

Improved Electric Motor for Use in a Rate Table

FIELD OF INVENTION

- 5 Embodiments of the present invention relate to the field of electric motors, specifically electric motors for use in rate tables for testing inertial or electronic components.

10 BACKGROUND

- A rate table is a testing device used for testing inertial or electronic components prior to the installation of those components into other devices/systems. The tables can be used to provide precise position, rate, acceleration, and sinusoidal motion for
15 various components being tested. In some currently available rate tables, electrical attachments are provided that allow the testing to be conducted over a wide temperature range.

- Rate tables include a torque motor that turns a turntable at a particular speed, to
20 allow for the testing. The tables come pre-assembled. Unfortunately, off the shelf rate tables can be very expensive, particularly if temperature testing is also desired. To perform temperature testing of components, prior art rate tables integrate an oven into the spin table. This is an extremely costly option.

- 25 In order to minimize expense, one option is to buy the components of a rate table and build one. Unfortunately, this also offers some challenges. Currently, the integration of a rate table requires the purchase of an assembled torque motor, with or without a hollow hub. A torque motor with a hollow hub is sufficient for the routing of wires but not for the other components such as a temperature sensing card and a
30 thermocouple. Furthermore, the off the shelf torque motor is probably not designed for such an application. Thus, a set of customized adaptors is required, making the integration of the wiring through the motor hub extremely difficult, if not impossible, as it requires the complex routing of wiring. Additionally, it is almost impossible to

achieve direct drive due to the complexity of the mechanism and the need for gearing. Furthermore, a certain amount of slippage is unavoidable in all gearing systems. This can introduce a certain level of inaccuracy when measuring the spin rate of the table. In extreme cases, backlash occurs, especially when the rate table changes its spin direction.

Alternately, one could assemble a torque motor for use in the rate table. However, this also introduces additional difficulties. For example, in a conventional torque motor, the inner edge of a stator is surrounded by a series of bushes. These bushes are mechanically fastened to springs so as to ensure positive contact with the rotor as the rotor turns. Unfortunately, assembling the stator/rotor for such a motor can be very challenging.

The stator includes a number of strong permanent magnets. Before the insertion of the rotor into the stator, the user must ensure that all the bushes are retracted into their individual housings. It is very difficult to perform such a procedure individually for each of the bushes. This is because the strong magnetic force of the permanent magnets tends to pull the rotor toward the stator. This in turn can result in the breakage of the bushes if they are not fully retracted. Likewise, the stator inner wall can be chipped when subjected to impacts from the rotor edge. This chipping can cause permanent damage to the components of the torque motor. Therefore, when assembling a rate table, a torque motor is either factory installed or installed using a customized tool.

It would, therefore, be a great improvement in the art if an electric motor and/or a rate table could be provided that overcomes one or more of the difficulties described above.

SUMMARY

One aspect of the present invention provides an electric motor comprising:

a housing; a stator mounted on the housing and having an inner diameter surrounding an inner opening; a plurality of spring loaded bushes mounted on an upper surface of the stator, each of the plurality of spring loaded bushes extending at least partially into the inner opening; a rotor having an outer diameter less than the inner diameter of the stator, and a tapered lower portion, such that the tapered lower portion contacts each of the plurality of bushes causing the bushes to retract when the rotor is inserted into the inner opening of the stator; and a hollow spinning hub connected to the rotor and resting on a deep groove bearing mounted on the housing.

In some embodiments, the electric motor may further include a hollow shaft extending downwardly from the spinning hub and a slip ring inserted into a lower end of the hollow shaft to allow one or more wires to be inserted through the hollow shaft and hollow spinning hub such that the one or more wires do not twist during operation of the motor. The hollow shaft may be secured with a locking ring mounted on the housing.

The bearing may be capable of preventing any vertical or horizontal movement of the spinning hub with respect to the housing. The electric motor may also include an encoder located proximate the hollow shaft, the encoder capable of generating an electrical signal indicating the rotational speed of the hollow shaft.

An alternate aspect of the present invention provides a rate table for testing a device, the rate table comprising: a housing; a spin table; a test stand mounted on the spin table; a stator mounted on the housing and having an inner diameter surrounding an inner opening; a plurality of spring loaded bushes mounted on an upper surface of the stator, each of the plurality of spring loaded bushes extending at least partially into the inner opening; a rotor having an outer diameter less than the inner diameter of the stator, and a tapered lower portion, such that the tapered lower portion contacts each of the plurality of bushes causing the bushes to retract when the rotor is inserted into the inner opening of the stator; and a hollow spinning hub connected to the rotor and the spin table and resting on a deep groove bearing.

