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(54) Title: AN ASSEMBLY FOR ELECTRICALLY CONNECTING A TEST COMPONENT TO A TESTING MACHINE FOR TESTING ELECTRICAL CIRCUITS ON THE TEST COMPONENT

(57) Abstract: In one embodiment, the invention provides a test assembly for electrically connecting a test component to a testing machine for testing electrical circuits on the test component. The assembly comprises a contactor assembly to interconnect with the test component, a probe assembly to mechanically support the contactor assembly and electrically connected the contactor assembly to the testing machine, and a clamping mechanism comprising a first clamping member and a second clamping member, the clamping members being urged together to exert a clamping force to deform contactor bumps of an electrical connection between the probe assembly and the contactor assembly.

AN ASSEMBLY FOR ELECTRICALLY CONNECTING A TEST COMPONENT TO A TESTING MACHINE FOR TESTING ELECTRICAL CIRCUITS ON THE TEST COMPONENT

FIELD OF THE INVENTION

[0001] This invention relates to test equipment. In particular, it relates to test equipment for testing electrical circuits including integrated circuits.

BACKGROUND

[0002] When fabrication of electronic devices, such as computer processors and memories, have been completed, the electronic devices are subjected to burn-in and electrical testing in order to identify and eliminate defective devices before shipment. The term "burn-in" relates to operation of an integrated circuit at a predetermined temperature or temperature profile, typically an elevated temperature in an oven. Certain operating electrical bias levels and/or signals are supplied to the electronic devices while they are at the elevated temperature. The use of the elevated temperature accelerates stress to which the devices are subjected during burn-in, so that marginal devices that would otherwise fail shortly after being placed in service fail during burn-in, and are therefore not shipped.

[0003] Test equipment for burn-in testing of electrical circuits generally comprise a connection arrangement for electrically connecting an electrical circuit to be tested such as an integrated circuit on a wafer or test substrate, to a test probe circuit.

SUMMARY

[0004] In one embodiment, the invention provides a test assembly for electrically connecting a test component to a testing machine for testing electrical circuits on the test component. The assembly comprises a contactor assembly to interconnect with the test component, a probe assembly to mechanically support the contactor assembly and electrically connect the contactor assembly to the testing machine, and a clamping mechanism comprising a first clamping member and a second clamping member, the

clamping members being urged together to exert a clamping force to deform conductive bumps of an electrical connection between the probe assembly and the contactor assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The invention is described by way of example with reference to the accompanying drawings wherein:

[0006] Figure 1 is a block diagram of an interposer, an electrical contactor and a wafer comprising circuits to be tested;

[0007] Figure 2 is a block diagram of a contactor assembly in accordance with one embodiment of the invention;

[0008] Figure 3 is a block diagram illustrating a stage in the formation of the contactor assembly of Figure 2;

[0009] Figure 4 is a perspective view of a vacuum plate connected to a ring, in accordance with one embodiment of the invention;

[0010] Figure 5 is a top plan view of the vacuum plate and ring of Figure 4;

[0011] Figure 6 is a section on 6-6 in Figure 5;

[0012] Figure 7 is a block diagram illustrating how a ring and interposer seated therein may be aligned with a contactor, in accordance with one embodiment of the invention;

[0013] Figure 8 is a perspective view of an alignment machine in accordance with one embodiment of the invention;

[0014] Figure 9 is an end view of the alignment machine shown in Figure 8 of the drawings with a microscope mounted thereon;

[0015] Figure 10 is a perspective view of the alignment machine of Figure 8 mounted on a probe plate;

[0016] Figure 11 is an end view of Figure 10;

[0017] Figure 12A is a block diagram of the probe plate showing a flexible connector in accordance with another embodiment of the invention electrically connecting a contactor assembly to the probe plate;

[0018] Figure 12B is a block diagram of a probe plate showing a flexible connector in accordance with one embodiment of the invention electrically connecting a contactor assembly to the probe plate;

[0019] Figure 13A is a side view of the flexible connector of Figure 12A;

[0020] Figure 13B is a top plan view of an end of the flexible connector of Figure 12A;

[0021] Figure 14 shows an arrangement of electrical contact elements on an electrical contactor in accordance with one embodiment of the invention;

[0022] Figures 15 and 16 are block diagrams showing different stages in the formation of an electrical connection between the flexible electrical connector and the electrical contactor of Figure 12;

[0023] Figure 17 is a block diagram of the probe plate of Figure 12 wherein without the electrical connector and showing fiducial markings on the contactor assembly; and

[0024] Figure 18 is a block diagram of a test probe assembly in accordance with one embodiment of the invention.

DETAILED DESCRIPTION

[0025] Figure 1 of the accompanying drawings illustrates an interposer 10 and an electrical contactor 26 which together form a contactor assembly, according to an embodiment of the invention, used to test electrical circuits, for example, on a wafer 32.

