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(54) Title: ELECTRICAL TESTER SETUP AND CALIBRATION DEVICE

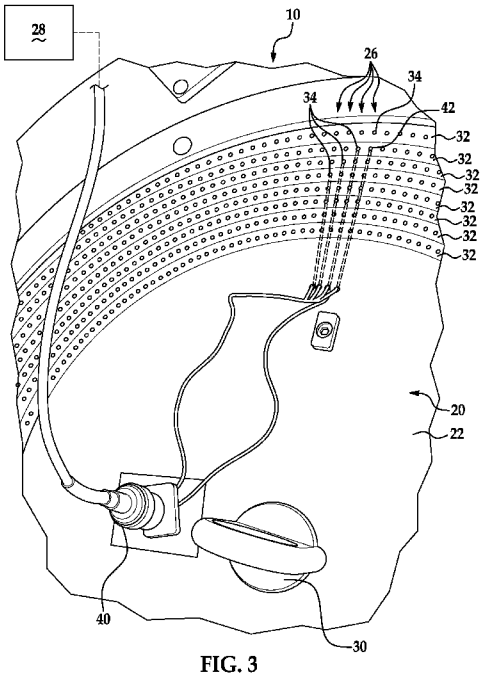


FIG. 3

(57) Abstract: An electronic testing machine includes a plurality of test modules, each of which has a plurality of contact pairs for testing electronic components. An apparatus and process for electrical test setup and calibration of the electronic testing machine includes a plate having at least one contact per track movable between test positions to electrically insert a test device selectively between any one contact pair. A control program can perform at least one test function through the plate.

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ELECTRICAL TESTER SETUP AND CALIBRATION DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates to an apparatus and method for setup and calibration of an electronic testing machine including a plurality of test modules, where each test module has a plurality of contacts for testing electronic components.

BACKGROUND

[0002] The setup and calibration of an electronic testing machine is known to be a difficult and time consuming task. Typically, the setup and calibration process includes one or more of the tasks of contact alignment and verification, voltage source calibration and verification, current source calibration and verification, insulation resistance (IR) leakage measurement calibration and verification, and source and measurement compensation.

[0003] Currently it is known to perform alignment verification using software alignment with an upper contact alignment tool that uses a row of parts in a test plate and a contact check to automate the alignment measurement, but this tool does not work on passive stations. It is also known to perform source verification by manually using a digital voltage meter (DVM) to measure voltage and current, which is a labor intensive effort since each contact must be manually probed with leads and measurements written down. It is known to perform measurement verification for leakage by testing the measurement card on the system with a precision resistor to be connected into the cable. This is a time consuming task requiring the precision resistor to be swapped numerous times, by way of example and not limitation, such as 256 times for systems having 64 channels and 4 ranges. The results of the measurements are manually recorded. This does not test the measurement card in isolation, but includes noise and voltage level errors from the source. It is known to perform measurement verification for compensation by manually inserting parts into a test plate, for example, in order to perform a part-present contact check verification or capacitance and dissipation measurement verification (CD). It is known that to perform measurement verification for calibration requires a technician to have access to the electronic testing machine in order to connect test cables and instruments. A port is typically connected to an external

computer that performs the calibration. This is a semi automatic task that requires the technician to swap a large number of cables during the calibration sequence.

SUMMARY

[0004] Since wires can be a major source of faults, it would be desirable to provide a quick way to check whether wires are crossed, or in poor condition, or to check for any cable discontinuity in the electronic testing machine. It would also be desirable to provide a process for checking the accuracy of the measurement card in isolation. It would further be desirable to directly source a current from a national industry standard test (NIST) calibrated "Keithley" source to test the measurement card in isolation.

[0005] As described herein, an electronic testing machine includes a plurality of test modules. Each test module can be located on angularly spaced radial lines extending from an associated central axis and can have a plurality of contact pairs for testing electronic components. An apparatus and method for electrical test setup and calibration of the electronic testing machine includes a plate having at least one electrode or contact per track movable between test positions to electrically insert a test device selectively between any one contact pair. The apparatus and method also includes a control program. The test device can be selected from a group consisting of a volt meter, a current meter, a precision current source, a precision voltage source, a calibration resistor and a calibration capacitor. By way of example and not limitation, the calibration resistor can be a National Industry Standard Test (NIST) traceable resistor or a stable reference resistor, and the calibration capacitor can be a National Industry Standard Test (NIST) traceable capacitor or a stable reference capacitor. The control program performs at least one test function through the plate. The test function can be selected from a group consisting of alignment verification, voltage/current source verification, insulation resistance (IR) leakage measurement verification, part-present contact check verification, capacitance and dissipation (CD) measurement verification, IR/CD compensation and IR/CD calibration.

[0006] These and other applications of the present invention will become apparent to those skilled in the art when the following description is read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

[0008] FIG. 1 is a simplified cross sectional detail view of one of a plurality of radial slots cut into a calibration plate or disk;

[0009] FIG. 2 is a simplified perspective view of a plurality of radial slots cut into the calibration plate or disk, where four radial slots in the foreground test the outer four tracks of the calibration plate or disk and the four radial slots in the background test the inner four tracks of the calibration plate or disk;

[0010] FIG. 3 is a simplified plan view of a top of a calibration plate or disk when mounted in an electronic testing machine, where a coax cable can be used for upper/lower electrode/contact cabling;

[0011] FIG. 4 is a simplified perspective view of a lower electrode/contact, where a compliant electrode/contact protrudes out of the disk to contact a single lower electrode/contact;

[0012] FIG. 5 is a simplified perspective view of an upper electrode/contact, where positioning of the contact is important so the calibration plate or disk can be used for contact alignment testing;

[0013] FIG. 6 is a simplified perspective view of an electronic testing machine having at least one test module, each test module having a plurality of contact pairs for testing electronic components carried between test positions by a component test plate;

[0014] FIG. 7 is a detailed cross sectional perspective view of a production test plate moveable between test positions to electrically insert an electronic component to be tested selectively between an opposing upper and lower contact pair of the electronic testing machine;

[0015] FIG. 8 is a simplified cross sectional view of an electrical test setup and calibration apparatus with a calibration plate or disk mounted thereon having at least one test electrode or contact moveable between test positions to electrically insert a test device selectively between an opposing upper and lower contact pair of the electronic testing machine; and

[0016] FIG. 9 is a simplified electric diagram illustrating the plurality of test electrodes or contacts moveable between test positions in association with rotation of the

calibration plate or disk to electrically insert the test device selectively between an opposing contact pair of the electronic testing machine.