In some embodiments, the rate table may include a test box capable of being mounted onto the test stand. The test box may include an outer insulating case and an inner heating box, the heating box containing the device and capable of heating the device at a desired rate. In alternate embodiments, the heating box may be

cooled to a first temperature prior mounting, and the heating box may then be heated at the desired rate during the test of the device.

The spinning hub may rest on a deep groove bearing, the bearing capable of preventing any vertical or horizontal movement of the spinning hub with respect to the housing.

Alternate embodiments of the rate table may include a hollow shaft extending downwardly from the spinning hub, and a slip ring inserted into a lower end of the hollow shaft to allow one or more wires to be inserted through the hollow shaft and hollow spinning hub such that said one or more wires do not twist during operation of the motor, the hollow shaft being secured with a locking ring mounted on the housing.

Additional embodiments of the rate table may include an encoder located proximate the hollow shaft, the encoder capable of generating an electrical signal indicating the rotational speed of the hollow shaft. The motor may further include a heat sink for dissipating heat generated by the motor within the housing.

In some embodiments, the motor may directly drive the spin table. Additionally, the heating box may further include at least one heating element for raising a temperature within the heating box. The heating element may be capable of raising the temperature at a desired rate, which may be 0.01 degrees C per second. The outer insulating case of the heating box may be made from Teflon®. The heating box itself may be made from aluminum or an aluminum alloy.

In some embodiments, the rate table may also include a computer connected to the rate table, the computer capable of controlling a speed of the motor and the desired rate based on an input of an operator. Alternately, the rate table may include a control console capable of controlling a speed of the motor and the desired rate based on an input of an operator. In some embodiments, the tested device may be any one of a sensor, a gyro and an accelerometer.

Another aspect of the present invention provides a method for testing an electronic device, the method comprising the steps of: providing a rate table for testing the device, the rate table comprising: a housing; a spin table; a test stand mounted on the spin table; a motor connected to and capable of driving the spin table, the motor comprising: a stator mounted on the housing and having an inner diameter surrounding an inner opening; a plurality of spring loaded bushes mounted on an upper surface of the stator, each of the plurality of spring loaded bushes extending at least partially into the inner opening; and a rotor having an outer diameter less than the inner diameter of the stator, and a tapered lower portion, such that the tapered lower portion contacts each of the plurality of bushes causing the bushes to retract when the rotor is inserted into the inner opening of the stator; a hollow spinning hub connected to the rotor and the spin table and resting on a deep groove bearing; and a test box capable of being mounted onto the test stand; the test box comprising an outer insulating case and an inner heating box, the heating box containing the device and capable of heating the device at a desired rate; lowering a temperature of the inner heating box containing the device to a desired beginning testing temperature; inserting the heating box into the outer insulating case to form the test box; placing the test box into the test stand; and performing the test on the device at a plurality of temperatures as the heating box is heated at the desired rate.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 illustrates a perspective view of a rate table having an improved electric motor according to one embodiment of the present invention;

Figure 2 illustrates a top view of the rate table of Figure 1;

Figure 3 illustrates a cross-sectional view of the rate table of Figures 1 and 2;

Figure 4 illustrates a perspective view of one embodiment of an improved electric drive motor of the present invention;

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Figure 5 illustrates an exploded perspective view of one embodiment of a test box illustrated in Figure 1;

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Figure 6 illustrates a cross-sectional perspective view of the test box of Figure 5; and

Figure 7 illustrates one embodiment of an external computer system that can be used to control the functions of the rate table shown in Figures 1-3.

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DETAILED DESCRIPTION

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Figure 1 illustrates a perspective view of a rate table, designated generally as reference numeral 100. Figure 2 illustrates a top view of the rate table 100 and Figure 3 illustrates a cross-sectional view of the rate table 100. With continuing reference to Figures 1-3, the rate table 100 includes a housing 102. A spin table 104 is located on a top 106 of the housing 104. A test stand 108 is mounted on the spin table 104. The test stand 108 can contain one or more slots 109 to receive a test box 200 that contains a device under test (DUT) 210 (see Figures 5 and 6).

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A control console 120 is mounted on a front portion of the housing 102 for controlling the operation of the rate table 100. The control console 120 can include a keypad 122 for operating the rate table 100 and an LCD display 124 for displaying the current command being executed. A plurality of control switches 126 is also found on the control console 120.