[0026] As will be seen from Figure 1, the interposer 10 includes a substrate having a first side 12 and a second side 14. The interposer 10 includes a number of electrical terminals 16 on the first side 12. The interposer 10 also includes resilient interconnection elements in the form of interconnection spring

elements 18. Each interconnection spring element 18 extends from an electrical terminal 16 on the side 12 and terminates in a free end. The purpose of each interconnection spring elements 18 is to make good electrical contact with corresponding electrical terminals on the electrical contactor 26. In other embodiments, the resilient interconnection elements include pogo pins and compliant conductive bumps.

[0027] The interposer 10 also has an interconnection spring element 20 on each electrical terminal 16 on side 14. The interconnection spring elements 20 are similar to the interconnection spring elements 18 except that the interconnection spring elements 20 are for making electrical contact with corresponding electrical terminals on the wafer 32.

[0028] The interposer also includes mechanical alignment stops 22 on the sides 12 and 14 to prevent overtravel of the interconnection spring elements 18 and to prevent the interposer from touching certain areas of the wafer 32.

[0029] The electrical contactor 26 includes a contactor substrate which includes a side 28. Electrical contactor 26 also includes electrical terminals 30 on the side 28.

[0030] The wafer 32 is shown to include a side 34 which has the electrical circuits to be tested. The wafer 32 has electrical terminals 36 on the side 34 whereby electrical connection to the electrical circuits may be made.

[0031] Figure 2 of the drawings shows a contactor assembly 40 in accordance with one embodiment of the invention. The assembly 40 includes an interposer 10 and a retaining component in the form of a ring 42. The interposer 10 is secured or held in a predetermined or aligned position relative to the electrical contactor 26 by the ring 42. It will be seen that in the predetermined or aligned position, each interconnection spring element 18 has been deformed against a spring force thereof to make electrical contact with a corresponding electrical terminal 30 of electrical contactor 26. The predetermined position is reached by moving the ring 42 and the interposer 10 seated therein until the alignment stops 22 bear against the side 28 of the electrical contactor 26. In other embodiments, the predetermined position is

reached when sufficient pressure is exerted by the interconnection spring elements 18 (or the pogo pins or compliant conductive bumps in other embodiments) to keep the contactor 26 in place. The stops 22 are thus optional. A spacing between the interposer 10 and the electrical contactor 26 is such that each of the interconnection spring elements 18 is under compression.

[0032] The ring 42 is formed with a recessed surface 44 which defines a seat for the interposer 10. The ring 42 has a flat flange-like face 46 which bears against side 28 of electrical contactor 26. The ring 42 is secured to the electrical contactor 26 by means of fasteners 43, for example screws, extending through screw holes 48 (see Figure 4). The holes 48 are dimensioned to accommodate the fasteners 43 with some degree of play to permit alignment of fiducial markings on the interposer 10 and contactor 26, respectively.

[0033] Figure 3 of the drawings shows a first stage in the formation of the contactor assembly 40. Referring to Figure 3, a vacuum plate 50 is releasably secured to a side of the ring 42 opposing face 46 to form a sub-assembly 51. The vacuum plate 50 can be connected to a pump (not shown) by means of a coupling 54 and a hose 52 connected to the coupling 54. In use, the pump creates a vacuum in a region 56 between the vacuum plate 50 the interposer 10. The vacuum retains interposer 10 against the recessed surface 44. As can be seen from Figures 4 and 5, the vacuum plate 50 is shaped and dimensioned to provide access to the fasteners 43.

[0034] As can be seen from Figure 6 which shows a sectional view through sub-assembly 51 taken at 6-6 in Figure 5, the interposer 10 seats snugly in the ring 42.

[0035] Figure 7 of the drawings shows a block diagram of how alignment of the interposer 10 with the electrical contactor 26 is achieved. The interposer 10 is seated in the ring 42 and moved in an x, y, or Θ direction such that a fiducial marking 58 on the side 12 of the interposer 10 is aligned with a fiducial marking 60 on the side 28 of the electrical contactor 26. Once the fiducial marking 58 is aligned with the fiducial marking 60, the ring 42 together with the interposer 10

is displaced in a z direction so that the ring 42 makes contact with the electrical contactor 26. A screw 43 located in hole 48 is then screw-threaded into a complementary threaded socket 68 formed in electrical contactor 26. The fiducial markings 58, 60 allow for alignment for the electrical terminals 30 on the electrical contactor 26 with the ends of the interconnection spring elements 18 without having to take an image of the interconnection spring elements 18. Tolerances in the position of each interconnection spring element in the x-y plane or the angle at which it projects from the x-y plane do not effect the alignment process. The mechanical stops 22 on the side 18 of the interposer 10 may be used to limit movement of the interposer 10 towards the electrical contactor 26 when forming the assembly 40, such that each of the interconnection spring elements 18 is under the desired compression.

[0036] Figure 8 of the drawings shows a perspective view of an alignment machine 70, in accordance with one embodiment of the invention, which may be used to align the ring 42 and interposer 10 combination with the electrical contactor 26. The alignment machine 70 includes a base 72 which is shaped and dimensioned to rest on a probe plate 152 (see Figure 10) which, in use, houses the electrical contactor 26 (see Figure 12A). The alignment machine 70 also includes a raised platform or plate 74 which is secured to the base 72 by means of mounting brackets 76. The platform 74 supports a carriage 78. The carriage 78 is seen in Figure 9 of the drawings which shows a side view of the alignment machine 70. The carriage 78 is secured to an underside of the platform 74 by means of a mounting arrangement comprising angle brackets 88 and horizontal springs 90. The angle brackets 88 are secured to the platform 74 and provide an anchor for one end of the springs 90, the other end of the springs 90 being secured to a floating plate 80 of carriage 78 as can be seen in Figure 9 of the drawings.