DETAILED DESCRIPTION

[0017] Referring briefly to FIGS. 6 and 7, an electronic testing machine 10 has at least one upper contact 14 and at least one lower contact 16 of a test module 12. Each test module 12 can be located on angularly spaced radial lines extending from an associated central axis and has a plurality of contact pairs 14, 16 for testing electronic components. A production test plate or disk 50 includes a plurality of pockets 52. Each pocket 52 can carry an electronic component 54 to a test position 26 to be electrically inserted between upper and lower contacts 14, 16 of a test module 12 of the electronic testing machine 10 in order to perform one or more tests on the electronic component 54. The test plate 50 is rotated about the central axis to transfer an electronic component 54 to and from a test position 26 associated with corresponding upper and lower contacts 14, 16 of different test modules 12. It should be understood that the contact pairs 14, 16 can be located to contact on opposite ends of the electric component device 54 to be tested as illustrated in FIGS. 7 and 8, or can be located to contact on a single side of the electronic component 54 to be tested depending on the configuration of the electronic component device without departing from the scope of the present disclosure. Also, the production test plate or disk 50 is configured to present first and second electrodes 36, 38 on opposite sides of the plate as illustrated in FIGS. 2 and 8 or can be configured to present first and second electrodes 36, 38 on a single side of the plate 50 depending on the configuration of the contact pairs 14, 16 to be tested.

[0018] Referring now to FIGS. 1-5 and 8, an electrical test set up and calibration apparatus 20 can include a calibration plate or disc 22 having at least one test electrode or contact 24 movable between test positions 26 to electrically insert a test device 28 selectively between a contact pair 14, 16 of the electronic testing machine 10. The test device 28 can be selected from a group consisting of a volt meter, a current meter, a precision current source, a precision voltage source, a calibration resistor and a calibration capacitor. The calibration resistor can be a National Industry Standard Test (NIST) traceable resistor or a stable reference resistor. The calibration capacitor can be a National Industry Standard Test (NIST) traceable capacitor or a stable reference capacitor. A control program performs at least one test function through the plate 22.

The test function can be selected from a group consisting of alignment verification, voltage/current source verification, insulation resistance (IR) leakage measurement verification, part-present contact check verification, capacitance and dissipation (CD) measurement verification, IR/CD compensation and IR/CD calibration. A lookup table can be provided to compensate for offsets introduced by the test device 28 that would limit accuracy. Robustness against track to track variations could help simplify design, manufacture and cost of the device.

[0019] The calibration plate 22 can include an axis of rotation coaxially alignable with a center shaft 30 of the electronic testing machine 10 associated with the plurality of test modules 12 for rotation about the axis of rotation to different angular positions. If desired, the calibration plate 22 can be engageable with the center shaft 30 for driving the calibration plate 22 in rotation about an axis to different angular positions in order to selectively align contact pairs 14, 16 sequentially for testing. The at least one test electrode or contact 24 is alignable angularly and radially with contact pairs associated with each test position 26 for each of the plurality of test modules 12 to be tested.

[0020] A plurality of tracks 32 are located on the plate 22. The test electrodes 24 can be spaced at even angular intervals about the rotational axis of the plate 22. The at least one electrode or contact 24 can include a single wired contact 34 associated with each track 32. Each wired contact 34 includes a first electrode 36 and a second electrode 38 electrically isolated from each other. The wired contact 34 can be located on the plate so that only a single wired contact 34 is touching a contact pair 14, 16 of the electronic testing machine 10 at one time. To reduce electrical interference during testing, four radial slots can be formed on two diametrically opposite sides of the plate 22, where there are eight tracks 32. A first set of four slots can test the four tracks 32 of the plate 22, by way of example and not limitation, such as the four outer tracks 32, and the second set of four slots can test the four tracks 32 of the plate 22, by way of example and not limitation, such as the four inner tracks 32.

[0021] A connector 40 is mounted to the plate 22 as shown in FIG. 3. The first electrodes 36 can be electrically connected to each other and connected to one of the inner and outer conductor of the connector 40. The second electrodes 38 can be electrically connected to each other and connected to the other of the inner and outer conductor of the connector 40. As best seen in the simplified electrical diagram of FIG. 9, the first electrodes 36 are electrically connected to each other and connected to one of

the inner and outer conductor of the connector 40. The second electrodes 38 are electrically connected to each other and connected to the other of the inner and outer conductor of the connector 40 mounted to the calibration plate 22. The connector 40 connects the first and second electrodes 36, 38 to the test device 28, which can be located external of the electronic component testing machine 10.

[0022] By way of example and not limitation, a test station 42 is located between every fourth wired contact 34 so that there are three wired contacts 34 between test stations 42. When the plate 22 is indexed by an even angular interval, the wired contact 34 currently under test is moved out of engagement with a contact pair 14, 16, and another wired contact 34 is moved into engagement with a different contact pair 14, 16 to be tested. The plate 22 can be rotated 360 degrees for testing 200 combined wired contacts 34 and test stations 42.

[0023] A method or process for set up and calibration of an electronic component testing machine 10 is disclosed. The electronic testing machine 10 includes a plurality of contacts 14 for test modules 12. Each test module 12 has a plurality of contact pairs 14, 16 for testing electronic components. The process or method can include positioning the calibration plate 22 for rotational movement to position at least one electrode 24 between test positions 26 to electrically insert a test device 28 as described above selectively between a contact pair 14, 16. The method or process can also include performing at least one test function through the plate 22 with a control program as also described above. The method or process can also include compensating for offsets introduced by the test device 28 that would limit accuracy with a lookup table value. Robustness against track to track variation could help simplify design, manufacture, and cost of the device 28.

[0024] The method or process can include driving the plate 22 in rotation about an axis to different angular positions in order to selectively align contact pairs 14, 16 sequentially with the at least one electrode 24 for testing. The process can align the at least one test electrode 24 angularly and radially with contact pairs 14, 16 associated with each test position 26 for each of the plurality of test modules 12 to be tested. By way of example and not limitation, a total of eight tracks 32 can be formed on the plate 22 with test electrodes 24 spaced every 1.8° at evenly angularly spaced intervals about the rotational axis of the plate 22. The process can include isolating a first electrode 36 and a second electrode 38 electrically from one another on the plate 22 to define a single wired contact 34 associated with each track 32. The wired contact 34 if, for example, located

on the plate 22 so that only a single wired contact 34 is touching a contact pair 14, 16 of the electronic test machine 10 at a time.