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In alternate embodiments of the rate table 100, an external computer 700 (see Figure 7) can be used to control the functions of the rate table 100. For this purpose, an interface console 110 is provided in a front 116 of the housing 102. In some embodiments, the

interface console 110 can include a plurality of Universal Serial Bus ports 112, and RS232 ports 114 for direct interface to the external computer 700.

5 An air filter 118 can also be disposed in the front 116 of the housing 102. An exhaust fan 134 can be located inside the housing to pull air through the air filter 118 and cool the motor 300. An emergency stop switch or button 130 can be located on the housing 102 to allow an operator of the rate table 100 to shut down power to the electric motor 300 (see Figures 3 and 6). A plurality of adjustable feet 132 can be located on a bottom of the housing 102 to allow the housing 102 to be made level when resting on an uneven
10 surface. A levelling meter 140 can be located in the spin table 104 to provide a guide as to when the rate table 100 is level.

In the embodiment illustrated in Figures 1-3, the spin table 104 can include a conduit 142 for routing wires from the controller (either the control panel 120, or the external
15 computer 700) to the device under test 210 (Figures 5 and 6). The spin table can also include a connector interface 144 that provides an electrical connection between the DUT 210 and the control system of the rate table 100.

Figure 4 illustrates a perspective view of the electric motor 300 that drives the spin table
20 104. With reference to Figures 3 and 4, the motor 300 can include a stator 302 secured in a stator holder 304. In some embodiments, the stator holder 304 can also act as a heat sink for the motor 300. The stator holder 304 is secured to the top 106 of the housing 102.

25 A rotor 310 is rotatably secured within the stator 302. A spinning hub 312 is attached to the rotor 310. The spin table 104 is secured to the spinning hub 312. The spinning hub 312 contains a hollow shaft 313 for the routing of wires and the placement of electronic components, including, but not limited to a thermal sensing board (not shown). The spinning hub 312 rests on a deep groove bearing 314 that prevents any vertical and/or
30 horizontal movement of the spinning hub 312. A pair of double lock rings 318 secures the spinning hub 312 firmly in position.

A narrow hollow shaft 316 extends downwardly from the spinning hub 312 to allow for the passage of wires through the spinning hub 312 and up to the spin table 104. The

shaft 316 is secured in a slip ring 324 that allows the wires to be routed through the motor 300 without twisting. The use of slip rings is known to those of skill in the art, and will not be described in detail herein. An encoder 320 is fixed adjacent the shaft 316 and connected to the controller or external computer 700 to measure the spin rate of the spinning hub 312 and spin table 104.

With reference to Figure 4, the stator 302 has an inner diameter that surrounds an inner opening 307. A plurality of spring loaded bushes 303 are located on a top surface 305 of the stator 302. The bushes 303 extend at least part way into the inner opening 307.

The rotor 310 has an outer diameter slightly smaller than the inner diameter of the stator 302, thus allowing the rotor 310 to be positioned within the stator 302. To facilitate the positioning of the rotor 310 within the stator 302, the rotor 310 includes a tapered section 311 at a lower end. The tapered section 311 contacts each of the bushes 303, causing the bushes 303 to retract during assembly of the motor 300, thus preventing damage to the rotor 310 or stator 302. Using this configuration prevents the stator wall from being chipped during the assembly process, and also prevents damage to the bushes 303.

Figure 5 illustrates an exploded perspective view of the test box 200. Figure 6 illustrates a cross-sectional perspective view of the test box 200. The test box 200 can include an outer insulating case 202, an inner heating box 204, and an access door 206 that seals the inner heating box 204 within the outer insulating case 202.

The access door 206 can include a DUT holder 208 that secures the DUT 210 within the test box 200. The access door 206 can also include one or more door locks 212 for securing the access door 206 onto the outer insulating case 202. In some embodiments, the door locks can be thumb screws that can be easily secured by hand. Alternate fasteners can also be used for the door locks 212. The access door 206 can further include an opening 216 that can be used for the installation of an interface cable (not shown) between the DUT 210 and the interface connector 144 located on the spin table 104. In some embodiments, the DUT holder 208 can be attached to a plate 214. This will be discussed in more detail below.

The inner heating box 204 can include one or more heating elements 220. The heating elements 220 can be connected to a power source and controlled by the system

controller or external computer 700. This allows the temperature within the heating box to be raised at a desired rate for testing the DUT 210. For example, in some testing operations, a heating rate of 0.01 degrees C per second can be used. Other heating rates, both faster and slower, are also possible. The heating box can also include one or
5 more guiding rails 222 that receive the sensor holder 208 and secure the sensor holder 208 in place.