[0037] The carriage 78 further includes ring holders 82 which are secured to the floating plate 80 of vertical members 84 extending between the ring holders mounting plate 82 and the floating plate 80.

[0038] Roller bearings 94 disposed between the platform 74 and the floating plate 80 allow for slidable displacement of the floating plate 80 relative to the

platform 74. Vertical springs 95 urge the floating plate 80 into contact with roller bearings 94. It will be appreciated that the spring mounting arrangement of the floating plate 80 to the platform 74 allows for movement of the floating plate 80 in an x-y plane. Such movement in the x y plane is controlled by means of an adjustment mechanism which, in one embodiment, includes micrometers 96, 98, and 100, each of which can be operated to urge a tip thereof to bear against an edge of the floating plate 80 thereby to cause the displacement of floating plate 80. For example, as can be seen in Figure 9 of the drawings, a tip 98.1 of the micrometer 98 may be displaced in a y direction to bear against an edge of the floating plate 80 thereby to cause the floating plate 80 to be displaced in the y direction. Because the ring holders 82 are rigidly connected to the floating plate 80, displacement of the floating plate 80 also causes corresponding displacement of the ring holders 82.

[0039] In use, the interposer 10 which is seated in the ring 42 by means of a suction force created with the aid of the vacuum plate 50 and a pump (not shown) is connected mechanically to the ring holders 82 of the carriage 78. Thereafter, the alignment machine 70 is positioned on a probe plate 152 as is shown in Figure 10. In this position, the ring 42 and the interposer 10 which is seated in the ring 42 is positioned directly over the electrical connector 26 which is seated in the probe plate 152.

[0040] A magnification system comprising a microscope 102 which includes a scope section 104 and a base 106 is secured on the platform 74 as can be seen in Figure 9 of the drawings.

[0041] The microscope 102 magnifies the fiducial markings 58, 60 on the interposer 10 and the electrical connector 26, respectively. The micrometers 96, 98 and 100 may then be operated to move the carriage 78, which carries the ring 42 and the interposer 10 with it, so that the interposer 10 may be positioned over the electrical connector 26 in a predetermined or aligned position in which the fiducial markings, 58, 60 on the interposer 10 and the electrical contactor 26, respectively, are in alignment.

[0042] The alignment machine 70, further includes micrometer heads 108 which may be operated to move the carriage 78 in a z direction which causes the interposer and ring combination to be displaced in the z direction towards the electrical contactor 26. In use, displacement in the z direction is continued until alignment stops 22 contact the side 28 of electrical contactor 26, or the desired z position is reached. When this position is reached, the screws 43 are screwed into the sockets 68 in the electrical contactor 26, thereby to secure the ring 42 and the interposer 10 seated therein to the electrical contactor 26.

[0043] Once the ring 42 and the interposer 10 are secured to the electrical contactor 26, the vacuum plate 50 and the alignment machine 70 are removed. The probe plate 152 includes an external interface component 164 comprising a plurality of electrical connectors in the form of electrical pins 166 as can be seen in Figure 12A. A flexible connector 110 electrically connects the contactor assembly 40 to the interface component 164 which in turn is electrically connected to a burn-in chamber of a testing machine (not shown) via the pins 166.

[0044] The flexible connector 110 includes a flexible substrate 112 having sides 112.1 and 112.2 as can be seen in Figure 13A. Further, the flexible substrate 112 has a first end 115 and a second end 116. Flexible line conductors 114.1 and 114.2 are formed on the sides 112.1 and 112.2 respectively, as can be seen in Figures 13A and 13B of the drawings. Each flexible line conductor 114.1 has a first end which is electrically connected to the interface component 164 and a second end remote from the first end. Each flexible line conductor 114.1 includes a terminal at its second end comprising two conductive bumps 118.1 as can be seen in Figure 13B of the drawings. Each flexible line conductor 114.2, likewise, has a first end which is electrically connected to the interface component 164 and a second end remote from the first end which is connected by a via 113 extending through the substrate 112 to a terminal comprising two conductive bumps 118.2 on the side 112.1. It will be appreciated that by having flexible line conductors on each side 112.1 and 112.2 of the substrate 112 it is possible for the substrate 112 to carry more line conductors 114.1 and 114.2.

[0045] The flexible connector 110 is sufficiently flexible so that it can fold onto itself without damage to the flexible substrate 112, and is typically made of a material such as polyimide. According to some embodiments, the flexible substrate 112 may have a thickness of 25.4 microns or 49 microns, although a thickness of up to 125 microns is still flexible in a sense that folding onto itself will still be possible without damage to the flexible substrate 112.

