ELECTRONICS TESTER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Patent Application No. 63/477,916, filed on December 30, 2022, all of which is incorporated herein by reference in its/their entirety.

[0002] BACKGROUND OF THE INVENTION

1). Field of the Invention

[0003] This invention relates to a tester apparatus that is used for testing microelectronic circuits.

2). Discussion of Related Art

[0004] Microelectronic circuits are usually fabricated in and on semiconductor wafers. Such a wafer is subsequently "singulated" or "diced" into individual dies. Such a die is typically mounted to a supporting substrate for purposes of providing rigidity thereto and for electronic communication with an integrated or microelectronic circuit of the die. Final packaging may include encapsulation of the die and the resulting package can then be shipped to a customer.

[0005] It is required that the die or the package be tested before being shipped to the customer. Ideally, the die should be tested at an early stage for purposes of identifying

defects that occur during early stage manufacture. Wafer level testing may be accomplished by providing a handler and a contactor with contacts and then using the handler to move the wafer so that contacts on the wafer make contact with the contacts on the contactor. Power and electronic signals can then be provided through the contactor to and from microelectronic circuits formed in the wafer.

[0006] According to various embodiments a wafer includes a substrate such as a silicon substrate or a printed circuit board and one or more devices fabricated in the substrate or mounted to the substrate.

[0007] Alternatively, the wafer can be located within a portable wafer pack having an electrical interface and a thermal chuck. Power and signals can be provided through the electric interface to and from the wafer while a temperature of the wafer is thermally controlled by heating or cooling the thermal chuck.

[0008] After the wafer is singulated it may again be required to test the individual dies, and it may again be required to test the die after it is mounted to a supporting substrate.

SUMMARY OF THE INVENTION

[0009] The invention provides a tester apparatus, including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals, a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components, a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity, and an electrical tester connected to the microelectronic circuit to test the microelectronic circuit.

[0010] The invention also provides a tester apparatus, including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals, a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components, a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed

cavity and closing of the supply keeping gas from entering the enclosed cavity, an electrical tester connected to the microelectronic circuit to test the microelectronic circuit, a gas supply passage formed through one of the components, the gas supply passage having an inlet opening outside the enclosed cavity and an outlet opening at the enclosed cavity, and a gas inlet supply connected to the gas supply passage, opening of the gas inlet supply allowing gas into the enclosed cavity and into a space between the contacts.

[0011] The invention further provides a tester apparatus, including a portable supporting structure including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, wherein the first component is a wafer chuck in the form of a planar piece having a planar face, a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals, a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components, a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity, a first electrical interface on the portable supporting structure and connected to the contacts, a portable structure gas removal interface on the portable structure, a stationary structure, the portable supporting structure being receivable to be held by the stationary structure and being removable from the stationary structure, a second electrical interface on the stationary structure, the second electrical interface being

connected to the first electrical interface when the portable structure is held by the stationary structure, and being disconnected from the first electrical interface when the portable supporting structure is removed from the stationary structure, wherein electrical tester is connected through the second electrical interface, the first electrical interface, and the contacts to the terminals, a thermal chuck on the stationary structure, wherein the planar face of the wafer chuck is movable towards a planar face of the thermal chuck, a gas removal conduit forming part of the stationary structure, a stationary structure gas removal interface forming part of the stationary structure, the portable structure gas removal interface shaped to mate with the stationary structure gas removal interface when the wafer chuck moves towards the thermal chuck to connect the outlet opening of the pressure reduction passage to the gas removal conduit of the stationary structure, and an electrical tester connected to the microelectronic circuit to test the microelectronic circuit.

[0012] The invention also provides a tester apparatus including a tray for releasably holding a wafer, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer, a contactor board, contactor front contacts mounted to the contactor board, each contactor front contact having a surface positioned to make contact with a respective front wafer terminal on a front side of the wafer, an electric tester connected to the contactor front contacts, such that, in use, current conducts through the front side wafer contacts and the contactor front contacts between the electric tester and a circuit in the wafer to test the circuit, and an electrical conductor connecting the portion that is electrically conductive such that, in use, the circuit is connected through the rear wafer contact, the exposed surface of the portion that is electrically conductive and the electrical path to the electric tester.

[0013] The invention further provides a tester apparatus including a wafer chuck, a tray for releasably holding a wafer the tray being releasably positioned on the wafer chuck, the wafer chuck having a vacuum passage therethrough, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the tray, a contactor board, contactor contacts mounted to the contactor board, each contactor contact having a surface positioned to make contact with a respective front wafer terminal on a front side of the wafer, and an electric tester connected to the contactor contacts, such that, in use, current conducts through the front side wafer contacts and the contactor contacts between the electric tester and a circuit in the wafer to test the circuit.

[0014] The invention further provides a tester apparatus including a vacuum conduit defining a vacuum passage, a wafer holder for releasably holding a wafer, the wafer holder having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the wafer holder, wherein each vacuum opening has an inlet opening at the wafer, an outlet opening remote from the wafer, and an enlarged section between the inlet opening and the outlet opening to reduce arcing between the openings, a contactor board, contactor contacts mounted to the contactor board, each contactor contact having a surface positioned to make contact with a respective front wafer terminal on a front side of the wafer, and an electric tester connected to the contactor contacts, such that, in use, current conducts through the front side wafer contacts and the contactor contacts between the electric tester and a circuit in the wafer to test the circuit.

[0015] The invention also provides a gas box including a vacuum regulator connectable to a pressure reduction passage to control flow of gas through the pressure reduction passage, a dielectric gas pressure regulator connectable the gas supply passage to control flow of dielectric gas to the gas supply passage, a nitrogen gas pressure regulator to control flow of nitrogen gas to the gas supply passage, and a channeling block connected to the dielectric gas pressure regulator and the nitrogen gas pressure regulator and connectable to the gas supply passage to selectably provide the nitrogen gas or the dielectric gas to the gas supply passage.

[0016] The invention further provides a wafer pack, including a portable supporting structure including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals, a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components, a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity; and a first electrical interface, on the portable supporting structure and connected to the contacts, for connection to a second electrical interface on a stationary structure when the portable supporting structure is removably held by the stationary structure.

[0017] The invention also provides a wafer pack, including a portable supporting structure

including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals, a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components, a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity, a first electrical interface, on the portable supporting structure and connected to the contacts, for connection to a second electrical interface on a stationary structure when the portable supporting structure is removably held by the stationary structure, a gas supply passage formed through one of the components, the gas supply passage having an inlet opening outside the enclosed cavity and an outlet opening at the enclosed cavity, and a gas inlet supply connected to the gas supply passage, opening of the gas inlet supply allowing gas into the enclosed cavity and into a space between the contacts.

[0018] The invention further provides a wafer pack, including a portable supporting structure including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, a plurality of contacts on the second component, the contacts

matching the terminals for making contact to the terminals, a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components, a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity, a first electrical interface, on the portable supporting structure and connected to the contacts, for connection to a second electrical interface on a stationary structure when the portable supporting structure is removably held by the stationary structure, and a portable structure gas removal interface shaped to mate with a stationary structure gas removal interface when the wafer chuck moves towards the thermal chuck to connect the outlet opening of the pressure reduction passage to a gas removal conduit of the stationary structure.

[0019] The invention also provides a method of testing a microelectronic circuit held by a substrate, including holding the substrate between first and second components, the second component having contacts against terminals of the substrate connected to the microelectronic circuit, locating a cavity seal between the first and second components to form an enclosed cavity by surfaces of the first and second components and the cavity seal, and transmitting signals between an electrical tester and the microelectronic circuit to test the microelectronic circuit.

[0020] The invention further provides a method of testing a microelectronic circuit held by a substrate, including holding the substrate between first and second components, the second component having contacts against terminals of the substrate connected to the

microelectronic circuit, locating a cavity seal between the first and second components to form an enclosed cavity by surfaces of the first and second components and the cavity seal, transmitting signals between an electrical tester and the microelectronic circuit to test the microelectronic circuit, and allowing a dielectric gas into the enclosed cavity into a space between the contacts.

[0021] The invention also provides a method of testing a microelectronic circuit held by a substrate, including holding the substrate between first and second components, the second component having contacts against terminals of the substrate connected to the microelectronic circuit wherein the first component is a wafer chuck in the form of a planar piece having a planar face, locating a cavity seal between the first and second components to form an enclosed cavity by surfaces of the first and second components and the cavity seal, receiving the portable supporting structure by a stationary structure with a first electrical interface on the portable supporting structure connected to a second electrical interface on the stationary structure, moving the planar face of the wafer chuck towards a planar face of a thermal chuck of a stationary structure to further mate a portable structure gas removal interface with a stationary structure gas removal interface to connect the outlet opening of the pressure reduction passage to a gas removal conduit of the stationary structure, and transmitting signals between an electrical tester and the microelectronic circuit to test the microelectronic circuit, wherein the signals are transmitted between the electrical tester and the microelectronic circuit through the terminals, contacts, and first and second electrical interfaces to test the microelectronic circuit.

[0022] The invention further provides a method of testing a wafer including holding a wafer in a tray, wherein the tray has at least a portion that is electrically conductive and has

an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer, moving a contactor board and the tray relatively towards one another so that surfaces of contactor contacts mounted to the contactor board make contact with respective front wafer contacts on a front side of the wafer, conducting current through the front side wafer contacts and the contactor contacts between an electric tester and a circuit in the wafer to test the circuit, the circuit being connected through the rear wafer terminal, the exposed surface of the portion that is electrically conductive and the electrical path to the electric tester, and removing the wafer from the tray.

[0023] The invention also provides a method of testing a wafer including holding a wafer in a tray, positioning the tray on a chuck, applying a vacuum to a vacuum passage though the wafer chuck, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that the vacuum secures the rear side of the wafer to the tray, moving a contactor board and the tray relatively towards one another so that surfaces of contactor contacts mounted to the contactor board make contact with respective front wafer contacts on a front side of the wafer, conducting current through the front side wafer contacts and the contactor contacts between an electric tester and a circuit in the wafer to test the circuit, and removing the wafer from the tray.

[0024] The invention further provides a method of testing a wafer including releasably holding a wafer in a wafer holder, the wafer holder having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage, applying a vacuum to the vacuum passage, the vacuum securing the rear side of the wafer to the wafer holder, moving a contactor board and the tray relatively towards one

another so that surfaces of contactor contacts mounted to the contactor board make contact with respective front wafer contacts on a front side of the wafer, conducting current through the front side wafer contacts and the contactor contacts between an electric tester and a circuit in the wafer to test the circuit, wherein each vacuum opening has an inlet opening at the wafer, an outlet opening remote from the wafer, and an enlarged section between the inlet opening and the outlet opening to reduce arcing between the openings, and removing the wafer from the tray.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The invention is further described by way of examples with reference to the accompanying drawings, wherein:

[0026] Figure 1 is a cross-sectional side view of a tester apparatus having slot assemblies according to one embodiment of the invention;

[0027] Figure 2 is a cross-sectional side view of the tester apparatus on line 2-2 in Figure 1;

[0028] Figure 3 is a cross-sectional side view of the tester apparatus on line 3-3 in Figure 1;

[0029] Figure 4 is a cross-sectional side view of the tester apparatus on line 4-4 in Figures 2 and 3;

[0030] Figures 5A, 5B and 5C are perspective views of the tester apparatus illustrating insertion or removal of portable wafer packs into or out of an oven defined by a frame;

[0031] Figure 6 is a time chart showing how one wafer pack can be inserted and used for testing electronic devices of wafers and subsequent insertion of another wafer pack;

[0032] Figure 7 is a perspective view of the tester apparatus illustrating insertion or removal of one slot assembly;

[0033] Figures 8A and 8B are cross-sectional side views illustrating the use of a stand-off in the configuration of the wafer pack described with respect to Figures 1-7;

[0034] Figures 9A, 9B and 10 are side views illustrating an apparatus that is used for insertion and removal of portable wafer packs into and out of the oven;

[0035] Figure 11 is a perspective view from above of the first wafer pack;

[0036] Figure 12 is perspective view from below of the first wafer pack;

[0037] Figure 13 is a cross-section on 13-13 in Figures 11 and 12 of the first wafer pack;

[0038] Figure 14 is a cross-section on 14-14 in Figure 13 of the first wafer pack;

[0039] Figure 15 is a cross-section on 15-15 in Figure 12 of the first wafer pack;

[0040] Figure 16 is a view in a direction of an arrow A in Figure 15 with components thereof removed;

[0041] Figure 17 is a is a cross-section on 17-17 in Figure 15;

[0042] Figures 18A(i) and 18A(ii) are views in the direction of arrows A and B in Figure 15 with a latch mechanism in an unlocked configuration;

[0043] Figures 18B(i) and 18B(ii) are views similar to Figures 18A(i) and 18A(ii) with the latch mechanism in a locked position;

[0044] Figure 19 is a perspective view illustrating how shims are used to set a height of wing pieces of the latch mechanism;

[0045] Figure 20 is a perspective view of components of a pressure monitoring system;

[0046] Figure 21 is a perspective view of further components of the pressure monitoring system;

[0047] Figures 22A and 22B are a perspective view and a side view of the components of the pressure monitoring system before engagement;

[0048] Figures 23A and 23B are view similar to Figures 22A and 22B after engagement of the components of the pressure monitoring system;

[0049] Figure 24 is a block diagram illustrating components of the tester apparatus that are used for introducing a dielectric gas;

[0050] Figure 25 is a top plan view of the slot assembly;

[0051] Figure 26 is a cross-sectional side view on 26A-26B in Figure 25;

[0052] Figure 27 is a cross-sectional side view on 27A-27B in Figure 25;

[0053] Figure 28 is a detailed view of an area marked "C" in Figure 26;

[0054] Figure 29 is a detailed view of an area marked "D" in Figure 27;

[0055] Figure 30 is a perspective view of the slot assembly;

[0056] Figures 31 and 32 are partially exploded perspective views of a gas box that is used in the slot assembly;

[0057] Figure 33 is a cross-sectional side view of the wafer pack and a portion of the slot assembly;

[0058] Figure 34 is a detailed view of an area marked "E" in Figure 33; and

[0059] Figures 35 and 36 are perspective views on two cross-sections that are right angles to one another of a wafer chuck and a tray of the wafer pack shown in Figure 33.

DETAILED DESCRIPTION OF THE INVENTION

[0060] Figure 1 of the accompanying drawings illustrates a tester apparatus 10, according to an embodiment of the invention, that comprising (i) a stationary structure that includes a tester 12, a frame 14, a power bus 16, first and second slot assemblies 18A and 18B, a tester cable 20, a power cable 22, a cold liquid supply line 24A, a cold liquid return line 24B, a control liquid supply line 24C, a control liquid return line 24D, a vacuum line 24E, (ii) a portable arrangement that includes first and second wafer packs 28A and 28B, and (iii) first and second wafers 30A and 30B. The first and second wafer packs 28A and 28B are described herein as "wafer packs" and their use is described for testing wafers. It should be understood that the first and second wafers 28A and 28B can be used for testing microelectronic circuits generally and can be classified as "first and second microelectronic circuit testing packs 28A and 28B" instead.

[0061] The slot assembly 18A includes a slot assembly body 32, a thermal chuck 34, a temperature detector 36, a temperature modification device in the form of a heating resistor 38, a first slot assembly interface 40, and a plurality of second slot assembly interfaces, including a control interface 44, a power interface 46 and a cold liquid supply interface 48A, a cold liquid return interface 48B, a control liquid supply interface 48C, a control liquid return interface 48D and a vacuum interface 48E.

[0062] The first slot assembly interface 40 is located within the slot assembly body 32 and is mounted to the slot assembly body 32. The second electrical interfaces in the form of the control interface 44, the power interface 46 and the interfaces 48A to 48E are mounted in a left wall of the slot assembly body 32.