The heating box 204 and plate 214 can be made from a metallic material to maintain an even temperature within the heating box 204 when the heating box 204 is installed within
10 the outer insulating casing 202. In some embodiments, the heating box can be made from aluminium, such as, but not limited to, a 2024 aluminium alloy having a thickness of about 3mm. Other materials and/or thicknesses can also be used.

The outer insulating box 202 can include one or more pairs of adjustment knobs 240
15 located on opposite sides of the insulating box 202. The pairs of adjustment knobs 240 allow the insulating box to be securely installed into the corresponding slots 109 on the test stand 108. In some embodiments, the adjustment knobs 240 and mating slots 109 facilitate the positioning of the test box 200 in various orientations for testing on the rate table 100. For example, the adjustment knobs 240 may have an octagonal shape that
20 permits the test box 200 to be tested in 45 degree increments. It is understood that other shapes and increments could also be used.

The insulating case 202 can also include one or more arresting bars 242 extending along a rear portion of the insulating case 202. The arresting bars 242 can have a
25 tapered side surface 244 to facilitate easy installation of the heating box 204 into the insulating case 202. In some embodiments, the taper can be about 1°. In some embodiments, the arresting bars 242, the insulating case 202, and the DUT holder 208 can be made from an insulating material. By way of example and not limitation, the insulating material can be Teflon®.

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Some portions of the description above are explicitly or implicitly presented in terms of algorithms and functional or symbolic representations of operations on data within a computer memory. These algorithmic descriptions and functional or symbolic representations are the means used by those skilled in the data processing arts to

convey most effectively the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities, such as electrical, magnetic or optical signals capable of being
5 stored, transferred, combined, compared, and otherwise manipulated.

Unless specifically stated otherwise, and as apparent from the following, it will be appreciated that throughout the present specification, discussions utilizing terms such as "scanning", "calculating", "determining", "replacing", "generating", "initializing",
10 "outputting", or the like, refer to the action and processes of a computer system, or similar electronic device, that manipulates and transforms data represented as physical quantities within the computer system into other data similarly represented as physical quantities within the computer system or other information storage, transmission or display devices.

15 The present specification also discloses apparatus for performing the operations and control functions associated with the rate table 100. Such apparatus may be specially constructed for the required purposes, or may comprise a general purpose computer or other device selectively activated or reconfigured by a computer program stored in the
20 computer. The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose machines may be used with programs in accordance with the teachings herein. Alternatively, the construction of more specialized apparatus to perform the required method steps may be appropriate. The structure of a conventional general purpose computer will appear
25 from the description below.

In addition, the present specification also implicitly discloses a computer program, in that it would be apparent to the person skilled in the art that the individual steps of the method described herein may be put into effect by computer code. The computer
30 program is not intended to be limited to any particular programming language and implementation thereof. It will be appreciated that a variety of programming languages and coding thereof may be used to implement the teachings of the disclosure contained herein. Moreover, the computer program is not intended to be limited to any particular

control flow. There are many other variants of the computer program, which can use different control flows without departing from the spirit or scope of the invention.

Furthermore, one or more of the steps of the computer program may be performed in parallel rather than sequentially. Such a computer program may be stored on any computer readable medium. The computer readable medium may include storage devices such as magnetic or optical disks, memory chips, or other storage devices suitable for interfacing with a general purpose computer. The computer readable medium may also include a hard-wired medium such as exemplified in the Internet system, or wireless medium such as exemplified in the GSM mobile telephone system. The computer program when loaded and executed on such a general-purpose computer effectively results in an apparatus that implements the steps of the preferred method.

The control functions needed to operate the rate table 100 may also be implemented as hardware modules. More particularly, in the hardware sense, a module is a functional hardware unit designed for use with other components or modules. For example, a module may be implemented using discrete electronic components, or it can form a portion of an entire electronic circuit such as an Application Specific Integrated Circuit (ASIC). Numerous other possibilities exist. Those skilled in the art will appreciate that the system can also be implemented as a combination of hardware and software modules.

The control functions of the rate table 100 discussed above can be implemented on a computer system 700, schematically shown in Figure 7. They may be implemented as software, such as a computer program being executed within the computer system 700, and instructing the computer system 700 to control the functions of the rate table 100.