[0046] Typically, the bumps 118.1, 118.2 are formed of gold and have a width of about 100 micrometers and a height of about 60 micrometers. Gold is preferred as a material for the bumps 118 since it does not oxidize and is able to tolerate temperatures of between 150°C to 350°C. Further, gold maintains its elasticity within a temperature range of between 180°C to 240°C. The flexible connector 110 includes a layer 119 which covers the line conductors 114.1 and 114.2. The layer 119 is made of a non-conductive flexible material as can be seen in Figure 15.

[0047] The flexible connector 110 is electrically connected to the rigidly, substantially unbendable electrical contactor 26 of the contactor assembly 40. For this purpose, the electrical contactor 26 has a plurality of electrical contact elements 120 that are compatible for electrical connection to the conductive bumps 118.1 and 118.2 of the flexible connector 110. Figure 14 shows a layout of the electrical contact elements 120 on the electrical contactor 26. Referring to Figure 14, it will be seen that the electrical contact elements 120 are generally rectangular and are arranged in two rows 125. Each of the elements 120 has a flat contact surface 120.1 (see Figure 15). The contact surfaces 120.1 of all the electrical contactor elements 120 are in the same plane. In one embodiment, each electrical contact element 120 has lateral dimensions of 125 and 500 microns and a height of 30 microns. In this embodiment, the electrical contact elements 120 are spaced on a pitch of 100 microns. The electrical contactor elements 120 are typically formed of gold which provides a fairly robust connection with the conductor bumps 118.1 and 118.2. The electrical connection between the flexible connector 110 and the electrical contactor 26 has a low profile and in one embodiment is only about 6 millimeters high.

[0048] Figure 15 of the drawings shows a block diagram of a stage in the formation of the electrical connection between the flexible connector 110 and the electrical contact elements 120.

[0049] Basically, in order to form the electrical connection between the flexible connector 110 and the electrical contactor 26, the second end 116 of the flexible electrical connector 110 is clamped onto the electrical contactor 26 using a clamp. The clamp comprises a first clamping member in the form of an elongate bar 122 of a work hardened metal and a second clamping member which is defined by the electrical contactor 26. A coefficient of thermal expansion of the metal bar 122 is matched to a coefficient of thermal expansion of the electrical contactor 26. In one embodiment, the coefficient of thermal expansion of the metal bar 122 is within 0.5 ppm/°C of the coefficient of thermal expansion of the electrical contactor 26.

[0050] The elongate metal bar 122, the flexible connector 110, and the electrical contactor 26 have axially extending holes to receive a fastening bolt 124 therein. A nut 126 mates with threads on the bolt 124 and urges the conductive bumps 118.1 and 118.2 into contact with the electrical contactor elements 120 to a position shown in Figure 16 of the drawings. The clamping force exerted by the fastening bolt 124 causes the conductive bumps 118.1 and 118.2 to bear against the electrical contactor elements 120 which results in an elastic and plastic deformation of the conductive bumps 118.1 and 118.2. This ensures good electrical contact between the conductive bumps 118.1 and 118.2 and the electrical contactor elements 120.

[0051] Because the fastening bolt 124, the metal bar 122 and the conductive bumps 118.1 and 118.2 may have different thermal coefficients, and due to the high temperatures achieved during the burn-in testing, the fastening bolt 124 may lengthen during the burn-in testing. This results in a gap between a head 124.1, of the fastening bolt 124, and the metal bar 122.

[0052] It will be appreciated that such a gap will release the clamping force exerted by the fastening bolt 124 on the flexible connector 110. In order to compensate for the tendency for such a gap to be created, an expander

member 128 of resilient material may be interposed or sandwiched between the elongate metal bar 122 and the flexible connector 110 as can be seen in Figure 16. The expander member 128, which is compressed under the clamping force generated by tightening of the fastening bolt 124 and relaxes or expands if lengthening of the fastening bolt 124 occurs. Thus, the expander member 128 takes up any gap between the head 124.1 and the metal bar 122, thereby to maintain the clamping force of the fastening bolt 124. The expander member is of a material that is able to withstand the elevated temperatures within a burn-in chamber. Further, since a height of the conductive bumps 118.1 and 118.2 may vary, the expander member 128 deforms the flexible substrate 112, differentially to compensate for variations in the height of the conductive bumps 118.1 and 118.2.

[0053] Figure 12A shows another embodiment 110A of a flexible connector. The flexible connector 110A is similar to the flexible connector 110, except that each end thereof has conductive bumps similar to the bumps 118.1 and 118.2. One end of the flexible connection 110A is clamped to the electrical contactor 26 as described above and an opposite end of the flexible connector 110A is clamped, in a similar fashion, to a connector 121 which carries electrical signals to and from the external interface 164.

[0054] The contactor 26 includes fiducial markings 130 (as can be seen in Figure 17) to facilitate alignment of the conductive bumps 118 with the electrical contactor elements 120 prior to clamping. The fiducial markings 130 are visible through the flexible connector 110. The flexible connector 110 has complementary fiducial markings 132 (as can be seen in Figure 13B) which can then be aligned with the fiducial markings 130 on the contactor 26 to ensure alignment of the conductive bumps 118 with the contactor elements 120.

