapping machine 30 in order to prepare the sleep support member 50 for shipping, such as to the customer or a local store. A print out showing the actual measured comfort/support analysis curves compared to the goal comfort/support analysis curves can be included with the product to provide the customer assurance that the delivered sleep support member meets specifications.

[37] According to an illustrative embodiment shown in FIG. 2, a second comfort/support analysis system 11 may also be employed to test the firmness of the sleep support member 50. For example, the comfort/support analysis system 10 may be configured to test one side of the sleep support member 50 and the second comfort/support analysis system 11 may be configured to test an opposite side of the sleep support member 50. According to the illustrative configuration shown in FIG. 2, for example, two opposing sides of the sleep

support member 50 can be tested at the same time and the physical attributes of two intended users of the sleep support member 50 (e.g., two sleeping partners) can be replicated.

[38] While the present invention has been particularly shown and described with reference to illustrative 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 invention as defined by the appended claims. The illustrative embodiments should be considered in a descriptive sense only and not for purposes of limitation. Therefore, the scope of the invention is defined not by the detailed description of the invention but by the claims set forth in the related non-provisional application and all differences within the scope will be construed as being included in the present invention.

CLAIMS

1. A method of testing a sleep support member, the method comprising:

identifying, by an identification unit, the sleep support member;

determining, by a testing unit, a tested comfort/support value for the identified sleep support member before the identified sleep support member is provided to a customer; and

determining, by an analysis unit, whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member.

2. The method of claim 1, wherein the goal comfort/support value comprises at least one goal Indention/Load/Deflection ("ILD") curve, and

wherein the tested comfort/support value is determined by an ILD test.

3. The method of claim 2, wherein the goal comfort/support value comprises a plurality of goal ILD curves, and

wherein each of the plurality of goal ILD curves is associated with a different location on the sleep support member.

4. The method of claim 1, wherein the goal comfort/support valve is retrieved from a memory, and

wherein the memory includes a plurality of other goal comfort/support values respectively associated with a plurality of other sleep support members, and

wherein the method further comprises, if it is determined that the tested comfort/support value is not within the predetermined tolerance level of the goal comfort/support value for the identified sleep support member, then searching the plurality of other goal comfort/support values to determine if the tested comfort/support value is within a predetermined tolerance level of another of the goal comfort/support values.

5. The method of claim 1, wherein the determining a tested comfort/support value for the identified sleep support member is performed while the identified sleep support member is in the manufacturing line.

6. The method of claim 1, wherein the determining a tested comfort/support value for the identified sleep support member comprises:

applying a load to the sleep support member at a location using a contact surface; and

measuring a deflection of the sleep support member caused by the applied load.

7. The method of claim 6, further comprising:

applying a plurality of loads to the sleep support member at the location using the contact surface; and

measuring a plurality of corresponding deflections of the sleep support member caused by the applied loads.

8. The method of claim 1, further comprising determining characteristics of the sleep support member wherein the determining recovery characteristics of the sleep support member comprises:

applying a load to the sleep support member at a location using a contact surface; and

measuring a plurality of deflections of the sleep support member caused by the applied load as the applied load is removed from the sleep support member.

9. An apparatus for testing a sleep support member, the apparatus comprising:

an identification unit configured to identify the sleep support member;

a comfort/support testing unit configured to determine a tested comfort/support value for the identified sleep support member before the identified sleep support member is provided to a customer; and

an analysis unit configured to determine whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member.

10. The apparatus of claim 9, wherein the goal comfort/support value comprises at least one goal Indention/Load/Deflection ("ILD") curve, and

wherein the tested comfort/support value is determined by an ILD test.

11. The apparatus of claim 9, further comprising a memory;

wherein the goal comfort/support value is retrieved from the memory, and

wherein the memory includes a plurality of other goal comfort/support values respectively associated with a plurality of other sleep support members, and

wherein the analysis unit is configured such that, if it is determined that the test comfort/support value is not within the predetermined tolerance level of the goal comfort/support value for the identified sleep support member, then the analysis unit searches the plurality of other goal comfort/support values to determine if the tested comfort/support value is within a predetermined tolerance level of another of the goal comfort/support values.

12. The apparatus of claim 9, wherein the sleep support member comprises an identified; and

wherein the identifier comprises information relating to at least one of goal specifications of the sleep support member, goal ILD curves of the sleep support member, goal tolerance levels of the sleep support member, a type of the sleep support member, a location where the sleep support member was manufactured, a date of manufacture of the sleep support member, manufacturing materials of the sleep support member, and customer information.

13. The apparatus of claim 9, wherein the analysis unit is configured to determine whether the tested comfort/support value is within a predetermined tolerance level of a goal comfort/support value for the identified sleep support member while the identified sleep support member is in the manufacturing line.

14. The apparatus of claim 9, wherein the comfort/support testing unit comprises:

a contact surface configured to apply a load to the sleep support member at a testing location; and

a measurement unit configured to measure a deflection of the sleep support member caused by the applied load at the testing location.

15. The apparatus of claim 14, wherein the contact surface is configured to apply a plurality of loads to the sleep support member at the testing location; and

wherein the measurement unit is configured to measure a plurality of corresponding deflections of the sleep support member caused by respective applied loads.

16. The method of claim 7, further comprising determining a plurality of tested comfort/support values for the identified sleep support member before the identified sleep support member is provided to the customer; and

determining whether the tested comfort/support values are within predetermined tolerance levels of goal comfort/support values for the identified sleep support member.

17. The apparatus of claim 9, wherein the comfort/support testing unit is configured to determine a plurality of tested comfort/support values for the identified sleep support member before the sleep support member is provided to customer; and

wherein the analysis unit is configured to determine whether the tested comfort/support values are within predetermined tolerance levels of goal comfort/support values for the identified sleep support member.