[0063] The slot assembly 18A is insertable from left to right into and is removable from

right to left from the frame 14. The tester cable 20, the power cable 22 and the lines 24A to 24E are manually connected to the control interface 44, the power interface 46 and the interfaces 48A to 48E, respectively. Before removing the slot assembly 18A from the frame 14, the tester cable 20, power cable 22 and the lines 24A to 24E are first manually disconnected from the control interface 44, power interface 46 and the interfaces 48A to 48E, respectively.

[0064] The slot assembly 18A includes a motherboard 60 having test electronics, a plurality of channel module boards 62 having test electronics, flexible connecters 64, and a connection board 66. The control interface 44 and the power interface 46 are connected to the motherboard 60 and a thermal controller 50 is mounted to the motherboard 60. The channel module boards 62 are electrically connected to the motherboard 60. The flexible connectors 64 connect the channel module boards 62 to the connection board 66. Control functionality is provided through electrical conductors connecting the control interface 44 to the motherboard 60. Power is provided through the power interface 46 to the motherboard 60. Both power and control are provided from the motherboard 60 through conductors to the channel module boards 62. The flexible connectors 64 provide conductors that connect the channel module boards 62 to the connection board 66. The connection board 66 includes a conductor that connects the flexible connectors 64 to the first slot assembly interface 40. This first slot assembly interface 40 is thus connected through various conductors to the control interface 44 and power interface 46 so that power and control can be provided via the control interface 44 and power interface 46 to the first slot assembly interface 40.

[0065] The second slot assembly 18B includes similar components to the first slot assembly 18A and like reference numerals indicate like components. The second slot

assembly 18B is inserted into the frame 14 and the control interface 44, power interface 46 and interfaces 48A to 48E of the second slot assembly18B are manually connected to a separate set of connecting components including a separate tester cable 20, a separate power cable 22 and separate lines 24A to 24E, respectively.

[0066] The wafer pack 28A includes a wafer pack body formed by a wafer chuck 72 and a backing plate 74. The wafer 30A has a plurality of microelectronic devices formed therein. The wafer 30A is inserted into the wafer pack body between the wafer chuck 72 and backing plate 74. Wafer pack contacts 76 make contact with respective contacts (not shown) on the wafer 30A. The wafer pack 28A further includes a wafer pack interface 78 on the backing plate 74. Conductors in the backing plate 74 connect the wafer pack interface 78 to the wafer pack contacts 76.

[0067] The wafer pack 28A has a lip seal 77 (also referred to herein as a "pressure differential cavity seal") connected between the backing plate 74 and the wafer chuck 72. A vacuum is applied to an area defined by the lip seal 77, backing plate 74 and the wafer chuck 72. The vacuum keeps the wafer pack 28A together and ensures proper contact between the wafer pack contacts 76 and the contacts on the wafer 30A.

[0068] The temperature detector 36 is located in the thermal chuck 34 and therefore close enough to the wafer 30A to detect a temperature of the wafer 30A or to within five degrees Celsius, preferably to within one or two degrees Celsius of the wafer 30A.

[0069] The slot assembly 18A further has a door 82 connected to the slot assembly body 32 by a hinge 84. When the door 82 is rotated into an open position, the wafer pack 28A can be inserted through a door opening 86 into the slot assembly body 32. The wafer pack 28A is then lowered onto the thermal chuck 34 and the door 82 is closed. The thermal chuck 34 is

mounted to the slot assembly body 32. The thermal chuck 34 then essentially forms a stationary holder having a testing station for a wafer.

[0070] The slot assembly 18A further has a thermal interface cavity seal 88 that is located between the thermal chuck 34 and the wafer chuck 72. A vacuum is applied through the vacuum interface 48E and a vacuum line 90 to an area defined by the thermal interface cavity seal 88, thermal chuck 34 and wafer chuck 72. A good thermal connection is thereby provided between the thermal chuck 34 and the wafer chuck 72. When heat is created by the heating resistor 38, the heat conducts through the thermal chuck 34 and the wafer chuck 72 to reach the wafer 30A. Heat conducts in an opposite direction when the thermal chuck 34 is at a lower temperature than the wafer 30A.

[0071] The wafer pack interface 78 engages with the first slot assembly interface 40. Power and signals are provided via the first slot assembly interface 40, wafer pack interface 78 and wafer pack contacts 76 to the wafer 30A. A performance of devices within the wafer 30A is measured through the wafer pack contacts 76, wafer pack interface 78 and first slot assembly interface 40.

[0072] The door 82 of the slot assembly 18B is shown in a closed position. A front seal 100 is mounted on an upper surface of the slot assembly 18A and seals with a lower surface of the slot assembly 18B. A front seal 102 is mounted to an upper surface of the slot assembly 18B and seals with a lower surface of the frame 14. A continuous sealed front wall 104 is provided by the door 82 of the slot assemblies 18A and 18B and the front seals 100 and 102.

[0073] The slot assembly 18A further includes a thermal controller 50. The temperature detector 36 is connected through a temperature feedback line 52 to the thermal controller 50.

Power is provided through the power interface 46 and a power line 54 to the heating resistor 38 so that the heating resistor 38 heats up. The heating resistor 38 then heats the thermal chuck 34 and the wafer 30A on the thermal chuck 34. The heating resistor 38 is controlled by the thermal controller 50 based on the temperature detected by the temperature detector 36.

[0074] The thermal chuck 34 has a thermal fluid passage 224 formed therein. The thermal fluid passage 224 holds a thermal fluid. The thermal fluid is preferably a liquid as opposed to a gas because liquid is not compressible, and heat convects faster to or from a liquid. Different thermal fluids are used for different applications with oil being used for applications where temperatures are the highest.

[0075] Control liquid supply and return lines 226 and 228 connect opposing ends of the thermal fluid passage 224 to the cold liquid supply and return interfaces 48C and 48D, respectively. The heating resistor 38 serves as a heater that is mounted in a position to heat the thermal chuck 34, which heats the thermal fluid. By recirculating the thermal fluid through the thermal fluid passage 224, a more uniform distribution of heat is provided by the thermal chuck 222 to the thermal chuck 34 and ultimately to the wafer 30A. The temperature of the fluid can also be controlled to add heat to the thermal chuck 34 or to cool the thermal chuck 34 down.

[0076] The tester apparatus 10 further includes a cooling system 240, a temperature control system 242 and a vacuum pump 244. The two cold liquid supply lines 24A that are connected to the first and second slot assemblies 18A and 18B are also connected through a manifold (not shown) to the cooling system 240. Additional manifolds connect the cold liquid return lines 24B to the cooling system 240, the control liquid supply lines 24C to the

temperature control system 242, the control liquid return lines 24D to the temperature control system 242 and the vacuum lines 24E to the vacuum pump 244. Each slot assembly 18A or 18B has a respective cold plate 246 with a respective fluid passage 248. The cooling system 240 circulates a fluid through the fluid passage 248 to cool the cold plate 246. The cold plate 246 then keeps the channel module boards 62 cool. The temperature control system 242 circulates a fluid through the thermal fluid passage 224 to control a temperature of the thermal chuck 34 and transfer heat from or to the wafers 30A and 30B. The vacuum pump 244 provides air at vacuum pressure to the vacuum line 90.

[0077] The slot assembly 18A includes a separator seal 108 mounted to an upper surface the slot assembly body 32 above the internal wall 106 thereof. The separator seal 108 seals with a lower surface of the slot assembly 18B. The slot assembly 18B has a separator seal 110 mounted to an upper surface of the slot assembly body 32 thereof. The separator seal 108 seals with a lower surface of the frame 14. A continuous sealed separator wall 112 is provided by the internal walls 106 of the slot assemblies 18A and 18B and the separator seals 108 and 110.

[0078] Figure 2 illustrates the tester apparatus 10 on 2-2 in Figure 1. The frame 14 defines a first closed loop air path 120. Air inlet and outlet openings (not shown) can be opened to change the first closed loop air path 120 into an open air path wherein air at room temperature passes through the frame 14 without being recirculated. A closed loop path is particularly useful in a clean room environment because it results in less particulate material being released into the air.

[0079] The tester apparatus 10 further includes a first fan 122, a first fan motor 124 and a temperature modification device in the form of a water cooler 126.

[0080] The first fan 122 and first fan motor 124 are mounted in an upper portion of the first closed loop air path 120. The water cooler 126 is mounted to the frame 14 within an upper portion of the first closed loop air path 120.

[0081] The wafer packs 28A and 28B are positioned with the slot assemblies 18A and 18B and are within a lower half of the first closed loop air path 120.

[0082] In use, current is provided to the first fan motor 124. The first fan motor 124 rotates the first fan 122. The first fan 122 recirculates air in a clockwise direction through the first closed loop air path 120.

[0083] The water cooler 126 then cools the air in the first closed loop air path 120. The air then flows through the slot assemblies 18A and 18B over the wafer packs 28A or 28B. The wafer packs 28A or 28B are then cooled by the air through convection.

[0084] Figure 3 shows the tester apparatus 10 on 3-3 in Figure 1. The frame 14 defines a second closed loop air path 150. The tester apparatus 10 further includes a second fan 152, a second fan motor 154 and a temperature modification device in the form of a water cooler 156. No electric heater or damper is provided as in Figure 2. Air inlet and outlet openings (not shown) can be opened to change the second closed loop air path 150 into an open air path wherein air at room temperature passes through the frame 14 without being recirculated.

[0085] A closed loop path is particularly useful in a clean room environment because it results in less particulate material being released into the air. The second fan 152 and second fan motor 154 are located in an upper portion of the second closed loop air path 150. The water cooler 156 is located slightly downstream from the second fan 152 within the second closed loop air path 150. The motherboard 60 and channel module boards 62 that form a part

of the slot assemblies 18A and 18B are located within a lower half of the second closed loop air path 150.

[0086] In use, electric current is provided to the second fan motor 154, which rotates the second fan 152. The second fan 152 then recirculates air in a clockwise direction through the second closed loop air path 150. The air is cooled by the water cooler 156. The cooled air then passes over the motherboard 60 and channel module boards 62 so that heat transfers from the motherboard 60 and channel module boards 62 to the air through convection.

[0087] Air recirculating through the first closed loop air path 120 in Figure 2 is kept separate from air in the second closed loop air path 150 in Figure 3 by the continuous sealed separator wall 112 shown in Figure 1. The continuous sealed front wall 104 shown in Figure 1 prevents air from escaping out of the first closed loop air path 120.

[0088] As shown in Figures 2 and 3, the same cooling system 240 that is used in Figure 1 is also used to cool the water coolers 126. As shown in Figure 4, a plenum 160 separates the first closed loop air path 120 from the second closed loop air path 150 in all areas except those provided by the continuous sealed separator wall 112. The frame 14 has left and right walls 162 and 164 that further define the closed loop air paths 120 and 150.

[0089] Figures 5A, 5B and 5C illustrate how wafer packs 30C, 30D and 30E can be inserted or be removed at any time while all other wafer packs are being used to test devices of wafers and may be in various states of temperature ramps. Figure 6 illustrates the concept in more detail. At time T1 a first wafer pack is inserted into the frame 14 while a second wafer pack is outside the frame 14. At T1 heating of the first wafer pack is initiated. Between T1 and T2 the temperature of the first wafer pack increases from room temperature, i.e., about 22°C, to a testing temperature that is 50°C to 150°C higher than

room temperature at T2. At T2 power is applied to the first wafer pack and the devices in the first wafer pack are tested. At T3, a second wafer pack is inserted into the frame 14 and heating of the second wafer pack is initiated. At T4, testing of the first wafer pack is terminated. At T4, cooling of the first wafer pack is also initiated. At T5, the second wafer pack reaches testing temperature and power is provided to the second wafer pack and the wafer in the second wafer pack is tested. At T6, the second wafer pack reaches a temperature close to room temperature and is removed from the frame 14. A third wafer pack can then be inserted in place of the first wafer pack. At T7, testing of the second wafer pack is terminated and cooling thereof is initiated. At T8, the second wafer pack has cooled down to room temperature or close to room temperature and is removed from the frame 14.

[0090] Different tests can be conducted at different temperatures. By way of example, a wafer pack may be inserted, and a test be run at room temperature. Another test can be conducted during an upward ramp in temperature. A further test can be conducted at an elevated temperature. A further test can be conducted during a downward ramp in temperature. Two of these tests can be a single test that runs from one temperature stage to the next.

[0091] As shown in Figure 7, one slot assembly 18A can be removed or be inserted into the frame 14. The slot assembly 18A can be inserted or be removed while the other slot assemblies within the frame 14 are used for testing devices of wafers as described with reference to Figure 6.

[0092] As shown in Figure 8A further show a signal distribution board 500, a contactor board 502, a plurality of wafer contact pins 504, a contactor hold-down ring 506, a fastener 508, and a post 510.

[0093] The signal distribution board 500 is primarily made of an insulative material and has a circuit (not shown) formed therein. Contacts 512 are formed on a lower side 514 of the signal distribution board 500. A threaded opening 516 is formed into the lower side 514.

[0094] The contactor board 502 has a plurality of pin openings 518, a post opening 520 and a fastener opening 522 formed from an upper side 524 to a lower side 526 therethrough. Each one of the pin openings 518 has a first section 528 and a second section 530. The first and second sections 528 and 530 are both circular when viewed in plan view. The first section 528 has a larger diameter than the second section 530. The larger diameter of the first section 528 when compared to the diameter of the second section 530 results in the first section 528 being wider than the second section 530 when view in the cross-sectional side view of Figure 8A.

[0095] The post opening 520 has a first section 534 and a second section 536. The first section 534 and the second section 536 are both circular when viewed in plan view. A diameter of the first section 534 is larger than a diameter of the second section 536. Because the diameter of the first section 534 is more than the diameter of the second section 536, the first section 534 is wider than the second section 536 when view in the cross-sectional side view of Figure 8A. The first and second sections 534 and 536 have vertical side walls. A horizontal landing 538 connects the vertical side walls of the first and second sections 534 and 536.

[0096] Each pin 504 includes an electrically conductive retainer portion 542, a coil spring 544 and first and second end pieces 546 and 548. The first end piece 546 has a first inner portion 550 and a first tip 552. The second end piece 548 has a second inner portion 554 and a second tip 556. The coil spring 544 and the first and second inner portions 550 and 554 are

retained with the retainer portion 542 with the coil spring 544 located between the first and second inner portions 550 and 554. The first and second tips 552 and 556 protrude out of upper and lower ends, respectively, of the retainer portion 542.

[0097] An upper surface of the first tip 552 forms a terminal 560. A lower end of the second tip 556 forms a contactor front contact 562. The coil spring 544 and the first and second end pieces 546 and 548 are made of metal and, therefore, electrically conductive material. The coil spring 544 and the first and second end pieces 546 and 548 form a conductor that is capable of conducting current between the terminal 560 and the contactor front contact 562.

[0098] A respective pin is inserted through the upper side 524 into a respective pin opening 518. The second tip 556 is slightly smaller than the second section 530 so that it passes through the second section 530 and protrudes from the lower side 526. The retainer portion 542 is slightly narrower than the first section 528, but is wider than the second section 530 to prevent the pin 504 from falling out of the lower side 526. When the pin 504 is fully inserted into the pin opening 518, and before the contactor board 502 is mounted to the signal distribution board 500, the first tip 552 still protrudes above the upper side 524 of the contactor board 502.

[0099] The post 510 has a stand-off 564, a force transfer potion 566 and a force delivery portion 568. The post 510 is made out of a single piece of metal or other material that is chosen because of its strength when compared to the strength and brittleness of the ceramic material of the contactor board 502.

[00100] The post 510 is inserted through the upper side 524 into the post opening 520. The stand-off 564 and the force transfer portion 566 are slightly narrower than the second section

536. The force delivery portion 568 is slightly narrower than the first section 534, but wider than the second section 536. A lower surface 570 of the force delivery portion 568 abuts against the landing 538. The post 510 is thereby prevented from falling out of the lower side 526.