[0055] Figure 18 of the drawings illustrates the components of test probe assembly 150 in accordance with one embodiment of the invention. The test probe assembly 150 includes a probe plate 152 and a chuck plate 154 which together define a space therebetween for receiving a contactor assembly such as the contactor assembly 40 shown in Figure 2 of the drawings.

[0056] The chuck plate 154 has a pedestal 156 which provides support for the wafer 32. The probe plate 152 includes a piston 158 which is displaceable in a cylinder 160 by a hydraulic fluid which, in use, is introduced into the cylinder 160 through a hose 162 which is releasably connectable to the cylinder 160. The piston 158 is connected to an electrical contactor 26 of the contactor assembly 40.

[0057] In use, air is introduced into the chamber 160 through hose 162 to urge the piston 158 to move in a z direction, thereby to displace the contactor assembly 40 towards the chuck plate 154 until the mechanical alignment stops 22 on the side 14 of the interposer 10 make contact with the side 34 of the wafer 32. A resiliently deformable member in form of an O-ring 163 positioned between the ring 42 and the chuck plate 154 serves to limit or control how much displacement of the contactor assembly 40 is produced by movement of the piston 158. Thus, movement of the piston 158 does not require precise control. Further, the O-ring 163 provides a seal between the ring 42 and the chuck plate 154. The O-ring 163 allows for variations in which the faces 46 of the ring 42 may not be on the same z-plane by cushioning the ring 42 as it is displaced towards the chuck plate 154. In some embodiment, the O-ring 163 may be replaced by springs which provide a reaction against movement of the piston 158. Once the mechanical stops 22 of the side 14 of the interposer 10 contact the side 34 of the wafer 32, the interconnection spring elements are compressed thereby to achieve good electrical contact between the interconnection spring elements 20 of the interposer 10 and the electrical terminals 36 of the wafer 32. Thereafter, the hose 162 is removed. The probe assembly 152 also includes a securing mechanism to releasably secure or fasten the chuck plate 154 to the probe plate 152. The securing mechanism has not been shown in Figure 12, but includes any suitably clamping arrangement such as the kinematic couplings of U.S. Patent No. 6,340,895 which is hereby incorporated by reference. The test probe assembly 150 is then inserted into a test burn-in chamber wherein the electrical connection pins 166 are received in complementary electrical sockets.

[0058] Although the present invention has been described with reference to specific exemplary embodiments, it will be evident that the various modification and changes can be made to these embodiments without departing from the broader spirit of the invention as set forth in the claims. Accordingly, the specification and drawings are to be regarded in an illustrative sense rather than in a restrictive sense.

CLAIMS**What is claimed is:**

1. An assembly for electrically connecting a test component to a testing machine for testing electrical circuits on the test component, the assembly comprising:
 - a contactor assembly including a plurality of first conductors; a plurality of first terminals each connected to a respective one of the first conductors; a plurality of resilient interconnection elements each connected to a respective one of the first conductors and have ends to electrically contact the test component; and a support component to support the contact assembly;
 - an external interface component on the support component and comprising electrical connectors to make electrical connections with the testing machine;
 - a flexible substrate;
 - flexible second conductors on the flexible substrate and electrically connected to the external interface component;
 - a plurality of second terminals on the flexible substrate electrically connected to the flexible second conductors;
 - a plurality of conductive bumps disposed between the first and second terminals; and
 - a clamp comprising first and second clamping members to urge the first and second terminals towards each other and to deform the conductive bumps.
2. The assembly of claim 1, wherein the first terminals each comprise a terminal body which has a flat contact.
3. The assembly of claim 2, wherein the first clamping member comprises an elongate bar spanning more than one conductive bump.
4. The assembly of claim 3, wherein the metal bar is a work-hardened metal of hardened steel.
5. The assembly of claim 3, wherein the second clamping member comprises a fastening bolt to urge the metal bar towards the contact surfaces of each terminal body.

6. The assembly of claim 5, further comprising an expander member in the clamp wherein the expander material is of a resilient material and is under compression and decompresses in a direction parallel to the fastening bolt to compensate for loss of clamping force caused by lengthening of the fastening bolt.
7. The assembly of claim 1, wherein the conductive bumps are of gold.
8. The assembly of claim 1, wherein the conductive bumps have a height of 60 micrometers and a width of 100 micrometers.
9. The assembly of claim 8, wherein the expander member comprises silicon rubber.
10. The assembly of claim 4, wherein the contactor assembly comprises an interposer, an electrical contactor, and a retaining component to retain the interposer in electrical contact with the electrical contactor, wherein the plurality of the first conductors and first terminals are located on the electrical contactor, the plurality of interconnection spring elements are located the interposer, and wherein the electrical contactor and the flexible substrate include fiducial markings thereon to facilitate alignment of the first and second terminals.
11. The assembly of claim 10, wherein a coefficient of thermal expansion of the metal bar is matched to within 0.5 ppm/°C of the coefficient of thermal expansion of the contactor substrate.
12. The assembly of claim 10, wherein the electrical contactor and the interposer have complementary fiducial markings to facilitate alignment of the resilient interconnection elements with electrical contact elements on the electrical contactor.