18. The method of claim 5, wherein the method is performed for substantially all sleep support members that are manufactured in the manufacturing line.

19. A method of testing a step support member, the method being substantially as hereinbefore described with reference to the accompanying drawings.

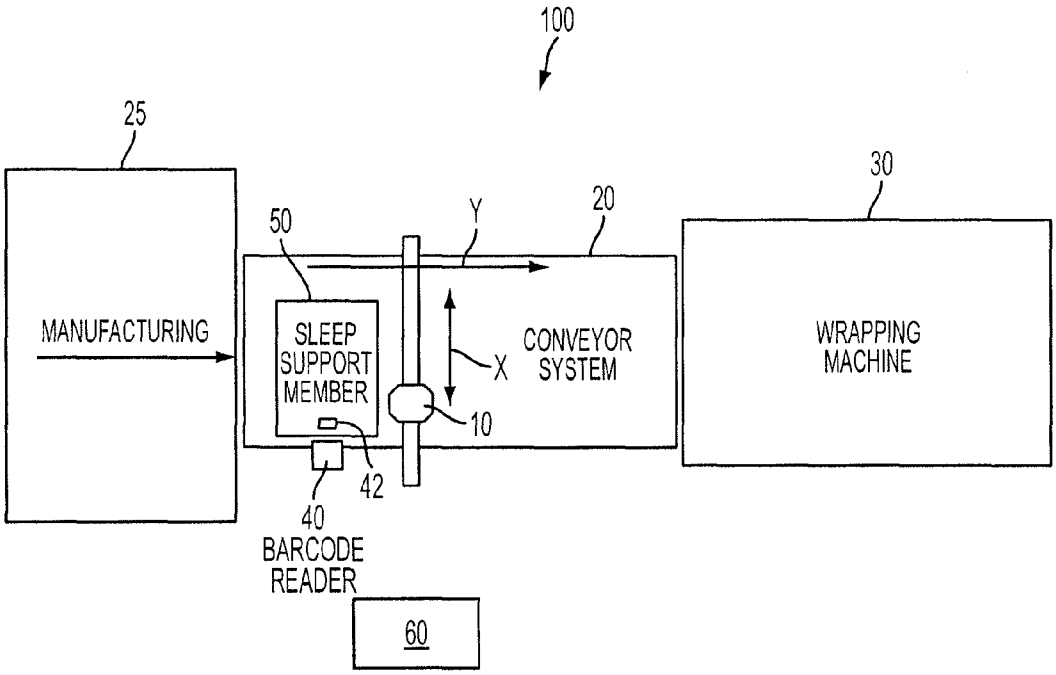
20. An apparatus for testing a sleep support member, the apparatus being substantially as hereinbefore described with reference to the accompanying drawings.

Dated 16 May 2012

Kingsdown, Inc.

Patent Attorneys for the Applicant/Nominated Person

SPRUSON & FERGUSON


100
25
30
50
Y
20
MANUFACTURING
SLEEP SUPPORT MEMBER
X
CONVEYOR SYSTEM
WRAPPING MACHINE
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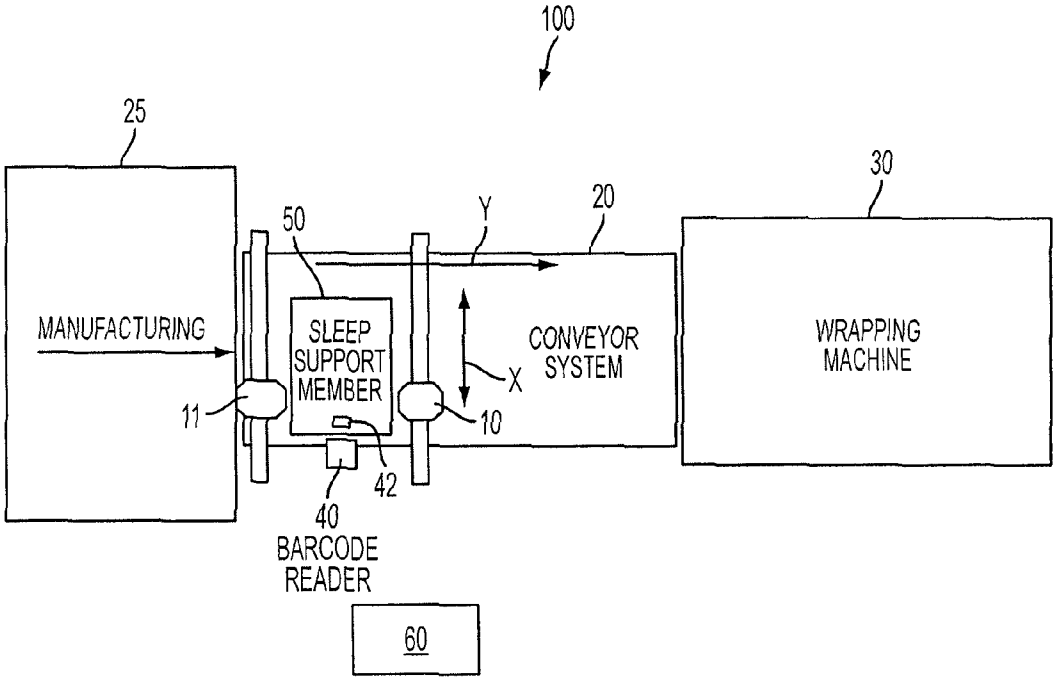
42
40
BARCODE READER
60

FIG. 1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MANUFACTURING
SLEEP SUPPORT MEMBER
CONVEYOR SYSTEM
WRAPPING MACHINE
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42
40
BARCODE READER
60

FIG. 2