The computer system 700 can include a computer module 702, input modules such as a keyboard 704 and mouse 706 and a plurality of output devices such as a display 708, and printer 710. In some embodiments, the computer module 702 can be connected to a computer network 712 via a suitable transceiver device 714, to enable access to e.g. the Internet or other network systems such as Local Area Network (LAN) or Wide Area Network (WAN).

The computer module 702 in the example includes a processor 718, a Random Access Memory (RAM) 720 and a Read Only Memory (ROM) 722. The computer module 702 also includes a number of Input/Output (I/O) interfaces, for example I/O
5 interface 724 to the display 708, and I/O interface 726 to the keyboard 704. The components of the computer module 702 typically communicate via an interconnected bus 728 and in a manner known to the person skilled in the relevant art.

10 The application program can be supplied to the user of the computer system 700 encoded on a data storage medium such as a CD-ROM or flash memory carrier and read utilizing a corresponding data storage medium drive of a data storage device 730. The application program is read and controlled in its execution by the processor 718. Intermediate storage of program data maybe accomplished using
15 RAM 720.

Embodiments of the rate table 100 discussed above can be used to test various types of components. By way of example and not limitation, the DUT 208 can be an electrical component for use on an aircraft, inertial components, or any other type of electrical
20 device that requires testing using the environment of the rate table 100. Examples of such components can be a gyro or an accelerometer. It is understood that any component capable of fitting within the test box 200 can be tested on the rate table 100 described herein.

25 In one embodiment, the rate table 100 can be used for testing and calibrating the temperature drift of a sensor. In this embodiment, the DUT 208 is placed in the heating box 204. The entire heating box 204 can then be placed in a cold environment, e.g. a freezer, until a desired temperature is reached. The heating box can then be inserted into the insulating case 202, which is installed onto the test stand 108 by mating the
30 adjustment knobs 240 to the slots 109. As previously discussed, different orientations of the test box are possible. The testing can then begin using a desired spin rate for the spin table 104. This testing can be controlled using the control console 120, or the external computer 700.

During the testing phase, the heating elements 220 can be engaged to heat the heating box 204 at a desired rate. This rate can also be controlled using either the control console 120 or the external computer 700. Various orientations can be tested as desired. In some embodiments, the test temperature range is from about 0 °C to about 5 70 °C. It is understood that other temperature ranges, both colder and warmer, can also be used.

The example embodiments of the present invention provide several advantages over the prior art. The rate table of the example embodiments can be assembled with easy to 10 procure components, thus reducing the cost of the system by 95% over similar commercially available systems. The design of the rotor/stator combination facilitates the easy installation of the torque motor as an integral part of the rate table. The motor design prevents any slippage due to the prior art gearing at the encoder, to ensure an accurate reading of the table spin rate. The motor design with the hollow hub also 15 allows the table to spin freely without entanglement of the wires within the motor hub. Additionally, the embodiments of the rate table and motor described above allow the use of an oversized torque motor so that direct driving of the spin table is possible. The example embodiments also protect the costly encoder from impact damage caused by any asymmetric hub motion. Additionally, the heat dissipation component protects the 20 motor from over-heating during the testing process.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific 25 embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. An electric motor comprising:
 - a housing;
 - a stator mounted on the housing and having an inner diameter surrounding an inner opening;
 - a plurality of spring loaded bushes mounted on an upper surface of the stator, each of the plurality of spring loaded bushes extending at least partially into the inner opening;
 - a rotor having an outer diameter less than the inner diameter of the stator, and a tapered lower portion, such that the tapered lower portion contacts each of the plurality of bushes causing the bushes to retract when the rotor is inserted into the inner opening of the stator; and
 - a hollow spinning hub connected to the rotor and resting on a deep groove bearing mounted on the housing.
2. The electric motor of claim 1, further comprising a hollow shaft extending downwardly from the spinning hub and a slip ring inserted into a lower end of the hollow shaft to allow one or more wires to be inserted through the hollow shaft and hollow spinning hub such that said one or more wires do not twist during operation of the motor, the hollow shaft being secured with a locking ring mounted on the housing.
3. The electric motor of claims 1 or 2, wherein , the bearing is capable of preventing any vertical or horizontal movement of the spinning hub with respect to the housing.
4. The electric motor of claims 2 or 3, further comprising an encoder located proximate the hollow shaft, the encoder capable of generating an electrical signal indicating the rotational speed of the hollow shaft.
5. A rate table for testing a device, the rate table comprising:
 - a housing;

- a spin table;
- a test stand mounted on the spin table;
- a stator mounted on the housing and having an inner diameter surrounding an inner opening;
- a plurality of spring loaded bushes mounted on an upper surface of the stator, each of the plurality of spring loaded bushes extending at least partially into the inner opening;
- a rotor having an outer diameter less than the inner diameter of the stator, and a tapered lower portion, such that the tapered lower portion contacts each of the plurality of bushes causing the bushes to retract when the rotor is inserted into the inner opening of the stator; and
- a hollow spinning hub connected to the rotor and the spin table and resting on a deep groove bearing.