13. The assembly of claim 1, wherein the resilient interconnection elements comprise springs.

14. A test assembly for electrically connecting a test component to a testing machine for testing electrical circuits on the test component, the test assembly comprising:

a contactor assembly comprising first electrical conductors, a plurality of first terminals connected to first ends of the first electrical conductors, a plurality of second terminals connected to second ends of the first electrical conductors, and resilient interconnection elements to electrically interconnect the first terminals to the test component;

a probe assembly comprising a plate component supporting the contactor assembly, and an interface component on the plate component comprising a plurality of external electrical connectors for electrically connecting to the testing machine; a flexible substrate having a first end which is connected to the interface component and a second end opposite the first end, flexible conductors on the flexible substrate, the flexible conductors having a first part which is connected to the interface component and a terminal part at the second end of the flexible substrate, the terminal part comprising a plurality of third terminals which are aligned with the second terminals;

a plurality of electrical contactor bumps between the second and third terminals; and

a clamping mechanism comprising a first clamping member and a second clamping member, the clamping members being urged together to exert a clamping force that moves the second and third terminals together so that the contactor bumps are deformed therebetween.

15. The test assembly of claim 14, wherein the resilient interconnection elements comprise springs.

16. The test assembly of claim 14, wherein the first clamping member comprises a metal bar and the second clamping member comprises a contact surface of each second terminal, the clamping mechanism further comprising a

fastening bolt and a complementary nut to urge the metal bar towards the third terminals.

17. The test assembly of claim 15, wherein the clamping mechanism further comprises an expander member located between a head of the fastening bolt and the nut, the expander member being of a resilient material which is under compression and which expands along an axis of the fastening bolt to compensate for loss of clamping force due to elongation of the fastening bolt.

18. The test assembly of claim 17, wherein the contactor assembly includes an electrical contactor on which is located the plurality of first electrical conductors, the plurality of first terminals and the plurality of second terminals, the electrical contactor and the flexible substrate having complementary fiducial markings to facilitate alignment of the second and third terminals.

19. The test assembly of claim 18, wherein the conductive bumps are bonded to the third terminals.

20. A unit for interfacing a test component with a testing machine for testing electrical circuits on the test component, the unit comprising:

- a support component to support a contactor assembly to make electrical contact with the test component;

- an external interface component on the support component comprising a plurality of electrical connectors for electrical connection to the testing machine;

- a flexible substrate having a first end which is electrically connected to the interface component and a second end opposite the first end;

- flexible conductors on the flexible substrate, the flexible conductors having a first part which is electrically connected to the interface component and a terminal part at the second end of the flexible substrate, the terminal part comprising a plurality of terminals, and a plurality of conductive bumps, each of which is connected to a respective one of the terminals, wherein the terminal part is connectable to the contactor assembly and carries electrical signals between the contactor assembly and the testing machine.

21. The unit of claim 20, wherein two conductive bumps are connected to each terminal by wire bonding.
22. The unit of claim 21, wherein the conductive bumps are of gold.
23. The unit of claim 22, wherein the conductive bumps have a width of 100 micrometers and a height of 60 micrometers.
24. A contactor assembly for electrically connecting an electrical test component to a testing machine for testing the test component, the contactor assembly comprising:
- a test structure;
 - a plurality of electrical terminals on the test structure;
 - a plurality of resilient interconnection elements, each having a first end connected to an electrical terminal and a free end opposite the first end to electrically contact the test component;
 - a plurality of electrical contact elements on the test structure distant from the electrical terminals; and
 - an electrical path bridging each electrical terminal with an respective one of the electrical contact elements, wherein each electrical contact element has a body which defines a flat surface to provide support to matching contactor elements when the matching contactor elements are deformed under a clamping force.
25. The contactor assembly of claim 14, wherein the resilient interconnection elements comprise springs.
26. The contactor assembly of claim 24, wherein the test structure comprises a plurality of apertures formed therein to cooperate with clamping members to clamp the matching contactor elements.

27. The contactor assembly of claim 26, wherein the test structure further comprises fiducial markings to facilitate alignment of the electrical contact elements with the matching contactor elements.

28. A contactor assembly for use in testing electrical circuits, the contactor assembly comprising:

an electrical contactor including a contactor substrate and a plurality of electrical terminals on the contactor substrate;

an interposer including an interposer substrate having first and second sides, a plurality of first and second resilient interconnection elements extending respectively from the first and second sides of the interposer substrate, wherein the interposer is positioned in a predetermined position relative to the electrical contactor in which predetermined position each first resilient interconnection element makes electrical contact with an electrical terminal of the electrical contactor, the interposer substrate having been moved relatively towards the contactor substrate to resiliently deform the first resilient interconnection elements; and

a retaining component having a first portion secured to the electrical contactor and a second portion in contact with the interposer to retain the interposer in the predetermined position relative to the electrical contactor.

29. The contactor assembly of claim 28, wherein the retaining component comprises a ring having an annular recess within which the interposer is seated, and a flange-like face secured to the electrical contactor.

30. The contactor assembly of claim 28, wherein the first and second resilient interconnection elements comprise springs.