[00101] The post 510 has a surface 572 that, when the post 510 is fully inserted as shown in Figure 8A, is in a plane that is parallel and below a surface of the lower side 526. When the post 510 is fully inserted, the force delivery portion 568 has a surface 574 that is in the same plane as the upper side 524.

[00102] The signal distribution board 500 is positioned on top of the contactor board 502. Each one of the contacts 512 makes contact with a respective one of the terminals 560. Because the terminals 560 are in a plane above a plane of the upper side 524, the lower side 514 is initially spaced from the upper side 524.

[00103] The fastener 508 has a threaded shaft 578 and a head 580. The contactor hold-down ring 506 has a ring opening 582. The contactor hold-down ring 506 is located on a lower surface 584 of the contactor board 502. The threaded shaft 578 is inserted from the bottom through the ring opening 582 and then through the fastener opening 522. The head 580 comes into contact with a lower surface of the contactor hold-down ring 506. The head 580 is then turned so that thread on the threaded shaft 578 screws into thread on the threaded opening 516. The threading action moves the signal distribution board 500 closer to the contactor board 502 and the contactor hold-down ring 506. The lower side 514 eventually comes into contact with the upper side 524. The contacts 512 move the first end piece 546 downward into the pin opening 518 until the terminals 560 are in the same plane as the upper side 524. The coil spring 544 compress, and therefore deform slightly to allow for

relative movement of the first end piece 546 relatively towards the second end piece 548.

[00104] The lower side 514 has a section that comes to a standstill against the surface 574 forming part of the post 510. Because the post 510 abuts against the signal distribution board 500, the post 510 is in a position to transfer a force through the surface 572 to the signal distribution board 500.

[00105] The first wafer 32A has a plurality of electronic devices formed therein. Each electronic device has a plurality of terminals 588 at an upper surface 590 of the first wafer 32A. When bringing the backing plate 74 and the first wafer 32A together, the first wafer 32A is aligned with the backing plate 74 to ensure that each one of the terminals 588 makes contact with a respective one of the contactor front contacts 562.

[00106] A vacuum pressure is created in an area between the upper surface 590 and the lower side 526 while a pressure below a lower surface 592 of the wafer chuck 72 and an upper surface 594 of the signal distribution board 500 remain at atmospheric pressure. The pressure differential creates equal and opposing forces F1 and F2 on the signal distribution board 500 and wafer chuck 72.

[00107] As shown in Figure 8B, the forces F1 and F2 move the backing plate 74 relatively towards the first wafer 32A and the wafer chuck 72. The coil springs 544 compress more to allow for the second end piece 548 to move into the pin opening 518. Each coil spring 544 is deformed against a spring force thereof, for example F3. The force F1 is, however, still more than the total of all the forces F3 added together. The upper surface 590 eventually comes to rest against the surface 572 of the stand-off 564. Because the post 510 abuts against the signal distribution board 500, the stand-off 564 prevents the upper surface 590 to move closer and into contact with the lower side 526 of the contactor board 502. The first wafer

32A transfers a forces F4 onto the stand-off 564. The force transfer portion 566 transfers the force F4 through the second section 536 of the post opening 520. The force delivery portion 568 receives the force F4 from the force transfer portion 566 and delivers the force F4 via the surface 574 to the signal distribution board 500.

[00108] It can thus be seen that the force F4 is not carried by the contactor board 502, thereby preventing stresses that could cause damage to the brittle ceramic material of the contactor board 502. Instead, the force F4 is transferred directly from an electronic device in the form of the first wafer 32A through the post 510 onto the signal distribution board 500.

[00109] In the embodiment described in Figures 8A and 8B, the contactor board 502 serves as a supporting board having a post opening 520 therethrough. The signal distribution board 500 serves as a backing structure, on a first side of the supporting board, and including at least a circuit board having a contact 512. The pin 504 serves as a conductor having a contactor front contact 562 to make contact with a terminal 588 on an electronic device positioned on a second side of the supporting board opposing the first side of the supporting board. The retainer portion 542 serves as a portion of the conductor that is held by the supporting board. The conductor further has a terminal 560 that is connected to the contact 512 on the signal distribution board 500. A spring in the form of the coil spring 544 is provided. The wafer chuck 72 serves as a force generation device on a side of the electronic device in the form of the first wafer 32A opposing the supporting board. The force generation device and the supporting board are moveable relative to one another to move the electronic device closer to the supporting board and to deform the spring. The post 510 has a stand-off 564 with a surface 572 in a plane spaced from a plane of a surface of the supporting board to prevent movement of the electronic device closer to the supporting

board, a force transfer portion 566 extending from the stand-off 564 at least partially through the post opening 520 and a force delivery portion 568 extending from the force transfer portion 566, the force delivery portion 568 being held by the backing structure.

[00110] Figure 9A illustrates a portion of the tester apparatus 10 that is used for insertion of a wafer pack into each slot assembly, for example into the slot assembly 18A, and removal therefrom. The components of the tester apparatus 10 shown in Figure 9A are components of the stationary structure, including include a frame 300, a portion of the first slot assembly 18A, the first slot assembly interface 40, a holding structure 302, a horizontal transportation apparatus 304, a vertical transportation apparatus 306, a push bar blade 308, and a locking mechanism 310.

[00111] The frame 300 includes first and second mounts 312 and 314 that are spaced from one another. The horizontal transportation apparatus 304 is a slide that is mounted between the first and second mounts 312 and 314. The holding structure 302 is mounted for sliding movement along the horizontal transportation apparatus 304. Opposing ends of the push bar blade 308 are mounted to the first and second mounts 312 and 314, respectively.

[00112] The locking mechanism 310 includes a connection lever 316, a control lever 318 and a pressure lever 320. The control lever 318 is mounted to the first mount 312 on a pivot connection 322. The vertical transportation apparatus 306 is a rigid beam. A connection 324 connects center points of the vertical transportation apparatus 306 and the push bar blade 308 to one another. The pressure lever 320 has a first link 326 rotatably connected to the control lever 318 and a second link 328 rotatably connected to an end of the vertical transportation apparatus 306. In the unlocked configuration shown in Figure 9A, a line 330 connects the pivot connection 322 with the second link 328 and the first link 326 is to the

left of the line 330.

[00113] In use, the first wafer pack 28A is located on the holding structure 302. The first wafer pack 28A is then moved together with the holding structure 302 from left to right into the first slot assembly 18A. The placement and movement of the first wafer pack 28A may be manually executed or may be executed using a robot.

[00114] The holding structure 302 slides along the horizontal transportation apparatus 304. The connection lever 316 connects an end of the control lever 318 to the holding structure 302. When the holding structure 302 moves in a horizontal direction along the horizontal transportation apparatus 304, the connection lever 316 rotates the control lever 318 in a counterclockwise direction about the pivot connection 322.

[00115] The first link 326 rotates together with the control lever 318 in a counterclockwise direction. The pressure lever 320 translates movement of the first link 326 to downwards movement of the second link 328. At first, the downward movement is minimal, but when the first wafer pack 28A is fully inserted into the first slot assembly 18A, vertical movement becomes more pronounced and the vertical transportation apparatus 306 engages the first wafer pack 28A with the first slot assembly 18A. The horizontal transportation apparatus 304 is thus operable to move the first wafer pack 28A horizontally from a first position to a second position into the first slot assembly 18A and the vertical transportation apparatus 306 is operable to move the first wafer pack 28A and the first slot assembly 18A in a first vertical direction relative to one another to engage the slot assembly interface 40 with a wafer pack interface on the first wafer pack 28A.

[00116] The control lever 318 is shown in an unlocked position in Figure 9A where the first link 326 is on a first side of the line 330 connecting the pivot connection 322 and the

second link 328. The control lever 318 rotates from the unlocked position shown in Figure 9A through a compression position where the push bar blade 308 is deformed by the vertical transportation apparatus 306 through the connection 324 by bending the push bar blade 308 against a spring force thereof and the first link 326 is in line with the pivot connection 322 and the second link 328. The control lever 318 continues to rotate from the compressed position to a locked position as shown in Figures 9B and 10. In the locked position, the first link 326 is on the right of the line 330, and therefore on a second side of the line 330 opposing the first side. Because the first link 326 has passed through the line 330, and the push bar blade 308 has deformed against a spring force thereof, the first wafer pack 28A is locked in position against the slot assembly interface 40.

[00117] The system can be unlocked by moving the holding structure 302 from right to left. The control lever 318 rotates in a clockwise direction and the first link 326 moves right to left past the line 330. The vertical transportation apparatus 306 moves in an upward direction, i.e., a second vertical direction opposing the first vertical direction, to release the first wafer pack 28A from the slot assembly interface 40. Further movement of the holding structure 302 along the horizontal transportation apparatus 304 removes the first wafer pack

[00118] Figures 11 and 12 illustrate further components of the first wafer pack 28A, including a pressure reduction check valve 600, a vacuum release check valve 602, components of a latch system that includes first, second, third and fourth latch assemblies 604A to 604D, and an electrical pressure sensor interface 606 forming part of a pressure monitoring system.

[00119] Figure 13 is a cross-section on 13-13 in Figures 11 and 12. A pressure reduction passage 608 is formed in the backing plate 74. The pressure reduction passage 608 has an

outlet opening 610 and an intermediate location 612 that are located in the same plane. The outlet opening 610 is connected to the pressure reduction check valve 600. The intermediate location 612 is closer to a center point of the backing plate 74 than the outlet opening 610. The pressure reduction passage 608 is formed by first drilling four passages into a backing plate 74 and then closing one end of three of the passages so that the resulting pressure reduction passage 608 is completely isolated from an atmospheric pressure external to the backing plate 74.

[00120] Figure 14 is cross-section on 14-14 in Figure 13. The pressure reduction passage 608 continues downward from the intermediate location 612 through the backing plate 74 and through the signal distribution board 500. The pressure reduction passage 608 has an inlet opening 624 that is in communication with the pressure differential cavity 622. The lip seal 77 is located within a recess of the wafer chuck 72. A pressure differential cavity 622 is formed jointly by the wafer chuck 72 that forms a lower side of the pressure differential cavity 622, the contactor board 502, the contactor hold-down ring 506, and the signal distribution board 500 forming an upper side of the pressure differential cavity 622, and the lip seal 77 forming a connection between the upper and lower sides of the pressure differential cavity 622. The lip seal 77 is completely circular and entirely surrounds the contactor board 502 and the wafer that is located between the contactor board 502 and the wafer chuck 72.

[00121] The components shown in Figure 14 form a portable supporting structure 626. The portable supporting structure 626 has a first component 628 that includes the signal distribution board 500 and the backing plate 74, and a second component 630 that includes the wafer chuck 72.

[00122] In use, the first component 628 is separated from the second component 630. A wafer is then placed on the wafer chuck 72. The first component 628 is then positioned on the second component 630. An upper periphery of the lip seal 77 makes contact with the signal distribution board 500. The wafer is thus held in the portable supporting structure 626.

[00123] Referring now to Figures 13 and 14 in combination, a pump is connected to the pressure reduction check valve 600. The pressure reduction check valve 600 is then opened. The pressure reduction passage 608 may initially be at atmospheric pressure and the pump subsequently reduces the pressure within the pressure reduction passage 608. The pressure differential cavity 622 is exposed to the lower-than-atmospheric pressure. External surfaces of the first wafer pack 28A are still exposed to atmospheric pressure. Because a pressure differential is created between the pressure differential cavity 622 and external surfaces of the first wafer pack 28A, the springs within the contactor board 502 compress as described with reference to Figure 8B. The lip seal 77 is made of a resilient elastomeric material which causes it to compress against a spring force thereof. Because the lip seal 77 compresses against a spring force thereof an improved seal is created between the lip seal 77 and the signal distribution board 500 so that a pressure within the pressure differential cavity 622 can be maintained. The pressure reduction check valve 600 is then closed, thereby isolating the pressure reduction passage 608 from external atmospheric pressure. The pump can then be disconnected from the pressure reduction check valve 600.

[00124] The first wafer pack 28A with the wafer loaded inside of it can now be moved within a fabrication environment without being connected to a pump or to a tester. Should it later be required to remove the wafer, positive pressure can be applied to the vacuum release

check valve 602 shown in Figures 11 and 12. The vacuum release check valve 602 is spring loaded which requires a predetermined amount of pressure to be applied before it opens. Air can then flow through a vacuum release passage in the backing plate 74 to the pressure differential cavity 622 and bring the pressure differential cavity 622 to atmospheric pressure. The first and second components 628 and 630 can then be separated from one another and the wafer can be removed. The vacuum release check valve 602 is subsequently closed when a new wafer is loaded in the first wafer pack 28A and when it is required to reduce the pressure within the pressure differential cavity 622 using the pressure reduction check valve 600.

[00125] Figure 15 is cross-section on 15-15 in Figure 12. The first latch assembly 604A includes a first part 640, a second part 642, a connecting part 644, an engaging mechanism 646, a tuning block 648, a locking nut 650, a spacer 652A, a shim 652B and a snap mechanism 654.

[00126] The first part 640 and the connection part 644 are machined out of one piece and are thus secured to each other. The first part 640 has a length 660 and a width 662. In cross-section only half of the width 662 is represented. The length 660 is larger than the width 662. The length 660 is also larger than a diameter of the connecting part 644. The first part 640 has a tool pin opening 664 formed therein.

[00127] The second part 642 has a body 666 and first and second wing pieces 668A and 668B extending from the body 666. The second part 642 has a length 670 that includes the wing pieces 668A and 668B and a width 672. Only half the width 672 is represented in cross-section. Because the first and second wing pieces 668A and 668B form part of the length 670 but are not part of the width 672, the length 670 is much larger than the width

672. The body 666 further has an opening 674 through which the connecting part 644 can be inserted.

[00128] The connecting part 644 includes a first portion 678 and a second portion 680. The second portion 680 has external thread formed thereon.

[00129] The engaging mechanism 646 is formed by opposing surfaces defining the width 662 of the first part 640. The opposing surfaces forming the engaging mechanism 646 are parallel to one another to promote engagement of parallel surfaces on a jaw of a tool capable of then rotating the first part 640.

[00130] The tuning block 648 is mounted in a fixed position to the spacer 652A. The wafer chuck 72 includes a metal portion 682 and a protective piece 684. The protective piece 684 forms a shoulder 686 on the wafer chuck 72. The shim 652B is located between the spacer 652A and the signal distribution board 500. Only a single shim 652B is shown. Additional shims are typically inserted one on top of the other until a levelling surface 690 of the tuning block 648 is at the same vertical elevation as the shoulder 686.

[00131] The snap mechanism 654 includes a retainer body 694, a spherical ball 696 and a spring 698. The body 666 of the second part 642 forms part of the snap mechanism 654 because the body 666 has a first snap depression 700A formed therein.

[00132] The retainer body 694 has an outer surface with a screw thread 702 thereon. The retainer body 694 further has an end with a slot 704 formed therein that is capable of receiving a tool such as screwdriver. The spring 698 is located within the retainer body 694. The spherical ball 696 is positioned within a mouth of the retainer body 694. The mouth of the retainer body 694 has a slightly reduced sized to prevent the spherical ball 696 from falling out of the retainer body 694. An external surface of the spherical ball 696 forms a

snap surface 706. The screw thread 702 engages with complementary screw thread within the tuning block 648. A tools such as a screwdriver is inserted within the slot 704 and is then rotated to adjust how far the snap surface 706 is spaced from the tuning block 648.