[0025] As best seen in FIG. 9, the first electrodes 36 can be electrically connected to each other and connected to one of the inner and outer conductor of the connector 40 mounted on the plate 22. The second electrodes 38 can be electrically connected to each other and connected to the other of the inner and outer conductor of the connector 40. By way of example and not limitation, a test station 42 can be located between every fourth wired contact 34 corresponding to 7.2° of rotation, so that there are three wired contacts 34 between test stations 42. The process can include indexing the plate 22 by 1.8° so that the wired contact 34 currently under test is moved out of engagement with a contact pair 14, 16, and another wired contact 35 is moved into engagement with a different contact pair 14, 16 to be tested. The process of rotating the plate 22 through 360° tests 200 combined wired contacts 34 and test stations 42.

[0026] The calibration plate or disk 22 is an electro-mechanical mechanism that provides an automated way to electrically insert a device 28 between any upper/lower (U/L) contact pair 14, 16. The device 28 electrically inserted between upper/lower (U/L) contacts 14, 16 can be selected from the meters and devices mentioned above. With the appropriate supporting software, the calibration plate or disk 22 can reduce a week of system checkout into hours. A device 20 according to an embodiment of the present invention can be used for subsystem checkout, calibration and system/cabling tests. The device 20 according to an embodiment of the present invention can simplify field calibration by using a precision resistor between the upper/lower contacts 14, 16 to calibrate the IR leakage measurement. The device 20 according to an embodiment of the present invention can perform alignment verification with software support. If desired, the software can specify which screw to adjust and by how much it needs to be adjusted. The device 20 according to an embodiment of the invention can perform voltage/current source verification by connecting a national industry standard test (NIST) traceable current/voltmeter to the bayonet Neill-Concelman (BNC) connector 40, and indexing the plate 360 degrees to individually present each contact pair to the meter. A general purpose interface bus (GPIB) is used to capture data and software outputs results to spreadsheet. Wiring can be tested with the device 20 according to an embodiment of the present invention by shorting together the inner/outer conductor of the BNC 40, then all channels can be scanned for current draw as the calibration plate or disk 22 rotates to

determine if there is a wiring problem. A lookup table can compensate for offsets introduced by the test device that would limit accuracy. Robustness against track to track variation could help simplify design, manufacture and cost of the device.

[0027] Measurement verification can be performed for insulation resistance leakage in two ways. First, a precision resistor or standard cap can be placed on the BNC 40 in electrical communication with a precision voltage source, so that with one end of the precision resistor grounded, automation can be used to verify system insulation resistance (IR) performance. Second, to test the measurements of the measurement (ME) card in isolation, a precision current can be directly sourced from a national industry standard test (NIST) calibrated "Keithley" source into the ME card. Compensation can be performed based on the values obtained during the measurement verification of the insulation resistance (IR), part-present contact check and the capacitance and dissipation (CD). The BNC 40 provides an easy way to place a standard cap or precision resistor across the contacts 14, 16. With the right supporting electrical hardware connected to the BNC 40, an open/short/standard compensation can be automated in three rotations of the disk 22. Calibration can be performed based on the values obtained during the measurement verification of the insulation resistance (IR), part-present contact check and the capacitance and dissipation (CD). Instead of plugging calibration instruments into the back of the electronic component testing machine 10, the test instruments 28 can be directly connected to the disk 22 and reduce the chances for errors or mistakes. A precision resistor can be inserted onto the disk 22 and be used to calibrate the electronic testing machine source and measurement unit. The ability to service, maintain and calibrate the systems of the electronic testing machine with efficient methods and tools reduces any downtime associated with the electronic testing machine system and the hours of labor associated with performing the task. Alignment can be performed based on the values obtained during contact alignment checking, where the calibration plate 22 can be micro-stepped past the contact pair 14, 16 to tell when the test electrode 26 is in electrical engagement with a contact pair 14, 16 of the electronic testing machine 10. The angular position can be recorded and translated into any physical adjustment of the contact pair 14, 16 required at that particular test station of the electronic testing machine 10.

[0028] The present invention in one embodiment is a calibration plate 22 having a predetermined number of tracks 32 and wired electrodes 24, 36, 38 or contacts 34 spaced

at a predetermined angular interval. By way of example and not limitation, a total of eight tracks 32 with a wired electrode 36, 38 or contact 34 spaced every 1.8 degrees can be provided, where each track 32 has a single wired electrode 36, 38 or contact 34. In this example, there can be a total of eight wired electrodes 36, 38, defining one contact 34 for each track 32. Each wired electrode 36, 38 location has a first or lower electrode 36 and a second or upper electrode 38 that are electrically isolated from each other. The wired electrodes 36, 38 are placed on the calibration plate 22, such that only a single wired electrode 36, 38 or contact 34 is touching an upper contact 14, 16 of the electronic testing machine 10 at a time. In this example, a BNC connector 40 is mounted to the calibration plate 22. The eight upper electrodes 38 can be electrically connected to each other and connected to one of the inner and outer conductor of the BNC 40. The eight lower electrodes 36 can be electrically connected to each other and connected to the other of the inner and outer conductor of the BNC 40. Automation can be provided according to one embodiment of the invention. In this example, under the upper contact 14, 16, there can be provided a test station every four contacts 34, or every 7.2 degrees, so there are three contacts 34 between test stations. When the calibration plate 22 is indexed 1.8 degrees, the wired electrode 36, 38 or contact 34 currently under test moves out from electrical engagement with a contact 14, 16 of the electronic testing machine 10, and a new wired electrode 36, 38 or contact 34 moves under a different contact 14, 16 of the electronic testing machine 10 and into electrical engagement with the different contact 14, 16. By way of example and not limitation, the calibration plate 22 can be rotated through 360 degrees so that each of the two hundred contacts 14, 16 of an electronic testing machine 10 can be tested.

[0029] While the invention has been described in connection with certain embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.

What is claimed is:

1. An electronic testing machine having a plurality of test modules located on angularly spaced radial lines extending from a central axis, each test module having a plurality of contact pairs for testing electronic components, the electronic testing machine characterized by:

an apparatus for electrical test setup and calibration comprising:

a plate having at least one test electrode movable between test positions to electrically insert a test device selectively between a contact pair, the test device selected from a group consisting of a volt meter, a current meter, a precision current source, a precision voltage source, a calibration resistor and a calibration capacitor; and

a control program configured to perform at least one test function through the plate, the test function selected from a group consisting of alignment verification, voltage/current source verification, insulation resistance (IR) leakage measurement verification, part-present contact check verification, capacitance and dissipation (CD) measurement verification, IR/CD compensation and IR/CD calibration.