31. The interposer assembly of claim 28, wherein the predetermined position corresponds to a position in which fiducial markings on each of the contactor substrate and interposer substrate are aligned.

32. A test probe assembly for testing electrical circuits, the test probe assembly comprising:

a frame structure having a first member;

a contactor assembly secured on the first member the contactor assembly comprising:

an electrical contactor including a contactor substrate, and a plurality electrical terminals on the contactor substrate;

an interposer including an electrically conductive interposer substrate having first and second sides, a plurality of first and second resilient interconnection elements extending respectively from the first and second sides of the interposer substrate, wherein the interposer is positioned in a predetermined position relative to the electrical contactor, in which predetermined position each first resilient interconnection element makes electrical contact with an electrical terminal of the electrical contactor, and wherein the second resilient interconnection elements make electrical contact with a substrate on which an electrical circuit to be tested is formed;

a retaining component having a first portion secured to the electrical contactor and a second portion secured to the interposer to retain the interposer in the predetermined position relative to the electrical contactor.;

33. The test probe assembly of claim 32, wherein the frame structure further comprises a second member, the first and second members defining a space therebetween when in a closed position.

34. The test probe assembly of claim 33 further comprising a wafer holder secured to the second member to hold a wafer, the first and second members being moveable relative to each other to resiliently deform the second resilient interconnection elements to bring them into contact with electrical terminals on the wafer.

35. The test probe assembly of claim 32, wherein at least one of the contactor substrate and the interposer substrate comprises stops to limit a spacing between the contactor substrate and the interposer substrate.

36. The test probe assembly of claim 32, wherein the interposer substrate comprises stops to limit spacing the interposer substrate and the wafer.

37. The contactor assembly of claim 32, wherein the first and second resilient interconnection elements comprise springs.

38. The test probe assembly of claim 32, wherein the retaining component comprises a ring having an annular recess within which the interposer is seated and a flange-like face secured to the electrical contactor.

39. The test probe assembly of claim 32, wherein the predetermined position corresponds to a position in which fiducial markings on each of the contactor substrate and interposer substrate are aligned.

40. An alignment machine for aligning an electrical contactor with an interposer, the alignment machine comprising:
a frame positionable over an electrical contactor;
a carriage mounted to the frame for displacement in an x-y plane and in a z direction normal to the x-y plane;
a displacement mechanism on the frame and operable to displace the carriage in the x-y plane and in the z direction;
a mounting arrangement on the carriage for mounting the interposer to the carriage.

41. The alignment machine of claim 40, further comprising an alignment mechanism mounted to the frame to indicate when the interposer is spatially aligned with the electrical contactor.

42. The alignment machine of claim 41, wherein the alignment mechanism comprises a magnification system to magnify fiducial markings on the electrical contactor and on the interposer respectively.

43. The alignment machine of claim 42, wherein the displacement mechanism comprises a plurality micrometers to displace the carriage in the x-y plane to align the fiducial markings.

44. The alignment machine of claim 43, wherein the displacement mechanism comprises a micrometer to displace the carriage in the z direction to bring the interposer into contact with the electrical contactor.

45. The alignment machine of claim 40, wherein the mounting arrangement comprises a releasable securing mechanism to secure a workpiece to the carriage, wherein the workpiece is shaped and dimensioned to hold the interposer.

46. The alignment machine of claim 45, wherein the mounting arrangement is shaped and dimensioned to allow a vacuum plate to be attached to the workpiece to create a suction force to hold the interposer in the workpiece.

47. A method of assembling a test contactor, the method comprising:
aligning an interposer and an electrical contactor wherein resilient interconnection elements of the interposer are resiliently deformed to make electrical contact with corresponding electrical terminals on the electrical contactor; and
securing the aligned interposer and electrical contactor together.

48. The method of claim 47, wherein aligning the interposer comprises first aligning the interposer in an x-y plane over the electrical contactor in a first position in which each resilient interconnection element of the interposer is aligned with its corresponding electrical terminal on the electrical contactor; and then displacing the interposer in a z direction to a second position in which each resilient interconnection element of the interposer makes contact with a corresponding electrical terminal on the electrical contactor.

49. The method of claim 48, wherein aligning the interposer further comprises displacing the interposer in a z direction to a third position wherein each resilient interconnection element of the interposer is under compression.

50. The method of claim 49, wherein the interposer is in the third position when stops on the interposer make contact with the electrical connector.

51. The method of claim 48, wherein aligning the interposer in the x-y plane comprises displacing the interposer in an x, y, or a Θ direction.

52. The method of claim 48, wherein aligning the interposer in the x-y plane comprises aligning fiducial markings on the interposer and electrical contactor respectively.

53. A method of assembling a test contactor for testing integrated circuits, the method comprising:

seating an interposer in a mount therefor;

coupling the mount to an alignment machine;

adjusting settings on the alignment machine to displace the mount relative to an electrical contactor to an aligned position wherein resilient interconnection elements of the interposer are resiliently deformed to make electrical contact with a corresponding electrical terminal on the electrical contactor; and

securing the mount to the electrical contactor in the aligned position.

54. The method of claim 53, wherein seating the interposer in the mount comprises retaining the interposer in a seat in the mount using a suction force.