6. The rate table of claim 5, further comprising a test box capable of being mounted onto the test stand; the test box comprising an outer insulating case and an inner heating box, the heating box containing the device and capable of heating the device at a desired rate.

7. The rate table of claim 6, wherein the heating box is cooled to a first temperature prior to mounting, and the heating box is then heated at the desired rate during the test of the device.

8. The rate table of any one of claims 5-7, wherein the bearing is capable of preventing any vertical or horizontal movement of the spinning hub with respect to the housing.

9. The rate table of any one of claims 5-8, further comprising a hollow shaft extending downwardly from the spinning hub, and a slip ring inserted into a lower end of the hollow shaft to allow one or more wires to be inserted through the hollow shaft and hollow spinning hub such that said one or more wires do not twist during operation of the motor, the hollow shaft being secured with a locking ring mounted on the housing.

10. The rate table of claim 9, further comprising an encoder located proximate the hollow shaft, the encoder capable of generating an electrical signal indicating the rotational speed of the hollow shaft.

11. The rate table of any one of claims 5-10, wherein the motor further comprises a heat sink for dissipating heat generated by the motor within the housing.

12. The rate table of any one of claims 5-11, wherein the motor directly drives the spin table.

13. The rate table of any one of claims 6-12, wherein the heating box further comprises at least one heating element for raising a temperature within the heating box.

14. The rate table of claim 13, wherein the heating element is capable of raising the temperature at a desired rate.

15. The rate table of claim 14, wherein the desired rate is 0.01 degrees Celsius per second.

16. The rate table of any one of claims 6-15, wherein the outer insulating case comprises Teflon®.

17. The rate table of any one of claims 6-16, wherein the heating box comprises aluminum.

18. The rate table of any one of claims 5-17, further comprising a computer connected to the rate table, the computer capable of controlling a speed of the motor and the desired rate based on an input of an operator.

19. The rate table of any one of claims 5-18, further comprising a control console capable of controlling a speed of the motor and the desired rate based on an input of an operator.

20. The rate table of any one of claims 5-19, wherein the device is one of a sensor, a gyro and an accelerometer.

21. A method for testing an electronic device, the method comprising the steps of:

providing a rate table for testing the device, the rate table comprising:

a housing;

a spin table;

a test stand mounted on the spin table;

a motor connected to and capable of driving the spin table, the motor comprising:

a stator mounted on the housing and having an inner diameter surrounding an inner opening;

a plurality of spring loaded bushes mounted on an upper surface of the stator, each of the plurality of spring loaded bushes extending at least partially into the inner opening; and

a rotor having an outer diameter less than the inner diameter of the stator, and a tapered lower portion, such that the tapered lower portion contacts each of the plurality of bushes causing the bushes to retract when the rotor is inserted into the inner opening of the stator;

a hollow spinning hub connected to the rotor and the spin table and resting on a deep groove bearing; and

a test box capable of being mounted onto the test stand; the test box comprising an outer insulating case and an inner heating box, the heating box containing the device and capable of heating the device at a desired rate;

lowering a temperature of the inner heating box containing the device to a desired beginning testing temperature;

inserting the heating box into the outer insulating case to form the test box;

placing the test box into the test stand; and

performing the test on the device at a plurality of temperatures as the heating box is heated at the desired rate.

Improved Electric Motor for Use in a Rate Table**ABSTRACT**

5 Embodiments of the present invention provide an electric motor for use in a rate
table. The electric motor may include a housing, a stator mounted on the housing
and having an inner diameter surrounding an inner opening, a plurality of spring
loaded bushes mounted on an upper surface of the stator, each of the plurality of
spring loaded bushes extending at least partially into the inner opening; and a rotor
10 having an outer diameter less than the inner diameter of the stator, and a tapered
lower portion, such that the tapered lower portion contacts each of the plurality of
bushes causing the bushes to retract when the rotor is inserted into the inner
opening of the stator. Embodiments of the present invention also include a rate
table incorporating the electric motor.

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FIG. 3