[00133] An intermediate protective component 708 is inserted into a complementary recess in an upper surface of the backing plate 74. Openings 710, 712 and 714 have been made in the intermediate protective component 708, the backing plate 74 and the signal distribution board 500, respectively. The second portion 680 of the connecting part 644 is inserted from above through the openings 710, 712 and 714. The length 660 of the first part 640 is more than a length of any one of the openings 710, 712 and 714 in the same direction, which prevents the first part 640 from entering the openings 710, 712 and 714. A lower surface of the first part 640 comes to rest on an upper surface that is formed within the intermediate protective component 708. The first portion 678 of the connecting part 644 is then located within the openings 710, 712 and 714 and the second portion 680 of the connecting part 644 is located below the openings 710, 712 and 714. A spring-loaded washer 720, the shim 652B and the spacer 652A are then positioned from below over the connecting part 644. The second part 642 is then positioned from below over the connecting part 644. The opening 674 forms a sliding fit with an outer diameter of the thread on the second portion 680 of the connecting part 644.

[00134] As the second part 642 slides upwardly over the connecting part 644, the first snap depression 700A also comes into contact with the snap surface 706. The spherical ball 696 moves by a small amount from right to left against a spring force of the spring 698. The locking nut 650 then engages with a protruding end of the second portion 680. Rotation of the locking nut 650 causes tightening of the body 666 of the second part 642 against a spring

force of the washer 720. A feeler gauge or other instrument may be used to determine a gap between the second wing piece 668B and the levelling surface 690. The locking nut 650 can be rotated until an acceptable gap is formed between the second wing piece 668B and the levelling surface 690. The gap will typically be the same as a desired gap between the first wing piece 668A and the shoulder 686. A locking arrangement is then formed by the first part 640, the second part 642, a connecting part 644.

[00135] As the locking nut 650 is rotated, the first snap depression 700A also moves upwardly. The first snap depression 700A is an elongated slot. The snap surface 706 and the first snap depression 700A can thus slide over one another as the second part 642 continues to move upwardly with continued rotation of the locking nut 650.

[00136] As shown in the drawings, the wafer chuck 72 is in place while the first latch assembly 604A is assembled. Additionally, a negative pressure exists with the pressure differential cavity 622. By having the first wafer pack 28A in a compressed state, it is possible to gauge whether the first and second wing pieces 668A and 668B are equivalently spaced from the shoulder 686 and the levelling surface 690. It may also be possible to assemble the first latch assembly 604A without the wafer chuck 72 in place by simply gauging a spacing between the second wing piece 668B and the levelling surface 690, provided that the levelling surface 690 has been set at the correct height using one or more shims such as the shim 652B.

[00137] Figure 16 is a view in a direction A in Figure 15, but only showing the connecting part 644 and the signal distribution board 500.

[00138] The opening 712 has a first dimension 724 on an axis 726 towards a center point of the signal distribution board 500 that is larger than a second dimension 728 transverse to

the axis 726. The first portion 678 of the connecting part 644 is smaller than the first dimension 724 in the direction of the axis 726 to allow for thermal expansion of the signal distribution board 500 and the backing plate 74 (see Figure 15) relative to one another. The first portion 678 is dimensioned to slidably fit within the second dimension 728 to prevent movement of the signal distribution board 500 in a direction transverse to the axis 726 relative to the backing plate 74.

[00139] The second portion 680 of the connecting part 644 has a first thickness 730 and a second thickness 732. The first thickness 730 can fit through the opening 712 in the direction of the axis 726 and is larger than the second dimension 728 of the opening 712. The second thickness 732 is transverse to the first thickness 730 and can fit through the second dimension 728 of the opening 712. Because the second dimension 728 is relatively large, it allows for thread that can be formed thereon and it is still relatively strong. The entire second portion 680 is located below the opening 712, which allows for the connecting part 644 to be rotated about a longitudinal axis thereof without the second portion 680 catching on the relatively narrow opening 712. The first portion 678 has a circular cross-section with a diameter that is no more than the second dimension 728, which allows for the first portion 678 to rotate freely within the relatively narrow second dimension 728 of the opening 712.

[00140] A further opening 734 is formed in the signal distribution board 500 for a further anchor of the shim or shims. The opening 734 is similarly proportioned to the opening 712, having a longer dimension on an axis 736 towards a center point of the signal distribution board 500. The anchor passing through the opening 734 does not have to rotate when used in a fabrication environment and the dimensions of the opening 734 only serve to allow for

thermal expansion of the signal distribution board 500 relative to the backing plate 74.

[00141] Figure 17 is a cross-section on 17-17 in Figure 15. An anchor 740 is inserted through the opening 734 in Figure 16 to secure the spacer 652A and the shim 652B to the backing plate 74. The anchor 740 includes a bolt and a nut with a head of the bolt on one side and the nut on the opposite side.

[00142] The body 666 has a circular outer surface 742 with first, second, third and fourth snap depressions 700A to 700D formed therein. The snap surface 706 of the spherical ball 696 is located within the first snap depression 700A, which prevents the body 666 from rotating. The opening 674 within the body 666 is keyed to accept the shape of the second portion 680 so that the second portion 680 cannot rotate if the body 666 remains stationary.

[00143] A small amount of torque is required to rotate the body 666 and have the spherical ball 696 come out of the first snap depression 700A. Should the body 666 be rotated clockwise, the snap surface 706 rides on the circular outer surface 742 between the first snap depression 700A and the second snap depression 700B. As the body 666 rotates, the second portion 680 rotates together with the body 666 through the same angle. As the body 666 approaches 90 degrees of rotation, the snap surface 706 snaps into the second snap depression 700B. The second snap depression 700B then resists rotation of the body 666 and the second portion 680. The first to fourth snap depressions 700A to 700D lightly lock the body 666 at four different rotational angles, including 0 degrees, 90 degrees, 180 degrees and 270 degrees.

[00144] Figures 18A(i) and 18A(ii) are views in the directions of the arrows A and B in Figure 15 but with the locking arrangement rotated into an unlocked position. A human operator may compare an orientation of the first part 640 to a reference 750 on an upper

surface of the wafer chuck 72 which, in Figure 18A(ii), shows that the first latch assembly 604A is unlocked. The shoulder 686 is unencumbered from below by either the first wing piece 668A or the second piece 668B. The wing pieces 668A and 668B are held in the position shown in Figure 18A(i) by the snap mechanism 654 shown in Figures 15 and 17. A pressure within the first wafer pack 28A can be reduced and the wafer chuck 72 can be removed for inserting or replacing a wafer. After the wafer has been replaced, the pressure within the first wafer pack 28A is again reduced to hold the first wafer pack 28A together.

[00145] When the first wafer pack 28A is fully assembled, it may be required to provide a further failsafe so that the electrical contact with the wafer is maintained even if the negative pressure within the first wafer pack 28A cannot be maintained due to a system failure. An operator may use a tool (not shown) having a jaw and a pin. The pin is inserted into the tool pin opening 664. The tool pin opening 664 is tapered so that the tool progressively becomes more aligned with the first part 640 the further the pin is inserted into the tool pin opening 664. An operator then engages opposing parallel surfaces of the jaw of the tool with opposing parallel surfaces formed by the engaging mechanism 646. Once the tool is engaged with the engaging mechanism 646, the operator rotates the tool, and the tool rotates the first part 640. The connecting part 644 and the second part 642 together with its first and second wing pieces 668A and 668B rotate together with the first part 640. Referring to Figure 17, the snap surface 706 leaves the fourth snap depression 700D and slides on the circular outer surface 742. The snap surface 706 then snaps into the first snap depression 700A.

[00146] Figures 18B(i) and 18B(ii) show the first latch assembly after the first and second parts 640 and 642 have rotated through an angle 752 of 90 degrees. An operator can see that the orientation of the first part 640 matches a locked position as shown in the reference 750.

The first wing piece 668A is now located over the shoulder 686, which prevents movement of the wafer chuck 72 in a vertically downward direction away from the rest of the wafer pack 28A. The second wing piece 668B is located over the tuning block 648. The first wing piece 668A can be disengaged from the shoulder 686 by rotating the first part 640 clockwise or counterclockwise through 90 degrees. Either wing piece 668A or 668B can be used to lock the wafer chuck 72 in position.

[00147] Figure 19 illustrates how one or more shims 652B to 652F can be used to adjust a height of the levelling surface 690 of the tuning block 648. The tuning block 648 should ideally be at the same height as shoulder 686. Because the tuning block 648 is mounted to the spacer 652A, the tuning block 648 moves up and down with the spacer 652A as more of the shims 652B to 652F are inserted. More shims can be inserted to raise the levelling surface 690 if it is below the shoulder 686, or shims can be removed if the levelling surface 690 is above the height of the shoulder 686.

[00148] The engaging mechanism 646 is conveniently located directly on the first part 640. In another arrangement, an engaging mechanism may be formed directly on the second part 642 or directly on the connecting part 644.

[00149] In a further embodiment, an engaging mechanism may be a separate mechanism from the first and second parts 640 and 642 and from the connecting part 644. For example, a worm gear may be formed on the connecting part 644 and the engaging mechanism may be a separate turnable mechanism that rotates the worm gear.

[00150] The engaging mechanism may also be located between the first part 640 and the connecting part 644. For example, the first wing piece 668A may be pivoted downwardly away from the shoulder 686 and back towards the shoulder 686 with a cam system that is

located between the first part 640 and the connecting part 644. Such a cam system serving as an engaging mechanism may alternatively be located between the connecting part 644 and the second part 642. Alternatively, the connecting part 644 can be made in two pieces and the engaging mechanism can connect the two pieces and adjust a spacing the two pieces and the spacing adjustment can then pivot the wing piece.

[00151] The first latch assembly 604A uses primarily incompressible and non-pliable materials. In alternate embodiment, straps or other pliable materials can be used with the same or similar objectives in mind.

[00152] Instead of having the engaging mechanism 646 on an external surface of the first part 640, an engaging mechanism may alternatively be on an internal surface of any part.

[00153] Referring again to Figure 12, the first, second, third and fourth latch assemblies 604A to 604D are identical except for their respective locations and orientations. The first and third latch assemblies 604A and 6040C are on opposite sides of the wafer chuck 72 and the second and fourth latch assemblies 604B and 604D are on opposite sides of the wafer chuck 72. Because the latch assemblies 604A to 604D are located on more than just one side of the wafer chuck 72, i.e., they cover more than 180 degrees around a periphery of the wafer chuck 72, they can collectively hold all sides of the wafer chuck 72 in place around its entire periphery.

[00154] The latch system provided by the first, second, third and fourth latch assemblies 604A to 604D helps to facilitate movement of the first wafer pack 28A through a fabrication environment without the need for human oversight. Without the latch system, human oversight may be required to determine when the negative pressure within the first wafer pack 28A has failed and the wafer 28A has come apart. The latch system provides a

structural failsafe to prevent the first wafer pack 28A from coming apart even if it were to take in air from the outside.

[00155] Figures 20, 21, 22A and 22B illustrate further components of the pressure monitoring system, including a pressure sensing passage 760 (Fig. 21), a pressure sensor 762 (Figs. 22A and 22B), the electrical pressure sensor interface 606 (Figs. 20, 21, 22A and 22B)) mentioned with reference to Figure 11, an electrical pressure connector interface 764, a mounting bracket 766, a ribbon cable 768 having first and second connectors 770 and 772 at opposing ends thereof (Figs. 20, 22A and 22B), a connector block 774, and a stiffener plate 776 (Fig. 20).

[00156] The pressure sensing passage 760 is formed in the backing plate 74 in a manner similar to the pressure reduction passage 608 described with reference to Figure 13. The pressure sensing passage 760 has a first end within the pressure differential cavity 622 shown in Figure 14. The pressure sensing passage 760 has a second end, opposing the first end, near an outer edge of the backing plate 74.

[00157] The electrical pressure sensor interface 606 is in the form of a printed circuit board having a substrate 780 and a plurality of contacts, including first, second and third contacts 782A, 782B and 782C formed on the substrate 780.

[00158] The pressure sensor 762 is mounted to the substrate 780 on a side of the substrate 780 opposing the first, second and third contacts 782A, 782B and 782C. The pressure sensor 762 is electrically connected through the substrate 780 to the first, second and third contacts 782A, 782B and 782C. The pressure sensor 762 is capable of sensing a pressure of a gas, in the present case air, and converting the pressure to an electrical signal wherein a magnitude of the pressure is indicated by a magnitude or another variable of the signal. Pressure can be

conveniently detected using a diaphragm that displaces by a known distance as the pressure increases or decreases. Other pressure sensors are also within the scope of the invention, for example pressure sensors that use piezoelectric crystals or pressure sensors that use stress gauges. In the case of a moving diaphragm, the movement can be converted to a voltage, for example by moving an inductive coil and a magnitude of the voltage is then indicative of the displacement and therefore the pressure. The pressure sensor may, for example be the MLX90809 sold by Melexis (www.melexis.com). The electrical pressure sensor interface 606 is mounted to the backing plate 74 using fasteners 784. The diaphragm of the pressure sensor 762 is then exposed to the air at the second end of the pressure sensing passage 760. The pressure sensor 762 can thus sense a pressure within the pressure differential cavity 622.

[00159] The electrical pressure connector interface 764 has a board 790 and a plurality of terminals, including first through sixth terminals 792A to 792F secured to the board 790. The board 790 is mounted through fasteners 794 to the mounting bracket 766. The stiffener plate 776 is secured between the two push bar blades 308. The mounting bracket 766 is secured with fasteners 796 to the stiffener plate 776. The slot assembly body 32 together with the push bar blades 308 and stiffener plate 776 form part of the stationary structure and the electrical pressure connector interface 764 is thus mounted to the stationary structure.

[00160] The connector block 774 is mounted to the slot assembly body 32. The connectors 770 and 772 are connected to the electrical pressure connector interface 764 and the connector block 774, respectively. The first to sixth terminals 792A to 792F are connected through the first connector 770, ribbon cable 768, and second connector 772 to a pressure sensing board of the electric tester.

[00161] Figures 23A and 23B illustrate engagement of the electrical pressure sensor

interface 606 with the electrical pressure connector interface 764 when the first wafer pack 28A is inserted into the slot assembly. The first, second and third contacts 782A, 782B and 782C first come into contact with the first, second and third terminals 792A, 792B and 792C, respectively. Further movement of the electrical pressure sensor interface 606 causes engagement of the first, second and third contacts 782A, 782B and 782C with the fourth, fifth and sixth terminals 792D, 792E and 792F, respectively. The first contact 782A thus makes contact with both the first terminal 792A and the fourth 792D. Similarly, each one of the contacts 782B and 782C makes contacts with two of the terminals 792B, 792C, 792E and 792F.

[00162] The terminals 792A to 792F are resiliently depressable relative to the board 790 to ensure proper contact with the contacts 782A to 782C. The ribbon cable 768 allows for a small amount of movement of the stiffener plate 776 relative to the slot assembly body 32 when the first wafer pack 28A is inserted.

[00163] The pressure within the pressure differential cavity 622 can be monitored throughout the entire process while a wafer is under test. Should a wafer fail testing, the tester can be programmed to determine whether such testing may be the result of a failure of the negative pressure within the pressure differential cavity 622.

[00164] Figure 24 illustrates further components of the tester apparatus 10 and the slot assemblies 18A and 18B. Figure 24 also shows further components found within a fabrication environment, including a nitrogen gas tank 802, a dielectric gas tank 804, and a vacuum pump 806. The nitrogen gas tank 802 and the vacuum pump 806 may be stand-ins for a nitrogen gas line and a vacuum line that may be found in a fabrication environment.

[00165] The tester apparatus 10 includes a first nitrogen gas pressure regulator 810 and

three manifolds 812, 814 and 816, respectively. The slot assembly 18A has three couplings 820A, 822A and 824A. Similarly, the slot assembly 18B has three couplings 820B, 822B and 824B.