2. The electronic testing machine of claim 1 further comprising:

the plate having an axis of rotation coaxially aligned with the central axis for rotation about the axis of rotation to different angular positions in order to selectively align the at least one test electrode with different contact pairs sequentially for testing.

3. The electronic testing machine of claim 1, wherein the at least one test electrode is alignable angularly and radially with contact pairs associated with each test position for each of the plurality of test modules to be tested.

4. The electronic testing machine of claim 1 further comprising:

a plurality of tracks located on the plate and the test electrodes spaced at even angular intervals about the axis of rotation of the plate.

5. The electronic testing machine of claim 4 wherein the at least one electrode further comprises:

a single wired contact associated with each track, each wired contact having a first electrode and a second electrode electrically isolated from each other and located on the plate so that only the single wired contact is touching a contact pair of the electronic testing machine to be tested at a time.

6. The electronic testing machine of claim 5 further comprising:

a connector mounted to the plate, the first electrodes electrically connected to each other and to an inner conductor of the connector, the second electrodes electrically connected to each other and to an outer conductor of the connector.

7. The electronic testing machine of claim 5 further comprising:

a test station located between every fourth wired contact such that there are three wired contacts between adjacent test stations; and wherein when the plate is indexed by the even angular interval, the wired contact currently under test is moved out of engagement with a contact pair, and another wired contact is moved into engagement with a different contact pair to be tested.

8. The electronic testing machine of claim 7, wherein rotating the plate 360 degrees tests 200 wired contacts/test stations.

9. The electronic testing machine of claim 1 further comprising:

a lookup table to compensate for offsets introduced by the test device.

10. The electronic testing machine of claim 1, wherein the plate further comprises:

a total of eight tracks located on the plate with test electrodes spaced every 1.8 degrees.

11. A process for setup and calibration of an electronic testing machine having a plurality of test modules located on angularly spaced radial lines extending from a central axis, each test module having a plurality of contact pairs for testing electronic components, the process comprising:

positioning a plate for rotational movement about an axis of rotation relative to the test modules to be tested in order to selectively position at least one electrode at one of a plurality of test positions to electrically insert a test device selectively between a contact pair;

selecting the test device to be inserted from a group consisting of a volt meter, a current meter, a precision current source, a precision voltage source, a calibration resistor and a calibration capacitor;

performing at least one test function through the plate with a control program; and

selecting the test function to be performed from a group consisting of alignment verification, voltage/current source verification, insulation resistance (IR) leakage measurement verification, part-present contact check verification, capacitance and dissipation (CD) measurement verification, IR/CD compensation and IR/CD calibration.

12. The process of claim 11 further comprising:

driving the plate in rotation about the axis of rotation to different angular positions in order to selectively align the at least one electrode with different contact pairs sequentially for testing.

13. The process of claim 11 further comprising:

aligning the at least one test electrode angularly and radially with contact pairs associated with each test position for each of the plurality of test modules to be tested.

14. The process of claim 11 wherein aligning the at least one electrode further comprises:

isolating a first electrode and a second electrode electrically from each other on the plate to define a single wired contact associated with each track of the plate and located on the plate so that only the single wired contact is touching a contact pair of the electronic test machine to be tested at a time.

15. The process of claim 11 further comprising:

compensating for offsets introduced by the test device with a lookup table.