[00166] In use, the couplings 820A, 822A and 824A connect to the manifolds 812, 814 and 816 when the slot assembly 18A is inserted into the tester apparatus 10. The couplings 820B, 822B and 824B simultaneously engage with the manifolds 812, 814 and 816 when the slot assembly 18B is inserted into the tester apparatus 10. The couplings 820A and 820B connect the slot assemblies 18A and 18B through the manifold 814 to the nitrogen gas pressure regulator 810. The first nitrogen gas pressure regulator 810is connected through a nitrogen gas inlet supply to the nitrogen gas tank 802. The couplings 822A and 822B connect the slot assemblies 18A and 18B through the manifold 814 and a dielectric gas inlet supply to the dielectric gas tank 804. The couplings 824A and 824B connect the slot assemblies 18A and 18B through the manifold 816 to the vacuum pump 806, which provides vacuum to the manifold 816.

[00167] The slot assemblies 18A and 18B are similar. For purposes of discussion, only further components of the slot assembly 18A are discussed, although it should be understood that the slot assembly 18B has similar components.

[00168] The slot assembly 18A further includes a second nitrogen gas pressure regulator 830, a dielectric gas pressure regulator 834, an inlet orifice 838, an outlet orifice 840, a vacuum regulator 844, and a heater control board 848. The second nitrogen gas pressure regulator 830 and the dielectric gas pressure regulator 834 are connected to the couplings 820A and 822A, respectively. The inlet orifice 838 is connected to the second nitrogen gas pressure regulator 830 and the dielectric gas pressure regulator 834.

[00169] The first wafer pack 28A has a gas supply valve 850 that is connected to the inlet orifice 838. The gas supply valve 850 is similar to the vacuum release check valve 602, except that it operates at a different pressure. A gas supply passage 852 has an inlet connected to the gas supply valve 850 and an outlet at the pressure differential cavity 622 shown in Figure 14.

[00170] The outlet orifice 840 is connected to the pressure reduction check valve 600. The outlet orifice 840 is connected through the vacuum regulator 844 to the coupling 824A.

[00171] The heater control board 848 is connected to the electrical pressure sensor interface 606 and to the second nitrogen gas pressure regulator 830, the dielectric gas pressure regulator 834, and the vacuum regulator 844. The heater control board 848 controls the second nitrogen gas pressure regulator 830, dielectric gas pressure regulator 834 and vacuum regulator 844 based on an input from the electrical pressure sensor interface 606.

[00172] In use, the heater control board 848 opens the vacuum regulator 844. The vacuum created by the vacuum pump 806 is then connected to the pressure reduction check valve 600 and opens the pressure reduction check valve 600. The heater control board 848 keeps the dielectric gas pressure regulator 834 closed. The heater control board 848 opens the second nitrogen gas pressure regulator 830. Nitrogen gas then flows from the nitrogen gas tank 802 through the nitrogen gas inlet supply, the nitrogen gas pressure regulator 810, the manifold 812, the coupling 820A, the second nitrogen gas pressure regulator 830, the inlet orifice 838, the gas supply valve 850, and the gas supply passage 852 into the pressure differential cavity 622. The nitrogen gas then fills the pressure differential cavity 622, which vacates all air within the pressure differential cavity 622 through the pressure reduction check valve 600, outlet orifice 840, vacuum regulator 844, coupling 824A, and vacuum

pump 806. Referring also to Figure 8B, the space between the contactor front contacts 562 is then filled with nitrogen gas.

[00173] Referring again to Figure 24, the heater control board 848 then closes the second nitrogen gas pressure regulator 830 and opens the dielectric gas pressure regulator 834. Dielectric gas then flows from the dielectric gas tank 804 through the dielectric gas inlet supply, the manifold 814, the coupling 822A, the dielectric gas pressure regulator 834, the inlet orifice 838, the gas supply valve 850, the gas supply passage 852, the pressure differential cavity 622, the pressure reduction check valve 600, the outlet orifice 840, the vacuum regulator 844, the coupling 824A, and the vacuum pump 806. The direction of flow of the dielectric gas across the pressure differential cavity 622 is shown by the arrow 858. The rate of flow of dielectric gas is controlled by the sizes of the inlet orifice 838 and outlet orifice 840.

[00174] Once the space between the contactor front contacts 562 shown in Figure 8B is filled with dielectric gas, the heater control board 848 partially closes the dielectric gas pressure regulator 834 and the vacuum regulator 844 to reduce the rate of flow of the dielectric gas. The flow rate of the dielectric gas is small and only required to compensate for leaking of dielectric gas out of the pressure differential cavity 622. Throughout the entire process of introducing the nitrogen gas and the dielectric gas into the pressure differential cavity 622, the heater control board 848 controls the vacuum regulator 844 in a manner so as to maintain the negative pressure that was established to compress the coil springs 544 in Figure 8B.

[00175] The dielectric gas is chosen to reduce arcing between the contactor front contacts 562 in Figure 8A when compared to air. Gases that may be used as dielectric gases may for

example be Novec® 4710 insulating gas which is sold by 3M, or may be commercially available octafluorocyclobutane. Both these gases have dielectric constants and dielectric strengths that are higher than air to reduce arcing when compared to air. More electric power can then be provided through the contactor front contacts 562 when testing the first wafer 32A in Figure 8B. After testing is complete, the dielectric gas is replaced with nitrogen gas, following the reverse of the process described above, which allows for removal of the first wafer pack 28A from the slot assembly 18A. Throughout the entire process, excess nitrogen gas and excess dielectric gas is removed from the first wafer pack 28A through the outlet orifice 840, the vacuum regulator 844, the coupling 824A and the vacuum pump 806. One fabrication facility may have a scrubber that separates the gases after leaving the vacuum pump 806. Another fabrication facility may have a cryogenic pump that separates the gases after leaving the tester apparatus 10 and before entering the vacuum pump 806.

[00176] As noted above, each slot assembly 18A, 18B, etc. has its own heater control board 848 and other similar components. The heater control board 848 controls the introduction of nitrogen gas and dielectric gas independently to contacts of a respective first wafer pack 28A, second wafer pack 28B, etc.

[00177] Figure 25 is a top plan view of the slot assembly 18A while holding the first wafer pack 28A. Figure 26 is a cross section on 26A-26B in Figure 25. Figure 27 is a cross section on 27A-27B in Figure 25.

[00178] Figures 28 and 29 are detail views of areas marked "C" and "D" in Figures 26 and 27, respectively. Figure 28 shows the horizontal transportation apparatus 304, push bar blade 308, and the backing plate 74 with the pressure reduction passage 608 formed within the backing plate 74. Figure 28 further shows a gas removal conduit 828 that is secured to the

horizontal transportation apparatus 304. The gas removal conduit 828 has a stationary structure gas removal interface 832. The backing plate 74 has a portable structure gas removal interface 836.

[00179] In use, the stationary structure gas removal interface 832 and the portable structure gas removal interface 836 are separated from each other. As described with reference to Figure 1, the wafer chuck 72 is moved downward into contact the thermal chuck 34. The stationary structure gas removal interface 832 moves downward and into engagement with the portable structure gas removal interface 836. A seal seals the stationary structure gas removal interface 832 with the portable structure gas removal interface 836. The pressure reduction passage 608 then extends from the backing plate 74 through the gas removal conduit 828. The vacuum shown in Figures 24 and 28 can be applied through the gas removal conduit 828 to the pressure reduction passage 608.

[00180] Figure 29 show the horizontal transportation apparatus 304, the push bar blade 308, and the backing plate 74 with the gas supply passage 852 formed within the backing plate 74. A gas supply conduit 826 is mounted to the horizontal transportation apparatus 304. The gas supply conduit 826 has a stationary structure gas supply interface 842. The backing plate 74 has a portable structure gas supply interface 846. The stationary structure gas supply interface 842 is initially separated from the portable structure gas supply interface 846. The portable structure gas supply interface 846 moves downward into contact with the stationary structure gas supply interface 842 when the wafer chuck 72 moves downward into contact with the thermal chuck 34 in Figure 1. A seal seals the portable structure gas supply interface 846 to the stationary structure gas supply interface 842. The gas supply passage 852 then extends through the horizontal transportation apparatus 304, the

gas supply conduit 826 into and through the backing plate 74. Nitrogen and dielectric pressurized gases are provided through the gas supply conduit 826 and the backing plate 74 to an area between the contacts as described with reference to Figure 24. After testing is complete, the backing plate 74 is separated from the gas removal conduit 828 shown in Figure 28 and the gas supply conduit 826 shown in Figure 29.

[00181] Figure 30 shows a gas box that forms part of the slot assembly 18A. The gas box 860 connects the couplings 820A, 822A and 824A to the gas supply conduit 826 shown in Figure 29 and the gas removal conduit 828 shown in Figure 28.

[00182] As shown in Figures 31 and 32, the gas box 860 includes a base 862, an intermediate substrate 864, a channeling block 866, a transposition block 868, a mounting plate 870, various regulators including the second nitrogen gas pressure regulator 830, the dielectric gas pressure regulator 834, the vacuum regulator 844 and various connectors including a vacuum receiving connector 872, a nitrogen gas receiving connector 874, a dielectric gas receiving connector 876, a vacuum supply connector 880, a gas supply connector 882, a valve control connector 884, releasable interfaces 892, and a lid 896.

[00183] The vacuum receiving connector 872, nitrogen gas receiving connector 874 and dielectric gas receiving connector 876 are secured to a front of the base 862. The base 862 has channels (not shown) formed therein that extend from the connectors 872, 874 and 876 to three of the releasable interfaces 892. The vacuum supply connector 880 and gas supply connector 882 are secured to a side of the base 862. More channels within the base 862 connect the connectors 880 and 882 to two more of the releasable interfaces 892. The connectors 872, 874, 876, 880, and 882 are generally located in the same plane.

[00184] The transposition block 868 and channeling block 866 are mounted to the

intermediate substrate 864. The releasable intermediate substrate 864 has three releasable interfaces (not shown) that are spaced the same distances as the releasable interfaces 892 that are connected to the connectors 872, 874, and 876. The channeling block 866 has two releasable interfaces (not shown) that are spaced the same as the releasable interfaces 892 connected to the connectors 880 and 882. When the intermediate substrate 864 is mounted on the base 862, the releasable interfaces of the intermediate substrate 864 mate with the releasable interfaces 892 of the base 862. Channels are formed through the intermediate substrate 864, transposition block 868, and channeling block 866. The transposition block 868 thus connects the connectors 872, 874, and 878 to the channeling block 866. The transposition block 868 also transposes flow of gases from horizontally parallel in a first direction 890 to vertically parallel in a second direction 894 that is at right angles to the first direction 890.

[00185] The regulators 830, 834, 844 are mounted to the channeling block 866. The regulators 830, 834 and 844 can individually regulate a respective gas through the channeling block 866. After leaving the regulators 830 and 834, the channeling block 866 merges the passages leading from the regulators 830 and 834 before passing through one of the releasable interfaces 892 in the base 862 to the gas supply connector 882.

[00186] The mounting plate 870 is secured to a side of the intermediate substrate 864. The valve control connector 884 is secured to the mounting plate 870. The valve control connector 884 is electrically connected to electrical terminals on the regulators 830, 834 and 844.

[00187] The lid 896 is shaped to fit over the channeling block 866, transposition block 868, mounting plate 870 and intermediate substrate 864. A slot in the side of the lid 896

allows for the valve control connector 884 to protrude externally to the lid 896.

[00188] In use, the gas supply connector 882 is connected to the inlet orifice 838 in Figure 24 and the vacuum supply connector 880 is connected to the outlet orifice 840 shown in Figure 24. The valve control connector 884 is connected to the heater control board 848 shown in Figure 24. The dielectric gas receiving connector 876, nitrogen gas receiving connector 874, and vacuum receiving connector 872 are also connected to the couplings 822A, 820A and 824A, respectively.

[00189] Signals are provided through the valve control connector 884 to the regulators 830, 834 and 844 to control gas flow and vacuum to the gas supply connector 882 and the vacuum supply connector 880. For example, if nitrogen gas is introduced, the vacuum regulator 844 is opened to introduce a vacuum through the vacuum receiving connector 872 to the vacuum supply connector 880, and the dielectric gas pressure regulator 830 is opened to connect the dielectric gas receiving connector 876 to the gas supply connector 882.

[00190] The gas box 860 provides a serviceable formfactor for the regulators 830, 834 and 844. The intermediate substrate 864 can be released from the base 862 and the base 862 can thus remain mounted to the remainder of the slot assembly 18A in Figure 30 while the regulators 830, 834 and 844 or the valve control connector 884 are serviced. The releasable interfaces 892 allow for vertical connection between the intermediate substrate 864 and the base 862 wherein all the gas lines and vacuum lines are simultaneously linked in a single, simple operation. There is thus no need to disconnect the lines from the connectors 872 to 882.

[00191] Figure 33 illustrates further aspects of the tester apparatus. Certain components have already been described with reference to the previous drawings. For example,

components of the slot assembly 18A include the thermal chuck 34, the thermal fluid passage 224, the connection board 66, and the first slot assembly interface 40. Components of the first wafer pack 28A that have already been described include the signal distribution board 500, the stiffener plate 776, the contactor board 502, the wafer contact pins 504, the contactor front contacts 562, the wafer pack interface 78, and the wafer chuck 72. As described earlier, the contactor front contacts 562 are located on tips of the wafer contact pins 504. Some of the contactor front contacts 562 are power contactor front contacts that provide power to select ones of the terminals 588 (see Figures 8A and 8B) of the wafer 32A. The power contactor front contacts provide power to the wafer 32A during test. Further ones of the contactor front contacts 562 provide and receive signal to and from the wafer 32A during test.

[00192] Further components of the tester apparatus include a tray 900, return terminal pins 902, wafer chuck pins 908 and a vacuum conduit 910.

[00193] The tray 900 includes a substrate 912 of a dielectric material and a conductive layer 914 formed on the substrate 912. The conductive layer 914 has a conductive portion 916 and return terminal area 918. The conductive portion 916 and the return terminal area 918 have an exposed upper surface 920. The wafer 32A has a terminal that forms part of the circuit in the wafer 32A and is located on a lower side of the wafer 32A. The terminal located on the lower side of the wafer 32A is in contact with the exposed upper surface 920 of the conductive portion 916. The conductive layer 914 can then be used to provide a reference voltage, such as a ground voltage to the terminal on the lower side of the wafer 32A.

[00194] The return terminal pins 902 are mounted to the contactor board 502. Each return

terminal pin 902 has a lower end forming a contactor return contact 922. The return terminal pins 902 extend past an edge of the wafer 32A so that the contactor return contact 922 makes contact with the return terminal area 918. The return terminal pins 902 form electrical conductors that connect the conductive layer 914 to the signal distribution board 500. The electric conductors extend through the signal distribution board 500, wafer pack interface 78, first slot assembly interface 40, the connection board 66 to the tester electronics described with reference to the earlier drawings. The tester electronics can then provide a reference voltage such as ground to the terminal on the lower side of the wafer 32A.

[00195] The wafer chuck pins 908 are mounted to the contactor board 502. Each wafer chuck pin 908 extends below the contactor board 502 past the wafer 32A and the tray 900 and have lower tips that make contact with the wafer chuck 72. A ground reference voltage can then be provided through the signal distribution board 500 and the wafer chuck pins 908 to the wafer chuck 72. By grounding the wafer chuck 72, the wafer chuck 72 is maintained at a known voltage, which makes it possible to control arcing between various conductive components such as between the terminals on the lower side of the wafer 32A and the wafer chuck 72.

[00196] When testing of the wafer 32A is complete, the wafer 32A may be removed from the tray 900 and the tray 900 may remain on the wafer chuck 72. Alternatively, the tray 900 carrying the wafer 32A is removed from the wafer chuck 72 after testing is completed and the tray 900 can provide structural rigidity for very thin wafers. In either case, the tray 900 and the wafer chuck 72 jointly form a wafer holder 924 for the wafer 32A when the wafer 32A is being tested.

[00197] A plurality of vacuum openings 926 are formed through the tray 900 and partially

through the wafer chuck 72. A vacuum passage 928 in the wafer chuck 72 connects lower ends of the vacuum openings 926 to one another. The vacuum conduit 910 also defines a vacuum passage and is connected to the vacuum passage 928 in the wafer chuck 72. The vacuum conduit 910 may for example be connected to the vacuum passage 928 using the interfaces 832 and 836 shown in Figure 28.

[00198] In use, a vacuum is provided through the vacuum conduit 910 and the vacuum passage 928 to the vacuum openings 926. Because the vacuum openings 926 are open at the top, a lower surface of the wafer 32A is exposed to the vacuum. The vacuum, when applied, secures the wafer 32A to the tray 900. A vacuum may be applied to secure the wafer 32A to the tray 900 when the first wafer pack 28A is assembled and before inserting the first wafer pack 28A into the slot assembly 18A. The vacuum can be maintained with the same pressure reduction check valve 600 and vacuum release check valve 602 shown in Figure 11 that are used for keeping the first wafer pack 28A closed. When the first wafer pack 28A is inserted into the slot assembly 18A, the vacuum can be maintained through the interfaces 832 and 836 in Figure 28 and the vacuum pump 806 shown in Figure 24.

[00199] Figure 34 is an enlarged view of detail "E" in Figure 33. The vacuum opening 926 includes a proximal section 932, a distal section 934, and an enlarged section 936. The proximal section 932 has a relatively small diameter and extends through the tray 900. The enlarged section 936 is formed in an upper surface of the wafer chuck 72 and has a much larger diameter than the proximal section 932. The distal section 934 is formed from a base of the enlarged section 936 and extends into the vacuum opening 926 shown in Figure 33. The distal section 934 has a diameter that is much smaller than a diameter of the enlarged section 936.

[00200] By varying a diameter of the vacuum opening 926 from an inlet opening 940 to outlet opening 942 thereof, it is possible to reduce the possibility of arcing between the conductive layer 914 and the wafer chuck 72 in a situation where the conductive layer 914 and the wafer chuck 72 are at different voltages. The large diameter of the enlarged section 936 creates a larger distance that an arc would have to follow between the conductive layer 914, through the inlet opening 940, through the proximal section 932 and a space within the enlarged section 936 before reaching the conductive metal material of the wafer chuck 72. Additionally, an electric insulator 944 is formed around the inlet opening 940 to further separate the metal of the conductive layer 914 from the inlet opening 940.

[00201] The vacuum that is provided through the vacuum opening 926 is also used to hold the tray 900 against the wafer chuck 72. A chamfer 948 is formed around an upper perimeter of the enlarged section 936 for deburring purposes and to ensure a flush contact between a lower surface of the tray 900 and an upper surface of wafer chuck 72. Figures 35 and 36 are cross sections at right angles of the wafer chuck 72 and the tray 900. The Figures show the relative positioning of the tray 900 and a groove 950 for the lip seal 77 described in more detail with reference to Figure 14.

[00202] While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative and not restrictive of the current invention, and that this invention is not restricted to the specific constructions and arrangements shown and described since modifications may occur to those ordinarily skilled in the art.

CLAIMS

What is claimed:

1. A tester apparatus, comprising:

first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit;

a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals;

a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components;

a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity;

a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity;

an electrical tester connected to the microelectronic circuit to test the microelectronic circuit;

a gas supply passage formed through one of the components, the gas supply passage having an inlet opening outside the enclosed cavity and an outlet opening at the enclosed cavity; and

a gas inlet supply connected to the gas supply passage, opening of the gas inlet

supply allowing gas into the enclosed cavity and into a space between the contacts.

2. The tester apparatus of claim 1, further comprising:

a source of dielectric gas connected to the gas supply passage.

3. The tester apparatus of claim 1, wherein the dielectric gas reduces arcing between the contacts compared to air.

4. The tester apparatus of claim 1, further comprising:

a vacuum pump connected to the a pressure reduction supply.

5. The tester apparatus of claim 1, further comprising:

an orifice connected to the gas supply passage to control flow of the dielectric gas through the gas supply passage.

6. The tester apparatus of claim 1, further comprising:

an orifice connected to the pressure reduction passage to control flow of the dielectric gas through the pressure reduction passage.

7. The tester apparatus of claim 1, further comprising:

a portable supporting structure including the first and second components;

a first electrical interface on the portable supporting structure and connected to the contacts;

a stationary structure, the portable supporting structure being receivable to be held by the stationary structure and being removable from the stationary structure; and

a second electrical interface on the stationary structure, the second electrical interface being connected to the first electrical interface when the portable structure is held by the stationary structure, and being disconnected from the first electrical interface when the portable supporting structure is removed from the stationary structure, wherein electrical tester is connected through the second electrical interface, the first electrical interface, and the contacts to the terminals.

8. The tester apparatus of claim 1, further comprising:

a vacuum regulator connected to the pressure reduction passage to control flow of gas through the pressure reduction passage.

9. The tester apparatus of claim 8, further comprising:

a dielectric gas pressure regulator connected to the gas supply passage to control flow of dielectric gas to the gas supply passage.

10. The tester apparatus of claim 9, further comprising:

a nitrogen gas pressure regulator connected to the gas supply passage to control flow of nitrogen gas to the gas supply passage.

11. The tester apparatus of claim 10, further comprising:

a channeling block connected to the dielectric gas pressure regulator and the nitrogen

gas pressure regulator and connected to the gas supply passage to selectably provide the nitrogen gas or the dielectric gas to the gas supply passage.

12. The tester apparatus of claim 11, further comprising:

a gas supply connector for connection to the gas supply passage to provide the nitrogen gas or the dielectric gas to the gas supply passage.

13. The tester apparatus of claim 12, further comprising:

a vacuum supply connector for connection to the pressure reduction passage to provide the vacuum from the vacuum regulator to the pressure reduction passage.

14. The tester apparatus of claim 13, wherein the vacuum supply connector is connected through the channeling block to the vacuum regulator.

15. The tester apparatus of claim 13, further comprising:

a vacuum receiving connector connectable to a vacuum pump to connect the vacuum regulator to the vacuum pump;

a nitrogen gas receiving connector connectable to a nitrogen gas inlet supply to connect the nitrogen gas inlet supply to the nitrogen gas pressure regulator; and

a dielectric gas receiving connector connectable to a dielectric gas inlet supply to connect the dielectric gas inlet supply to the dielectric gas pressure regulator.

16. The tester apparatus of claim 15, further comprising:

a base, wherein the gas supply connector, vacuum supply connector, vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector are mounted to the base.

17. The tester apparatus of claim 16, further comprising:

an intermediate substrate, wherein the channeling block is mounted to the intermediate substrate, wherein the intermediate substrate is separable in a vertical direction from the base, wherein the base and the intermediate substrate have matching interfaces that releasably connect the gas supply connector, vacuum supply connector, vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector to the channeling block.

18. The tester apparatus of claim 17, further comprising:

a mounting plate secured to the intermediate substrate; and

a valve control connector secured to the mounting plate through which electrical signals can be provided to the vacuum regulator, nitrogen gas regulator and dielectric gas regulator.

19. The tester apparatus of claim 15, further comprising:

a transposition block to connect the vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector to the channeling block and transpose flow of gasses from horizontally parallel in a first direction to vertically parallel in a second

direction that is at right angles to the first direction.

20. The tester apparatus of claim 10, further comprising:

a control circuit to control the vacuum regulator, dielectric gas pressure regulator and nitrogen gas pressure regulator.

21. The tester apparatus of claim 1, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, further comprising:

a gas supply conduit forming part of the stationary structure;

a stationary structure gas supply interface forming part of the stationary structure; and

a portable structure gas supply interface on the portable structure and shaped to mate with the stationary structure gas supply interface when the wafer chuck moves towards the thermal chuck to connect the inlet opening of the gas supply passage to the gas supply conduit of the stationary structure.

22. The tester apparatus of claim 1, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, further comprising:

a gas removal conduit forming part of the stationary structure;

a stationary structure gas removal interface forming part of the stationary structure; and

a portable structure gas removal interface on the portable structure and shaped to mate with the stationary structure gas removal interface when the wafer chuck moves towards the thermal chuck to connect the outlet opening of the pressure reduction passage to the gas removal conduit of the stationary structure.

23. The tester apparatus of claim 1, wherein opening of the pressure reduction supply to allow gas out of the enclosed cavity moves the first and second components relatively towards one another for ensuring proper contact between the contacts and the terminals.

24. The tester apparatus of claim 1, wherein the pressure reduction passage is formed in the first component.

25. The tester apparatus of claim 1, further comprising a latch system that includes:

a first latch assembly having:

a first part that engages with the first component;

a second part that engages with the second component;

a connecting part having opposing ends secured to the first and second parts respectively to form a locking arrangement; and

an engaging mechanism connected to the locking arrangement and operable to move the locking arrangement between a locking position wherein the locking arrangement maintains the first and second components locked in the closed position and an unlocked position wherein the locking arrangement permits movement of the first and second components from the closed relationship into the spaced relationship.

26. The tester apparatus of claim 1, further comprising a pressure monitoring system that includes:

a pressure sensor positioned to detect a pressure in the enclosed cavity; and

an electrical pressure sensor interface connected to the pressure sensor to communicate the pressure with an electric tester.

27. A wafer pack, comprising:

a portable supporting structure including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit;

a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals;

a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components;

a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity;

a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity;

a first electrical interface, on the portable supporting structure and connected to the contacts, for connection to a second electrical interface on a stationary structure when the

portable supporting structure is removably held by the stationary structure;

a gas supply passage formed through one of the components, the gas supply passage having an inlet opening outside the enclosed cavity and an outlet opening at the enclosed cavity; and

a gas inlet supply connected to the gas supply passage, opening of the gas inlet supply allowing gas into the enclosed cavity and into a space between the contacts.

28. The wafer pack of claim 27, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, further comprising:

a portable structure gas supply interface shaped to mate with a stationary structure gas supply interface when the wafer chuck moves towards the thermal chuck to connect the inlet opening of the gas supply passage to a gas supply conduit of the stationary structure.

29. The wafer pack of claim 27, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, further comprising:

a portable structure gas removal interface shaped to mate with a stationary structure gas removal interface when the wafer chuck moves towards the thermal chuck to connect the outlet opening of the pressure reduction passage to a gas removal conduit of the stationary structure.

30. The wafer pack of claim 27, wherein opening of the pressure reduction supply to allow gas out of the enclosed cavity moves the first and second components relatively towards one another for ensuring proper contact between the contacts and the terminals.

31. The wafer pack of claim 27, wherein the pressure reduction passage is formed in the first component.

32. The wafer pack of claim 27, further comprising a latch system that includes:

a first latch assembly having:

a first part that engages with the first component;

a second part that engages with the second component;

a connecting part having opposing ends secured to the first and second parts respectively to form a locking arrangement; and

an engaging mechanism connected to the locking arrangement and operable to move the locking arrangement between a locking position wherein the locking arrangement maintains the first and second components locked in the closed position and an unlocked position wherein the locking arrangement permits movement of the first and second components from the closed relationship into the spaced relationship.

33. The wafer pack of claim 27, further comprising a pressure monitoring system that includes:

a pressure sensor positioned to detect a pressure in the enclosed cavity; and

an electrical pressure sensor interface connected to the pressure sensor to

communicate the pressure with an electric tester.

34. A method of testing a microelectronic circuit held by a substrate, comprising:

holding the substrate between first and second components, the second component having contacts against terminals of the substrate connected to the microelectronic circuit;

locating a cavity seal between the first and second components to form an enclosed cavity by surfaces of the first and second components and the cavity seal;

transmitting signals between an electrical tester and the microelectronic circuit to test the microelectronic circuit; and

allowing a dielectric gas into the enclosed cavity into a space between the contacts.

35. The method of claim 34, wherein a pressure reduction passage is formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, further comprising:

opening a gas inlet supply to allow a dielectric gas through a gas supply passage formed through one of the components into the enclosed cavity into space between the contacts.

36. The method of claim 34, wherein the dielectric gas reduces arcing between the contacts compared to air.

37. The method of claim 34, further comprising:

controlling flow of the dielectric gas through the gas supply passage by passing the

dielectric gas through an orifice.

38. The method of claim 34, further comprising:

controlling flow of the dielectric gas through the pressure reduction passage by passing the dielectric gas through an orifice.

39. The method of claim 34, wherein the first and second components form part of a portable supporting structure, further comprising:

receiving the portable supporting structure by a stationary structure with a first electrical interface on the portable supporting structure connected to a second electrical interface on the stationary structure, wherein the signals are transmitted between the electrical tester and the microelectronic circuit through the terminals, contacts, and first and second electrical interfaces to test the microelectronic circuit.

40. The method of claim 34, further comprising:

using a vacuum regulator connected to the pressure reduction passage to control flow of gas through the pressure reduction passage.

41. The method of claim 40, further comprising:

using a dielectric gas pressure regulator connected to the gas supply passage to control flow of dielectric gas to the gas supply passage.

42. The method of claim 41, further comprising:

a nitrogen gas pressure regulator connected to the gas supply passage to control flow of nitrogen gas to the gas supply passage.

43. The method of claim 42, further comprising:

using a control circuit to control the vacuum regulator, dielectric gas pressure regulator and nitrogen gas pressure regulator.

44. The method of claim 39, wherein the first component is a wafer chuck in the form of a planar piece having a planar face, further comprising:

moving the planar face of the wafer chuck towards a planar face of a thermal chuck of a stationary structure to further mate a portable structure gas supply interface with a stationary structure gas supply interface to connect the inlet opening of the gas supply passage to a gas supply conduit of the stationary structure.

45. The method of claim 34, wherein the first component is a wafer chuck in the form of a planar piece having a planar face, further comprising:

moving the planar face of the wafer chuck towards a planar face of a thermal chuck of a stationary structure to further mate a portable structure gas removal interface with a stationary structure gas removal interface to connect the outlet opening of the pressure reduction passage to a gas removal conduit of the stationary structure.

46. The method of claim 34, wherein opening of the pressure reduction supply to allow gas out of the enclosed cavity moves the first and second components relatively towards one another for ensuring proper contact between the contacts and the terminals.

47. The method of claim 34, wherein the pressure reduction passage is formed in the first component.

48. The method of claim 34, further comprising:

operating an engaging mechanism to move the locking arrangement between a locking position wherein the locking arrangement maintains the first and second components locked in the closed position and an unlocked position wherein the locking arrangement permits movement of the first and second components from the closed relationship into the spaced relationship, the locking arrangement including:

a first part that engages with the first component;

a second part that engages with the second component; and

a connecting part having opposing ends secured to the first and second parts, respectively.

49. The method of claim 34, further comprising:

detecting a pressure in the enclosed cavity; and

communicating the pressure with the electric tester.

50. A gas box comprising:

a vacuum regulator connectable to a pressure reduction passage to control flow of gas through the pressure reduction passage;

a dielectric gas pressure regulator connectable the gas supply passage to control flow of dielectric gas to the gas supply passage;

a nitrogen gas pressure regulator to control flow of nitrogen gas to the gas supply passage; and

a channeling block connected to the dielectric gas pressure regulator and the nitrogen gas pressure regulator and connectable to the gas supply passage to selectably provide the nitrogen gas or the dielectric gas to the gas supply passage.

51. The gas box of claim 50, further comprising:

a gas supply connector for connection to the gas supply passage to provide the nitrogen gas or the dielectric gas to the gas supply passage.

52. The gas box of claim 51, further comprising:

a vacuum supply connector for connection to the pressure reduction passage to provide the vacuum from the vacuum regulator to the pressure reduction passage.

53. The gas box of claim 52, wherein the vacuum supply connector is connected through the channeling block to the vacuum regulator.