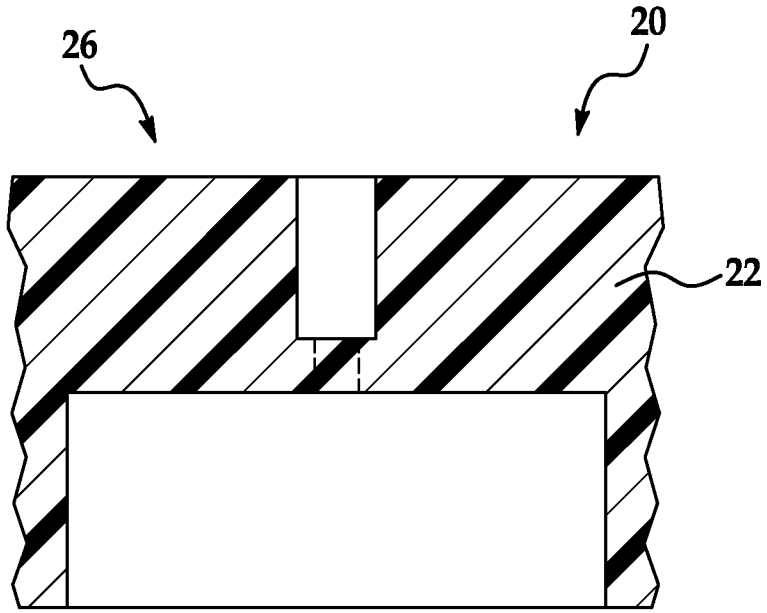


FIG. 1

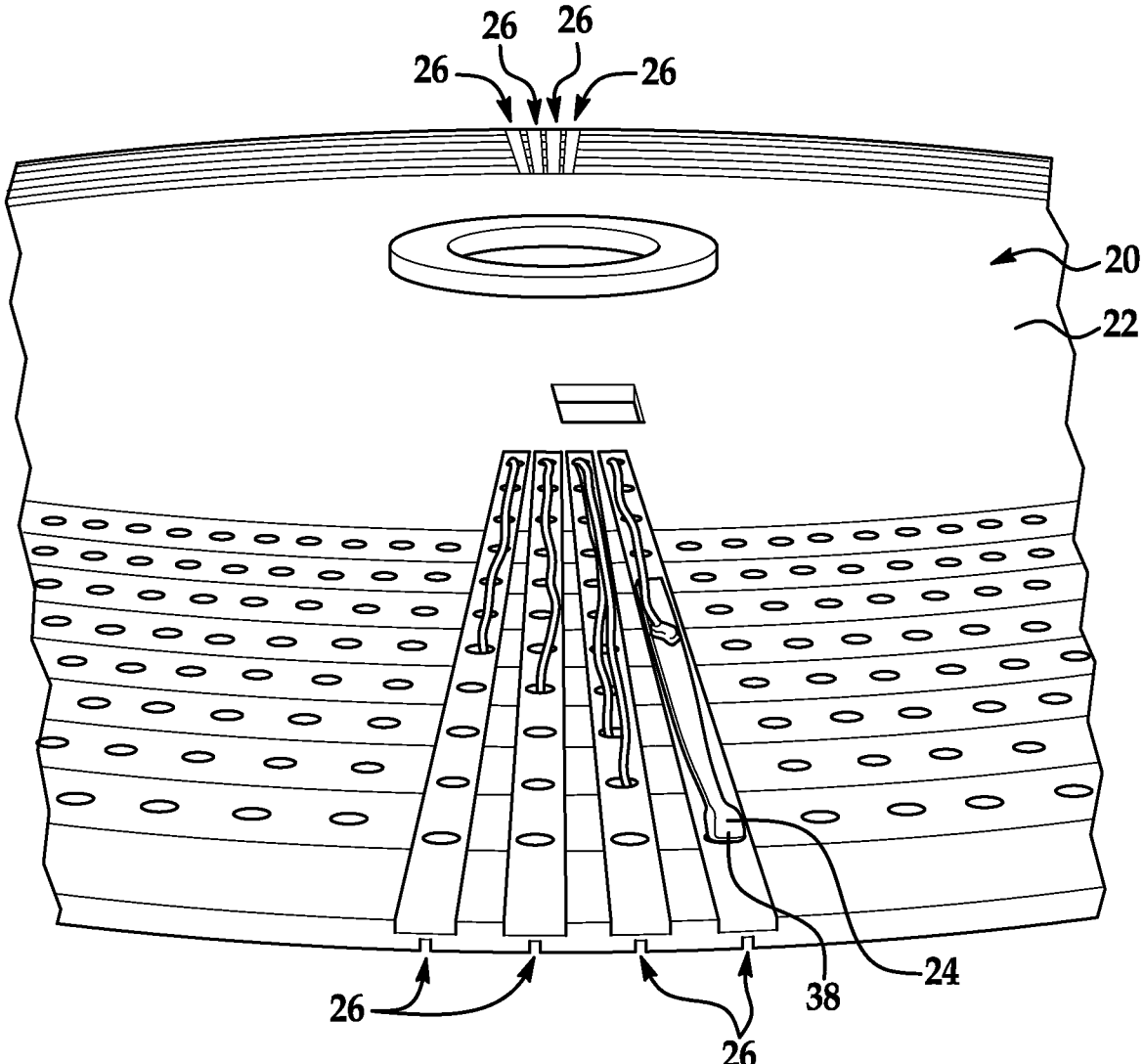


FIG. 2

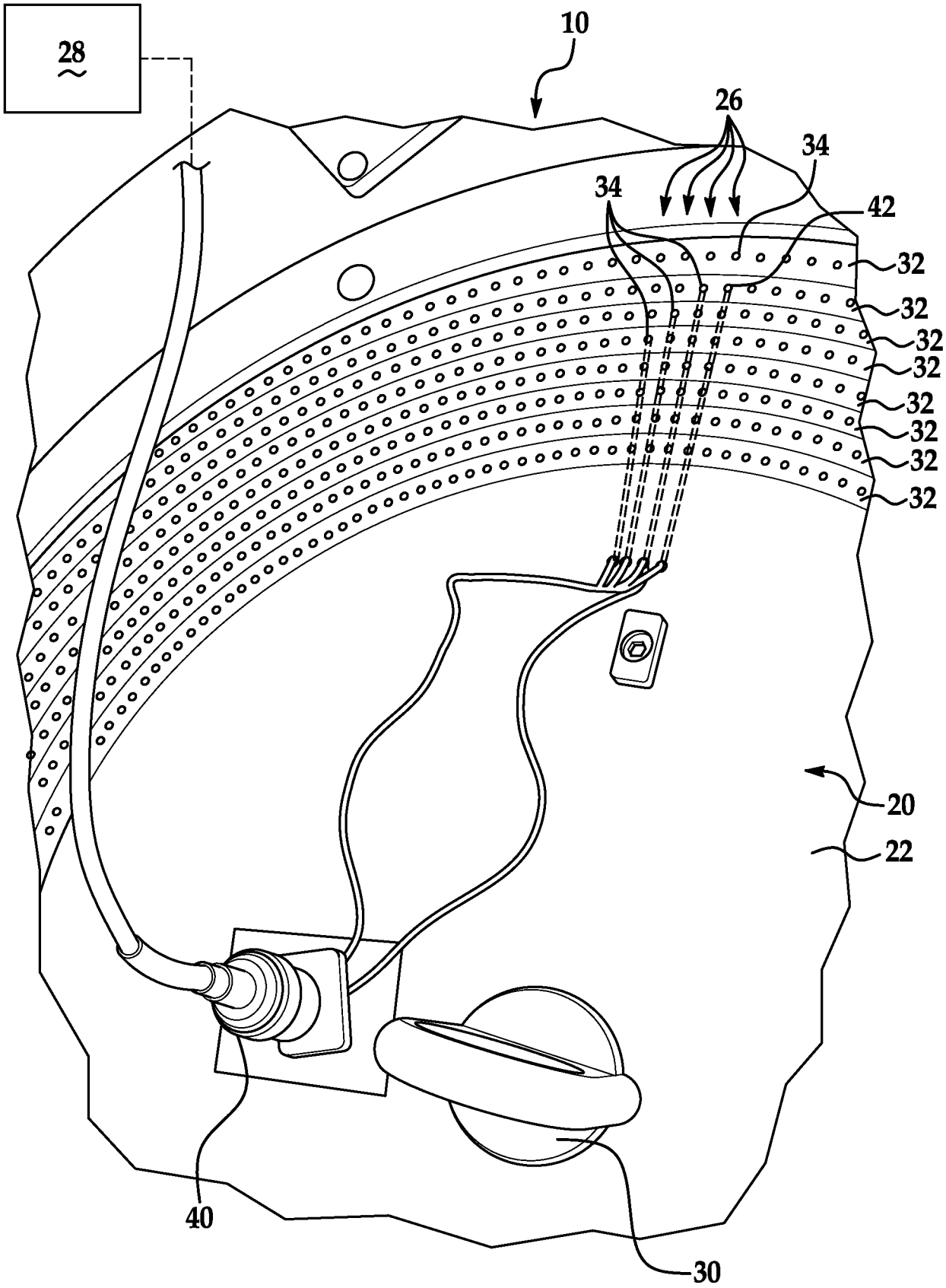


FIG. 3

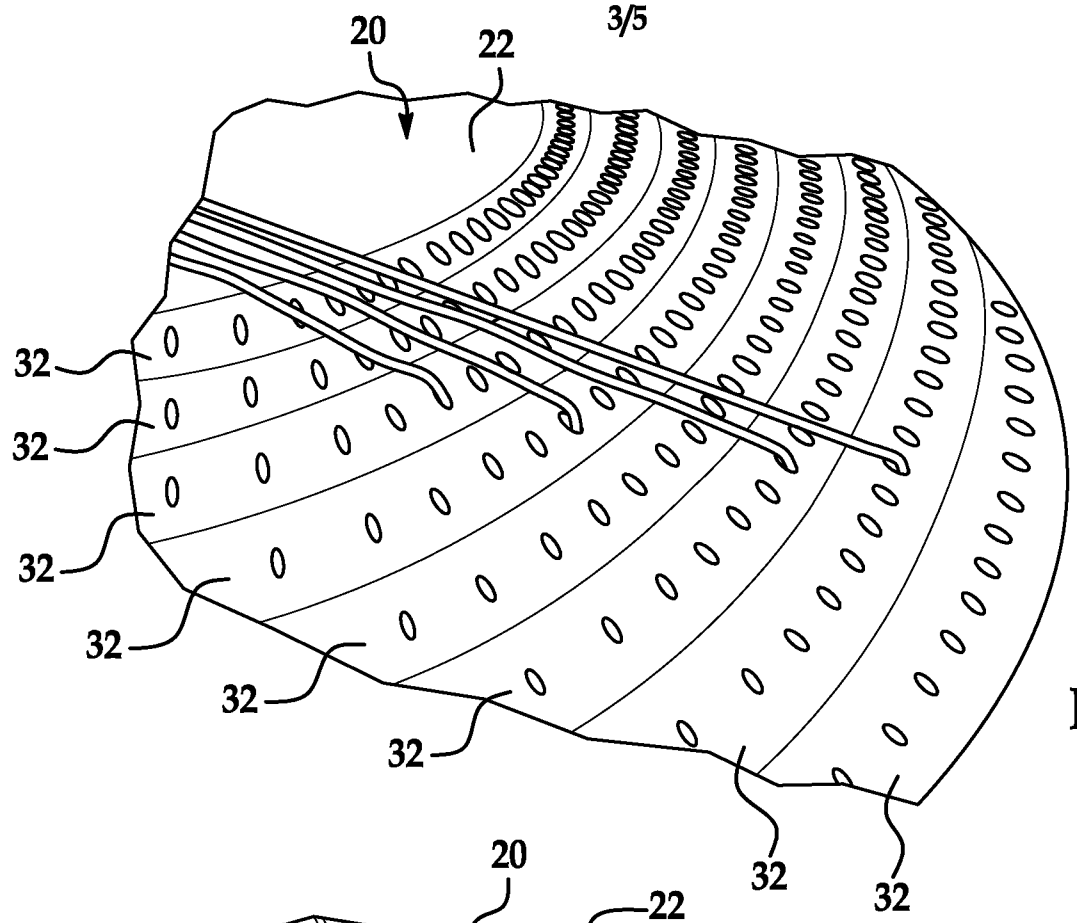

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FIG. 4

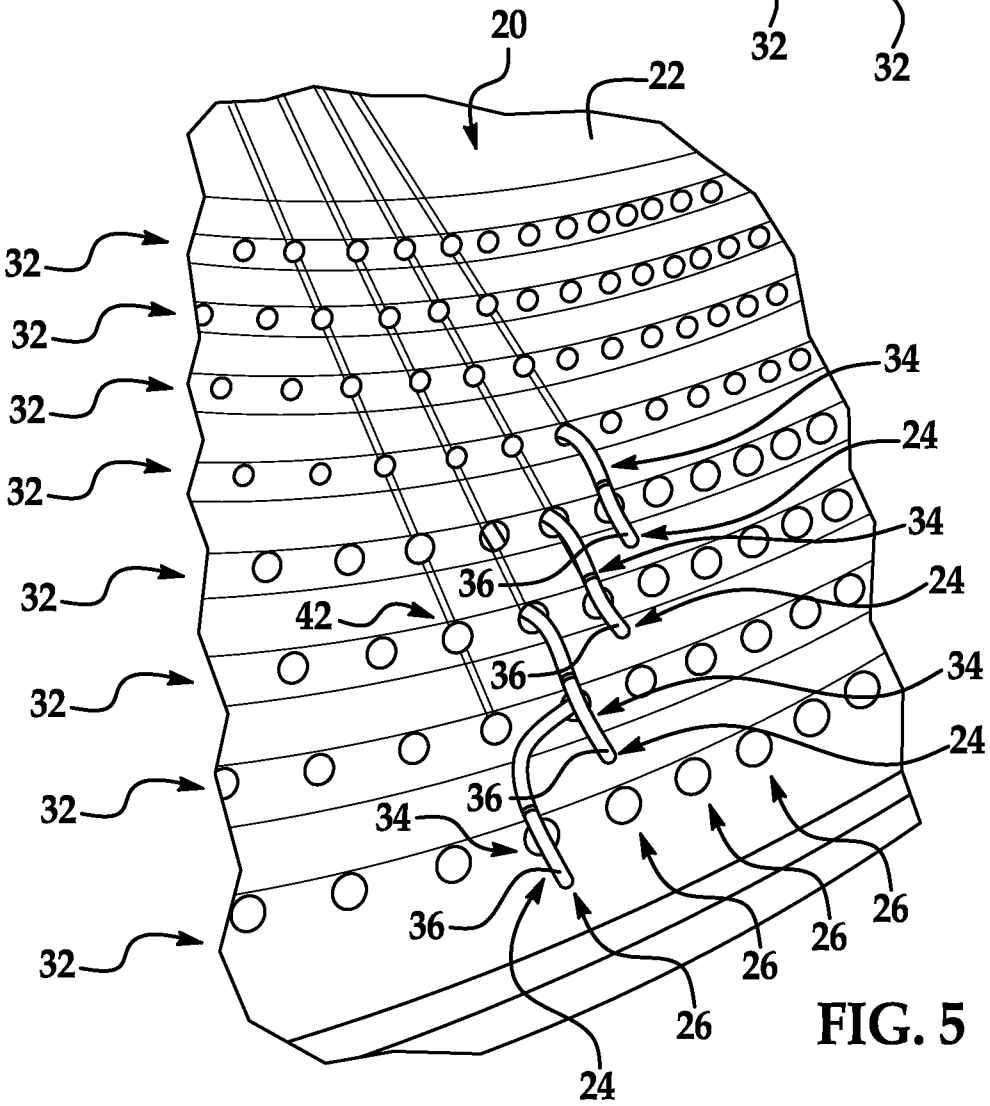

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FIG. 5

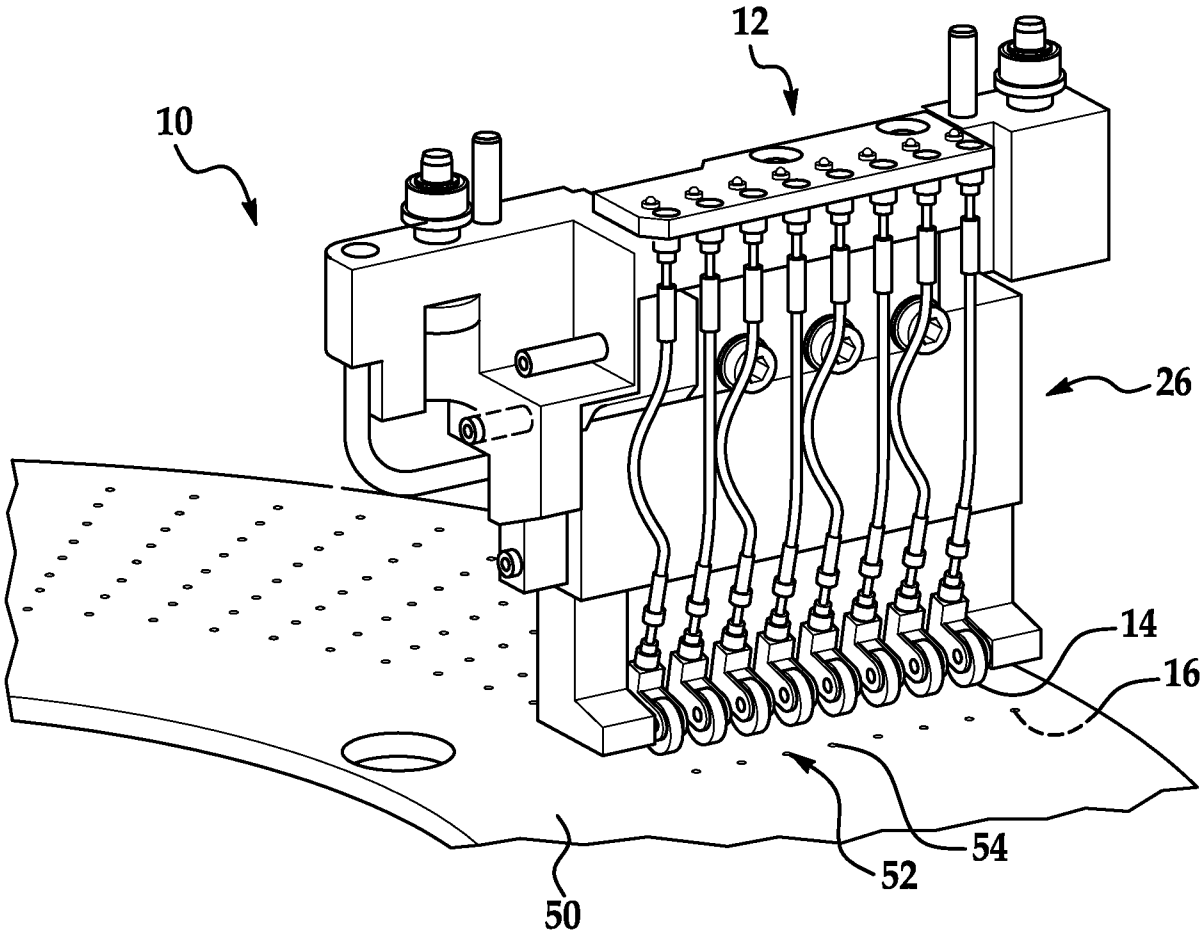