54. The gas box of claim 52, further comprising:

a vacuum receiving connector connectable to a vacuum pump to connect the vacuum regulator to the vacuum pump;

a nitrogen gas receiving connector connectable to a nitrogen gas inlet supply to connect the nitrogen gas inlet supply to the nitrogen gas pressure regulator; and

a dielectric gas receiving connector connectable to a dielectric gas inlet supply to connect the dielectric gas inlet supply to the dielectric gas pressure regulator.

55. The gas box of claim 54, further comprising:

a base, wherein the gas supply connector, vacuum supply connector, vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector are mounted to the base.

56. The gas box of claim 55, further comprising:

an intermediate substrate, wherein the channeling block is mounted to the intermediate substrate, wherein the intermediate substrate is separable in a vertical direction from the base, wherein the base and the intermediate substrate have matching interfaces that releasably connect the gas supply connector, vacuum supply connector, vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector to the channeling block.

57. The gas box of claim 56, further comprising:

a mounting plate secured to the intermediate substrate; and

a valve control connector secured to the mounting plate through which electrical signals can be provided to the vacuum regulator, nitrogen gas regulator and dielectric gas regulator.

58. The gas box of claim 54, further comprising:

a transposition block to connect the vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector to the channeling block and transpose flow of gasses from horizontally parallel in a first direction to vertically parallel in a second direction that is at right angles to the first direction.

59. A tester apparatus, comprising:

a portable supporting structure including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, wherein the first component is a wafer chuck in the form of a planar piece having a planar face;

a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals;

a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components;

a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity;

a pressure reduction supply connected to the pressure reduction passage, opening of

the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity;

a first electrical interface on the portable supporting structure and connected to the contacts;

a portable structure gas removal interface on the portable structure;

a stationary structure, the portable supporting structure being receivable to be held by the stationary structure and being removable from the stationary structure;

a second electrical interface on the stationary structure, the second electrical interface being connected to the first electrical interface when the portable structure is held by the stationary structure, and being disconnected from the first electrical interface when the portable supporting structure is removed from the stationary structure, wherein electrical tester is connected through the second electrical interface, the first electrical interface, and the contacts to the terminals.

a thermal chuck on the stationary structure, wherein the planar face of the wafer chuck is movable towards a planar face of the thermal chuck;

a gas removal conduit forming part of the stationary structure;

a stationary structure gas removal interface forming part of the stationary structure, the portable structure gas removal interface shaped to mate with the stationary structure gas removal interface when the wafer chuck moves towards the thermal chuck to connect the outlet opening of the pressure reduction passage to the gas removal conduit of the stationary structure; and

an electrical tester connected to the microelectronic circuit to test the microelectronic circuit.

60. The tester apparatus of claim 59, further comprising:

a gas supply passage formed through one of the components, the gas supply passage having an inlet opening outside the enclosed cavity and an outlet opening at the enclosed cavity; and

a gas inlet supply connected to the gas supply passage, opening of the gas inlet supply allowing gas into the enclosed cavity and into a space between the contacts.

61. The tester apparatus of claim 60, further comprising:

a source of dielectric gas connected to the gas supply passage.

62. The tester apparatus of claim 61, wherein the dielectric gas reduces arcing between the contacts compared to air.

63. The tester apparatus of claim 60, further comprising:

a vacuum pump connected to the a pressure reduction supply.

64. The tester apparatus of claim 60, further comprising:

an orifice connected to the gas supply passage to control flow of the dielectric gas through the gas supply passage.

65. The tester apparatus of claim 60, further comprising:

an orifice connected to the pressure reduction passage to control flow of the

dielectric gas through the pressure reduction passage.

66. The tester apparatus of claim 60, further comprising:

a vacuum regulator connected to the pressure reduction passage to control flow of gas through the pressure reduction passage.

67. The tester apparatus of claim 66, further comprising:

a dielectric gas pressure regulator connected to the gas supply passage to control flow of dielectric gas to the gas supply passage.

68. The tester apparatus of claim 67, further comprising:

a nitrogen gas pressure regulator connected to the gas supply passage to control flow of nitrogen gas to the gas supply passage.

69. The tester apparatus of claim 68, further comprising:

a channeling block connected to the dielectric gas pressure regulator and the nitrogen gas pressure regulator and connected to the gas supply passage to selectably provide the nitrogen gas or the dielectric gas to the gas supply passage.

70. The tester apparatus of claim 69, further comprising:

a gas supply connector for connection to the gas supply passage to provide the nitrogen gas or the dielectric gas to the gas supply passage.

71. The tester apparatus of claim 70, further comprising:

a vacuum supply connector for connection to the pressure reduction passage to provide the vacuum from the vacuum regulator to the pressure reduction passage.

72. The tester apparatus of claim 71, wherein the vacuum supply connector is connected through the channeling block to the vacuum regulator.

73. The tester apparatus of claim 71, further comprising:

a vacuum receiving connector connectable to a vacuum pump to connect the vacuum regulator to the vacuum pump;

a nitrogen gas receiving connector connectable to a nitrogen gas inlet supply to connect the nitrogen gas inlet supply to the nitrogen gas pressure regulator; and

a dielectric gas receiving connector connectable to a dielectric gas inlet supply to connect the dielectric gas inlet supply to the dielectric gas pressure regulator.

74. The tester apparatus of claim 73, further comprising:

a base, wherein the gas supply connector, vacuum supply connector, vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector are mounted to the base.

75. The tester apparatus of claim 74, further comprising:

an intermediate substrate, wherein the channeling block is mounted to the intermediate substrate, wherein the intermediate substrate is separable in a vertical direction

from the base, wherein the base and the intermediate substrate have matching interfaces that releasably connect the gas supply connector, vacuum supply connector, vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector to the channeling block.

76. The tester apparatus of claim 75, further comprising:

a mounting plate secured to the intermediate substrate; and

a valve control connector secured to the mounting plate through which electrical signals can be provided to the vacuum regulator, nitrogen gas regulator and dielectric gas regulator.

77. The tester apparatus of claim 73, further comprising:

a transposition block to connect the vacuum receiving connector, nitrogen gas receiving and dielectric gas receiving connector to the channeling block and transpose flow of gasses from horizontally parallel in a first direction to vertically parallel in a second direction that is at right angles to the first direction.

78. The tester apparatus of claim 68, further comprising:

a control circuit to control the vacuum regulator, dielectric gas pressure regulator and nitrogen gas pressure regulator.

79. The tester apparatus of claim 59, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, further comprising:

a gas supply conduit forming part of the stationary structure;

a stationary structure gas supply interface forming part of the stationary structure; and

a portable structure gas supply interface on the portable structure and shaped to mate with the stationary structure gas supply interface when the wafer chuck moves towards the thermal chuck to connect the inlet opening of the gas supply passage to the gas supply conduit of the stationary structure.

80. The tester apparatus of claim 59, wherein opening of the pressure reduction supply to allow gas out of the enclosed cavity moves the first and second components relatively towards one another for ensuring proper contact between the contacts and the terminals.

81. The tester apparatus of claim 59, wherein the pressure reduction passage is formed in the first component.

82. The tester apparatus of claim 59, further comprising a latch system that includes:

a first latch assembly having:

a first part that engages with the first component;

a second part that engages with the second component;

a connecting part having opposing ends secured to the first and second parts

respectively to form a locking arrangement; and

an engaging mechanism connected to the locking arrangement and operable to move the locking arrangement between a locking position wherein the locking arrangement maintains the first and second components locked in the closed position and an unlocked position wherein the locking arrangement permits movement of the first and second components from the closed relationship into the spaced relationship.

83. The tester apparatus of claim 59, further comprising a pressure monitoring system that includes:

a pressure sensor positioned to detect a pressure in the enclosed cavity; and

an electrical pressure sensor interface connected to the pressure sensor to communicate the pressure with an electric tester.

84. A wafer pack, comprising:

a portable supporting structure including first and second components for holding a substrate therebetween, the substrate carrying a microelectronic circuit and having a plurality of terminals connected to the microelectronic circuit, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure;

a plurality of contacts on the second component, the contacts matching the terminals for making contact to the terminals;

a cavity seal between the first and second components, the cavity seal forming an enclosed cavity together with surfaces of the first and second components;

a pressure reduction passage formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity;

a pressure reduction supply connected to the pressure reduction passage, opening of the pressure reduction supply allowing gas out of the enclosed cavity and closing of the supply keeping gas from entering the enclosed cavity;

a first electrical interface, on the portable supporting structure and connected to the contacts, for connection to a second electrical interface on a stationary structure when the portable supporting structure is removably held by the stationary structure; and

a portable structure gas removal interface shaped to mate with a stationary structure gas removal interface when the wafer chuck moves towards the thermal chuck to connect the outlet opening of the pressure reduction passage to a gas removal conduit of the stationary structure.

85. The wafer pack of claim 84, further comprising:

a gas supply passage formed through one of the components, the gas supply passage having an inlet opening outside the enclosed cavity and an outlet opening at the enclosed cavity; and

a gas inlet supply connected to the gas supply passage, opening of the gas inlet supply allowing gas into the enclosed cavity and into a space between the contacts.

86. The wafer pack of claim 85, wherein the first component is a wafer chuck in the form of a planar piece having a planar face that is movable towards a planar face of a thermal chuck of a stationary structure, further comprising:

a portable structure gas supply interface shaped to mate with a stationary structure gas supply interface when the wafer chuck moves towards the thermal chuck to connect the inlet opening of the gas supply passage to a gas supply conduit of the stationary structure.

87. The wafer pack of claim 84, wherein opening of the pressure reduction supply to allow gas out of the enclosed cavity moves the first and second components relatively towards one another for ensuring proper contact between the contacts and the terminals.

88. The wafer pack of claim 84, wherein the pressure reduction passage is formed in the first component.

89. The wafer pack of claim 84, further comprising a latch system that includes:

a first latch assembly having:

a first part that engages with the first component;

a second part that engages with the second component;

a connecting part having opposing ends secured to the first and second parts respectively to form a locking arrangement; and

an engaging mechanism connected to the locking arrangement and operable to move the locking arrangement between a locking position wherein the locking arrangement maintains the first and second components locked in the closed position and an unlocked

position wherein the locking arrangement permits movement of the first and second components from the closed relationship into the spaced relationship.

90. The wafer pack of claim 84, further comprising a pressure monitoring system that includes:

a pressure sensor positioned to detect a pressure in the enclosed cavity; and

an electrical pressure sensor interface connected to the pressure sensor to communicate the pressure with an electric tester.

91. A method of testing a microelectronic circuit held by a substrate, comprising:

holding the substrate between first and second components, the second component having contacts against terminals of the substrate connected to the microelectronic circuit wherein the first component is a wafer chuck in the form of a planar piece having a planar face;

locating a cavity seal between the first and second components to form an enclosed cavity by surfaces of the first and second components and the cavity seal;

receiving the portable supporting structure by a stationary structure with a first electrical interface on the portable supporting structure connected to a second electrical interface on the stationary structure;

moving the planar face of the wafer chuck towards a planar face of a thermal chuck of a stationary structure to further mate a portable structure gas removal interface with a stationary structure gas removal interface to connect the outlet opening of the pressure reduction passage to a gas removal conduit of the stationary structure; and

transmitting signals between an electrical tester and the microelectronic circuit to test the microelectronic circuit, wherein the signals are transmitted between the electrical tester and the microelectronic circuit through the terminals, contacts, and first and second electrical interfaces to test the microelectronic circuit.

92. The method of claim 91, further comprising:

allowing a dielectric gas into the enclosed cavity into a space between the contacts.

93. The method of claim 92, wherein a pressure reduction passage is formed through one of the components, the pressure reduction passage having an inlet opening at the enclosed cavity and an outlet opening outside the enclosed cavity, further comprising:

opening a gas inlet supply to allow a dielectric gas through a gas supply passage formed through one of the components into the enclosed cavity into space between the contacts.

94. The method of claim 91, wherein the dielectric gas reduces arcing between the contacts compared to air.

95. The method of claim 93, further comprising:

controlling flow of the dielectric gas through the gas supply passage by passing the dielectric gas through an orifice.

96. The method of claim 93, further comprising:

controlling flow of the dielectric gas through the pressure reduction passage by passing the dielectric gas through an orifice.

97. The method of claim 93, wherein the first and second components form part of a portable supporting structure, further comprising:

receiving the portable supporting structure by a stationary structure with a first electrical interface on the portable supporting structure connected to a second electrical interface on the stationary structure, wherein the signals are transmitted between the electrical tester and the microelectronic circuit through the terminals, contacts, and first and second electrical interfaces to test the microelectronic circuit.

98. The method of claim 93, further comprising:

using a vacuum regulator connected to the pressure reduction passage to control flow of gas through the pressure reduction passage.

99. The method of claim 93, further comprising:

using a dielectric gas pressure regulator connected to the gas supply passage to control flow of dielectric gas to the gas supply passage.

100. The method of claim 93, further comprising:

a nitrogen gas pressure regulator connected to the gas supply passage to control flow

of nitrogen gas to the gas supply passage.

101. The method of claim 100, further comprising:

using a control circuit to control the vacuum regulator, dielectric gas pressure regulator and nitrogen gas pressure regulator.

102. The method of claim 97, wherein the first component is a wafer chuck in the form of a planar piece having a planar face, further comprising:

moving the planar face of the wafer chuck towards a planar face of a thermal chuck of a stationary structure to further mate a portable structure gas supply interface with a stationary structure gas supply interface to connect the inlet opening of the gas supply passage to a gas supply conduit of the stationary structure.

103. The method of claim 91, wherein opening of the pressure reduction supply to allow gas out of the enclosed cavity moves the first and second components relatively towards one another for ensuring proper contact between the contacts and the terminals.

104. The method of claim 91, wherein the pressure reduction passage is formed in the first component.

105. The method of claim 91, further comprising:

operating an engaging mechanism to move the locking arrangement between a locking position wherein the locking arrangement maintains the first and second components

locked in the closed position and an unlocked position wherein the locking arrangement permits movement of the first and second components from the closed relationship into the spaced relationship, the locking arrangement including:

a first part that engages with the first component;

a second part that engages with the second component; and

a connecting part having opposing ends secured to the first and second parts, respectively.

106. The method of claim 91, further comprising:

detecting a pressure in the enclosed cavity; and

communicating the pressure with the electric tester.

107. A tester apparatus comprising:

a tray for releasably holding a wafer, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer;

a contactor board;

contactor front contacts mounted to the contactor board, each contactor front contact having a surface positioned to make contact with a respective front wafer terminal on a front side of the wafer;

an electric tester connected to the contactor front contacts, such that, in use, current conducts through the front side wafer contacts and the contactor front contacts between the electric tester and a circuit in the wafer to test the circuit; and

an electrical conductor connecting the portion that is electrically conductive such that, in use, the circuit is connected through the rear wafer contact, the exposed surface of the portion that is electrically conductive and the electrical path to the electric tester.

108. The tester apparatus of claim 107, further comprising:

a thermal chuck, in use, the tray being thermally connected to the thermal chuck and heat transferring between the thermal chuck and the wafer.

109. The tester apparatus of claim 108, wherein the thermal chuck has a thermal passage so that, in use, a fluid flows through the thermal passage and heat transfers between the fluid and the thermal chuck.

110. The tester apparatus of claim 107, further comprising:

a wafer chuck, the tray being positioned on the wafer chuck, the wafer chuck having a vacuum passage therethrough, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the tray.

111. The tester apparatus of claim 110, wherein the tray includes:

an electric insulator around the inlet opening of each vacuum opening.

112. The tester apparatus of claim 110, further comprising:

at least one wafer chuck pin mounted to the contactor board, the wafer chuck pin having a grounding contact making contact with the wafer chuck.