FIG. 6

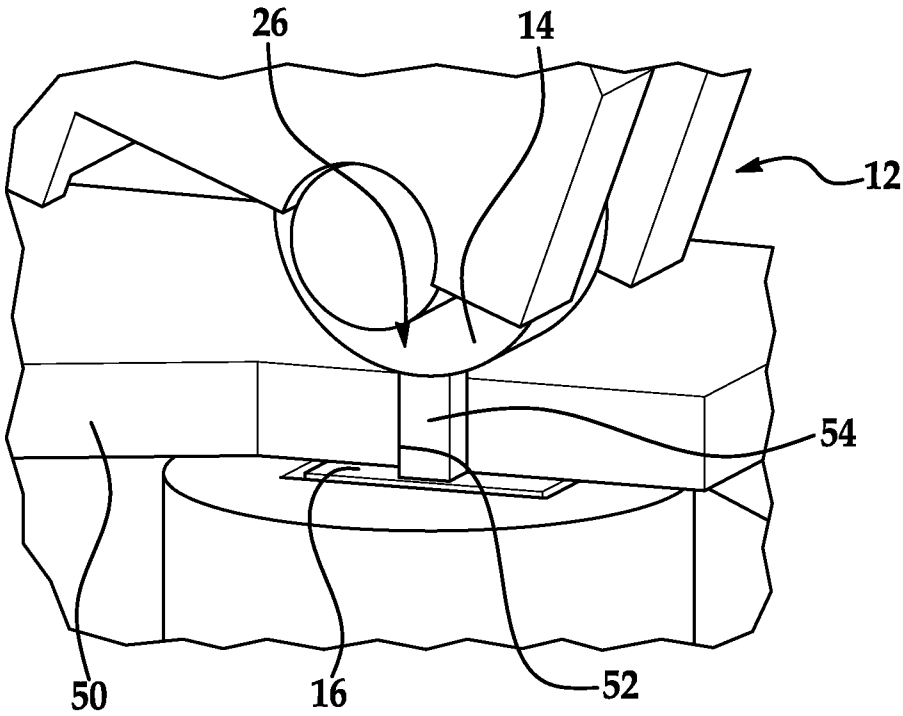


FIG. 7

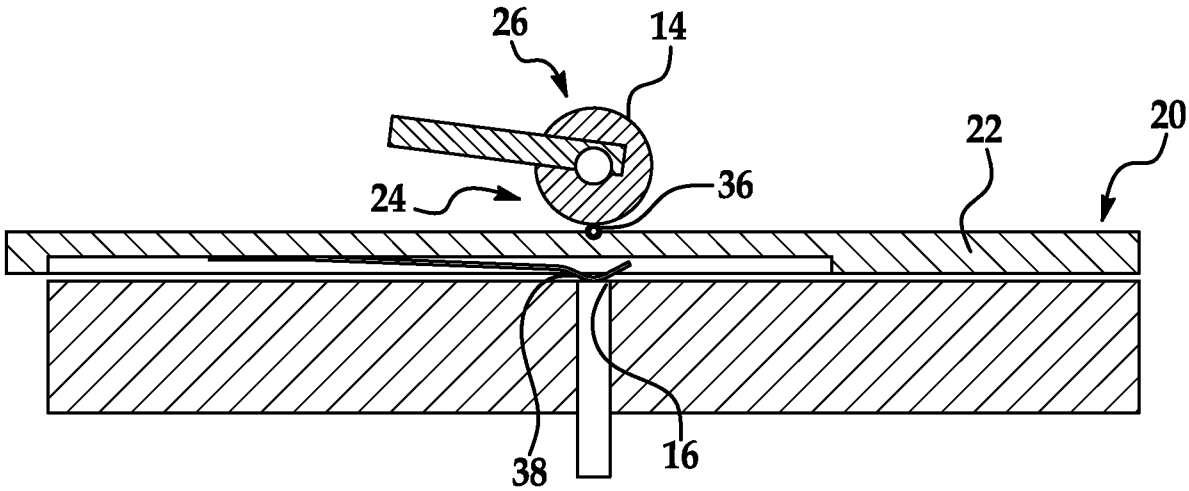


FIG. 8

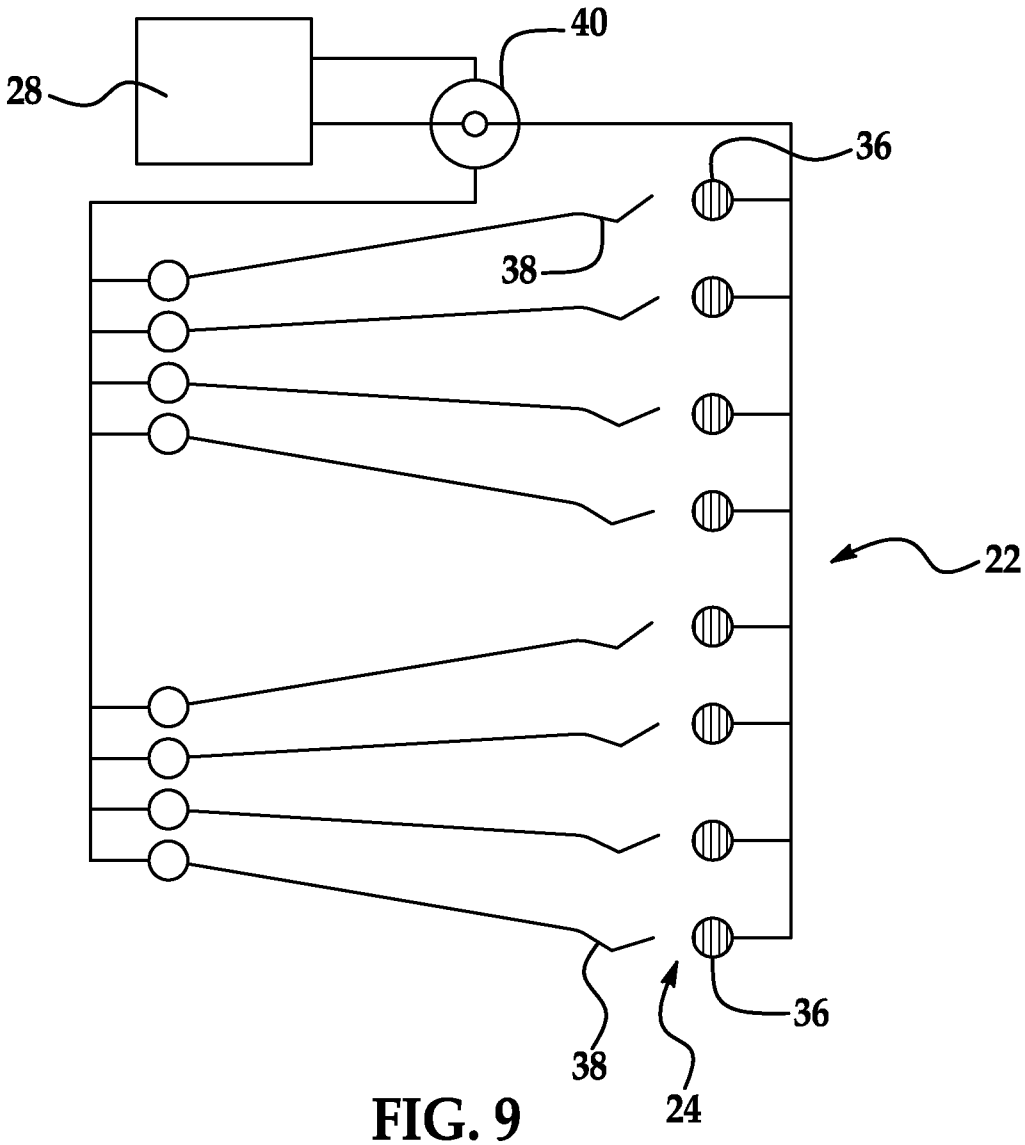


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/036373

A. CLASSIFICATION OF SUBJECT MATTER

G01R 19/145(2006.01)i, G01R 31/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 : G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility Models and applications for Utility Models since 1975; IPC above

Japanese Utility Models and applications for Utility Models since 1975; IPC above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) "electrode", "test", "calibration", "verification", "disk", "radial"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-349723 A (TOSHIBA CERAMICS CO. LTD.) 21 December 2001 See abstract and figures 1-2.	1 - 15
A	US 4975638 A (EVANS A., et al.) 4 December 1990 See abstract and figure 1.	1 - 15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 JUNE 2009 (29.06.2009)	**30 JUNE 2009 (30.06.2009)**

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2009/036373

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2001-349723 A	21.12.2001	None	
US 4975638 A	04.12.1990	None	