113. The tester apparatus of claim 112, wherein the wafer chuck pin extends past an edge of the tray.

114. The tester apparatus of claim 112, further comprising a plurality of wafer chuck pins.

115. The tester apparatus of claim 107, wherein the tray includes a return terminal area that is electrically connected to the exposed surface of the tray and the contactor front contacts that are mounted to the contactor board are power contactor front contacts, and the electrical return conductor includes:

a contactor return contact mounted to the contactor board and having a surface positioned to make contact with the return terminal area on the tray.

116. The tester apparatus of claim 115, further comprising:

a plurality of wafer contact pins mounted to the contactor board, the power contactor front contacts being located on the wafer contact pins; and

at least one return terminal pin mounted to the contactor board, the contactor return contact being on the return terminal pin.

117. The tester apparatus of claim 116, wherein the return terminal pin extends past an edge of the wafer.

118. The tester apparatus of claim 116, further comprising a plurality of return terminal pins.

119. The tester apparatus of claim 115, further comprising:

a signal distribution board that includes:

a signal distribution board substrate;

signal distribution board contacts on the signal distribution board substrate;

signal distribution board terminals on the signal distribution board substrate; and

signal distribution board conductors connecting the signal distribution board contacts to the signal distribution board terminals.

120. The tester apparatus of claim 119, further comprising:

a stiffener plate that is positioned to support the signal distribution board substrate.

121. A method of testing a wafer comprising:

holding a wafer in a tray, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer;

moving a contactor board and the tray relatively towards one another so that surfaces of contactor contacts mounted to the contactor board make contact with respective front

wafer contacts on a front side of the wafer;

conducting current through the front side wafer contacts and the contactor contacts between an electric tester and a circuit in the wafer to test the circuit,

the circuit being connected through the rear wafer terminal, the exposed surface of the portion that is electrically conductive and the electrical path to the electric tester; and

removing the wafer from the tray.

122. The method of claim 121, further comprising:

thermally connecting the tray to the thermal chuck; and

transferring heat between the thermal chuck and the wafer.

123. The method of claim 122, wherein a fluid flows through the thermal passage of the thermal chuck and heat transfers between the fluid and the thermal chuck.

124. The method of claim 121, the tray being positioned on the wafer chuck, the wafer chuck having a vacuum passage therethrough, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that, further comprising:

applying a vacuum to the vacuum passage, the vacuum securing the rear side of the wafer to the tray.

125. The method of claim 124, wherein the tray includes:

an electric insulator around the inlet opening of each vacuum opening.

126. The method of claim 124, further comprising:

making contact between a grounding contact of at least one wafer chuck pin mounted to the contactor board and the wafer chuck.

127. The method of claim 126, wherein the wafer chuck pin extends past an edge of the tray.

128. The method of claim 126, further comprising making contact between a plurality of wafer chuck pins mounted to the contactor board and the wafer chuck.

129. The method of claim 121, wherein the tray includes a return terminal area that is electrically connected to the exposed surface of the tray and the contactor front contacts that are mounted to the contactor board are power contactor front contacts, and the electrical return conductor includes:

a contactor return contact mounted to the contactor board and having a surface positioned to make contact with the return terminal area on the tray.

130. The method of claim 129, wherein:

a plurality of wafer contact pins are mounted to the contactor board, the power contactor front contacts being located on the wafer contact pins; and

at least one return terminal pin is mounted to the contactor board, the contactor return contact being on the return terminal pin.

131. The method of claim 130, wherein the return terminal pin extends past an edge of the wafer.

132. The method of claim 130, wherein a plurality of return terminal pins are mounted to the contactor board.

133. The method of claim 129, further comprising:

attaching the contactor board to a signal distribution board that includes:

a signal distribution board substrate;

signal distribution board contacts on the signal distribution board substrate;

signal distribution board terminals on the signal distribution board substrate; and

signal distribution board conductors connecting the signal distribution board contacts to the signal distribution board terminals.

134. The method of claim 133, further comprising:

positioning a stiffener plate to support the signal distribution board substrate.

135. A tester apparatus comprising:

a wafer chuck;

a tray for releasably holding a wafer the tray being releasably positioned on the wafer chuck, the wafer chuck having a vacuum passage therethrough, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of

the wafer to the vacuum passage in the wafer chuck so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the tray;

a contactor board;

contactor contacts mounted to the contactor board, each contactor contact having a surface positioned to make contact with a respective front wafer terminal on a front side of the wafer; and

an electric tester connected to the contactor contacts, such that, in use, current conducts through the front side wafer contacts and the contactor contacts between the electric tester and a circuit in the wafer to test the circuit.

136. The tester apparatus of claim 135, further comprising:

a thermal chuck, in use, the tray being thermally connected to the thermal chuck and heat transferring between the thermal chuck and the wafer.

137. The tester apparatus of claim 136, wherein the thermal chuck has a thermal passage so that, in use, a fluid flows through the thermal passage and heat transfers between the fluid and the thermal chuck.

138. The tester apparatus of claim 135, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer, further comprising:

an electrical conductor connecting the portion that is electrically conductive such that, in use, the circuit is connected through the rear wafer contact, the exposed surface of

the portion that is electrically conductive and the electrical path to the electric tester.

139. The tester apparatus of claim 138, wherein the tray includes:

an electric insulator around the inlet opening of each vacuum opening.

140. The tester apparatus of claim 138, further comprising:

at least one wafer chuck pin mounted to the contactor board, the wafer chuck pin having a grounding contact making contact with the wafer chuck.

141. The tester apparatus of claim 140, wherein the wafer chuck pin extends past an edge of the tray.

142. The tester apparatus of claim 140, further comprising a plurality of wafer chuck pins.

143. The tester apparatus of claim 138, wherein the tray includes a return terminal area that is electrically connected to the exposed surface of the tray and the contactor front contacts that are mounted to the contactor board are power contactor front contacts, and the electrical return conductor includes:

a contactor return contact mounted to the contactor board and having a surface positioned to make contact with the return terminal area on the tray.

144. The tester apparatus of claim 135, further comprising:

a plurality of wafer contact pins mounted to the contactor board, the power contactor

front contacts being located on the wafer contact pins;

at least one return terminal pin mounted to the contactor board, the contactor return contact being on the return terminal pin.

145. The tester apparatus of claim 144, wherein the return terminal pin extends past an edge of the wafer.

146. The tester apparatus of claim 144, further comprising a plurality of return terminal pins.

147. The tester apparatus of claim 143, further comprising:

a signal distribution board that includes:

a signal distribution board substrate;

signal distribution board contacts on the signal distribution board substrate;

signal distribution board terminals on the signal distribution board substrate; and

signal distribution board conductors connecting the signal distribution board contacts to the signal distribution board terminals.

148. The tester apparatus of claim 147, further comprising:

a stiffener plate that is positioned to support the signal distribution board substrate.

149. A method of testing a wafer comprising:

holding a wafer in a tray;

positioning the tray on a chuck;

applying a vacuum to a vacuum passage though the wafer chuck, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that the vacuum secures the rear side of the wafer to the tray;

moving a contactor board and the tray relatively towards one another so that surfaces of contactor contacts mounted to the contactor board make contact with respective front wafer contacts on a front side of the wafer;

conducting current through the front side wafer contacts and the contactor contacts between an electric tester and a circuit in the wafer to test the circuit; and

removing the wafer from the tray.

150. The method of claim 149, further comprising:

thermally connecting the tray to the thermal chuck; and

transferring heat between the thermal chuck and the wafer.

151. The method of claim 150, wherein a fluid flows through the thermal passage of the thermal chuck and heat transfers between the fluid and the thermal chuck.

152. The method of claim 149, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer, the circuit being connected through the rear wafer terminal, the exposed

surface of the portion that is electrically conductive and the electrical path to the electric tester.

153. The method of claim 152, wherein the tray includes:

an electric insulator around the inlet opening of each vacuum opening.

154. The method of claim 152, further comprising:

making contact between a grounding contact of at least one wafer chuck pin mounted to the contactor board and the wafer chuck.

155. The method of claim 154, wherein the wafer chuck pin extends past an edge of the tray.

156. The method of claim 154, further comprising making contact between a plurality of wafer chuck pins mounted to the contactor board and the wafer chuck.

157. The method of claim 149, wherein the tray includes a return terminal area that is electrically connected to the exposed surface of the tray and the contactor front contacts that are mounted to the contactor board are power contactor front contacts, and the electrical return conductor includes:

a contactor return contact mounted to the contactor board and having a surface positioned to make contact with the return terminal area on the tray.

158. The method of claim 157, wherein:

a plurality of wafer contact pins are mounted to the contactor board, the power contactor front contacts being located on the wafer contact pins; and

at least one return terminal pin is mounted to the contactor board, the contactor return contact being on the return terminal pin.

159. The method of claim 158, wherein the return terminal pin extends past an edge of the wafer.

160. The method of claim 158, wherein a plurality of return terminal pins are mounted to the contactor board.

161. The method of claim 157, further comprising:

attaching the contactor board to a signal distribution board that includes:

a signal distribution board substrate;

signal distribution board contacts on the signal distribution board substrate;

signal distribution board terminals on the signal distribution board substrate; and

signal distribution board conductors connecting the signal distribution board contacts to the signal distribution board terminals.

162. The method of claim 161, further comprising:

positioning a stiffener plate to support the signal distribution board substrate.

163. A tester apparatus comprising:

a vacuum conduit defining a vacuum passage;

a wafer holder for releasably holding a wafer, the wafer holder having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the wafer holder, wherein each vacuum opening has an inlet opening at the wafer, an outlet opening remote from the wafer, and an enlarged section between the inlet opening and the outlet opening to reduce arcing between the openings;

a contactor board;

contactor contacts mounted to the contactor board, each contactor contact having a surface positioned to make contact with a respective front wafer terminal on a front side of the wafer; and

an electric tester connected to the contactor contacts, such that, in use, current conducts through the front side wafer contacts and the contactor contacts between the electric tester and a circuit in the wafer to test the circuit.

164. The tester apparatus of claim 163, further comprising:

a thermal chuck, in use, the wafer holder being thermally connected to the thermal chuck and heat transferring between the thermal chuck and the wafer.

165. The tester apparatus of claim 164, wherein the thermal chuck has a thermal passage so that, in use, a fluid flows through the thermal passage and heat transfers between the fluid and the thermal chuck.

166. The tester apparatus of claim 163, wherein the wafer holder has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer; and

an electrical conductor connecting the portion that is electrically conductive such that, in use, the circuit is connected through the rear wafer contact, the exposed surface of the portion that is electrically conductive and the electrical path to the electric tester.

167. The tester apparatus of claim 163, wherein the wafer holder includes:

a wafer chuck; and

a tray for releasably holding a wafer the tray being releasable positioned on the wafer chuck, the wafer chuck having a vacuum passage therethrough, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the tray.

168. The tester apparatus of claim 167, wherein the tray includes:

an electric insulator around the inlet opening of each vacuum opening.

169. The tester apparatus of claim 167, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer; and

an electrical conductor connecting the portion that is electrically conductive such

that, in use, the circuit is connected through the rear wafer contact, the exposed surface of the portion that is electrically conductive and the electrical path to the electric tester.

170. The tester apparatus of claim 169, further comprising:

at least one wafer chuck pin mounted to the contactor board, the wafer chuck pin having a grounding contact making contact with the wafer chuck.

171. The tester apparatus of claim 170, wherein the wafer chuck pin extends past an edge of the tray.

172. The tester apparatus of claim 170, further comprising a plurality of wafer chuck pins.

173. The tester apparatus of claim 169, wherein the tray includes a return terminal area that is electrically connected to the exposed surface of the tray and the contactor front contacts that are mounted to the contactor board are power contactor front contacts, and the electrical return conductor includes:

a contactor return contact mounted to the contactor board and having a surface positioned to make contact with the return terminal area on the tray.

174. The tester apparatus of claim 163, further comprising:

a plurality of wafer contact pins mounted to the contactor board, the power contactor front contacts being located on the wafer contact pins; and

at least one return terminal pin mounted to the contactor board, the contactor return

contact being on the return terminal pin.

175. The tester apparatus of claim 174, wherein the return terminal pin extends past an edge of the wafer.

176. The tester apparatus of claim 174, further comprising a plurality of return terminal pins.

177. The tester apparatus of claim 173, further comprising:

a signal distribution board that includes:

a signal distribution board substrate;

signal distribution board contacts on the signal distribution board substrate;

signal distribution board terminals on the signal distribution board substrate; and

signal distribution board conductors connecting the signal distribution board contacts to the signal distribution board terminals.

178. The tester apparatus of claim 177, further comprising:

a stiffener plate that is positioned to support the signal distribution board substrate.

179. A method of testing a wafer comprising:

releasably holding a wafer in a wafer holder, the wafer holder having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage;

applying a vacuum to the vacuum passage, the vacuum securing the rear side of the wafer to the wafer holder;

moving a contactor board and the tray relatively towards one another so that surfaces of contactor contacts mounted to the contactor board make contact with respective front wafer contacts on a front side of the wafer;

conducting current through the front side wafer contacts and the contactor contacts between an electric tester and a circuit in the wafer to test the circuit, wherein each vacuum opening has an inlet opening at the wafer, an outlet opening remote from the wafer, and an enlarged section between the inlet opening and the outlet opening to reduce arcing between the openings; and

removing the wafer from the tray.

180. The method of claim 179, further comprising:

thermally connecting the tray to the thermal chuck; and

transferring heat between the thermal chuck and the wafer.

181. The method of claim 180, wherein a fluid flows through the thermal passage of the thermal chuck and heat transfers between the fluid and the thermal chuck.

182. The method of claim 179, wherein the tray has at least a portion that is electrically conductive and has an exposed surface to make contact with a rear wafer terminal on a rear side of the wafer, the circuit being connected through the rear wafer terminal, the exposed

surface of the portion that is electrically conductive and the electrical path to the electric tester.

183. The method of claim 179, wherein the wafer holder includes:

a wafer chuck; and

a tray for releasably holding a wafer the tray being releasable positioned on the wafer chuck, the wafer chuck having a vacuum passage therethrough, the tray having a plurality of vacuum openings therethrough, each vacuum opening connecting a rear side of the wafer to the vacuum passage in the wafer chuck so that, when a vacuum is applied to the vacuum passage, the vacuum secures the rear side of the wafer to the tray.

184. The method of claim 182, wherein the tray includes:

an electric insulator around the inlet opening of each vacuum opening.

185. The method of claim 182, further comprising:

making contact between a grounding contact of at least one wafer chuck pin mounted to the contactor board and the wafer chuck.

186. The method of claim 185, wherein the wafer chuck pin extends past an edge of the tray.

187. The method of claim 186, further comprising making contact between a plurality of wafer chuck pins mounted to the contactor board and the wafer chuck.

188. The method of claim 179, wherein the tray includes a return terminal area that is electrically connected to the exposed surface of the tray and the contactor front contacts that are mounted to the contactor board are power contactor front contacts, and the electrical return conductor includes:

a contactor return contact mounted to the contactor board and having a surface positioned to make contact with the return terminal area on the tray.

189. The method of claim 188, wherein:

a plurality of wafer contact pins are mounted to the contactor board, the power contactor front contacts being located on the wafer contact pins; and

at least one return terminal pin is mounted to the contactor board, the contactor return contact being on the return terminal pin.

190. The method of claim 189, wherein the return terminal pin extends past an edge of the wafer.

191. The method of claim 189, wherein a plurality of return terminal pins are mounted to the contactor board.

192. The method of claim 188, further comprising:

attaching the contactor board to a signal distribution board that includes:

a signal distribution board substrate;

signal distribution board contacts on the signal distribution board substrate;

signal distribution board terminals on the signal distribution board substrate; and

signal distribution board conductors connecting the signal distribution board contacts to the signal distribution board terminals.

193. The method of claim 192, further comprising:

positioning a stiffener plate to support the signal distribution board substrate.