55. The method of claim 53, wherein the mount comprises a ring having an annular recess which defines the seat.

56. The method of claim 53, wherein adjusting the settings comprises adjusting a displacement mechanism of the alignment machine to move the mount in an x-y plane to align fiducial markings on the interposer and the electrical contactor respectively.

57. The method of claim 56, wherein adjusting the settings further comprises adjusting the displacement mechanism to move the mount in a z direction to bring the interposer in the aligned position.

58. The method of claim 57, wherein displacement in the z direction is limited by stops between the interposer and the electrical contactor which bear against the electrical contactor when the interposer and the electrical contactor are in the aligned position.

59. The method of claim 55, further comprising mounting a vacuum plate to one face of the ring and creating a negative pressure zone between the interposer and the seat.

60. The method of claim 59, further comprising removing the vacuum plate after securing the ring to the electrical contactor.

61. A method of assembling a test contactor, the method comprising:
aligning an interposer and an electrical contactor wherein first resilient interconnection elements of the interposer are resiliently deformed to make electrical contact with corresponding electrical terminals on the electrical contactor;

securing the aligned interposer and electrical contactor together to form a sub-assembly; and

moving the sub-assembly towards a test substrate to bring second resilient interconnection elements on the interposer into electrical contact with the test substrate; and

connecting the electrical contactor to a test probe circuit.

62. A method of assembly a test contactor, the method comprising:
- positioning an interposer in an x-y plane over an electrical contactor in a first position in which fiducial markings on the interposer and the contactor, respectively, are aligned;
 - displacing the interposer in a z direction to a second position in which a respective one of a plurality of resilient interconnection elements of the interposer makes electrical contact with a respective one of a plurality of electrical terminals on the electrical contactor; and
 - displacing the interposer in a z direction to a third position wherein each resilient interconnection element of the interposer is under compression.

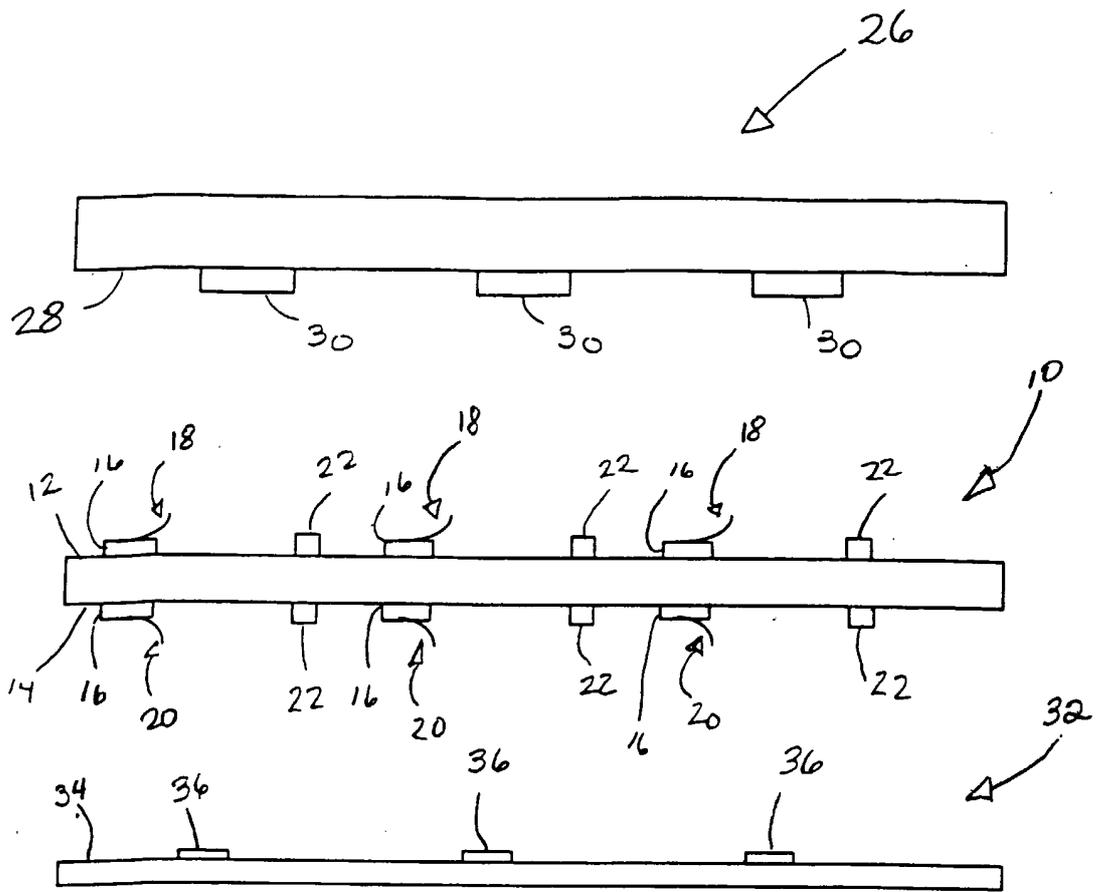
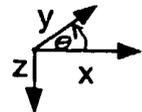


FIGURE 1



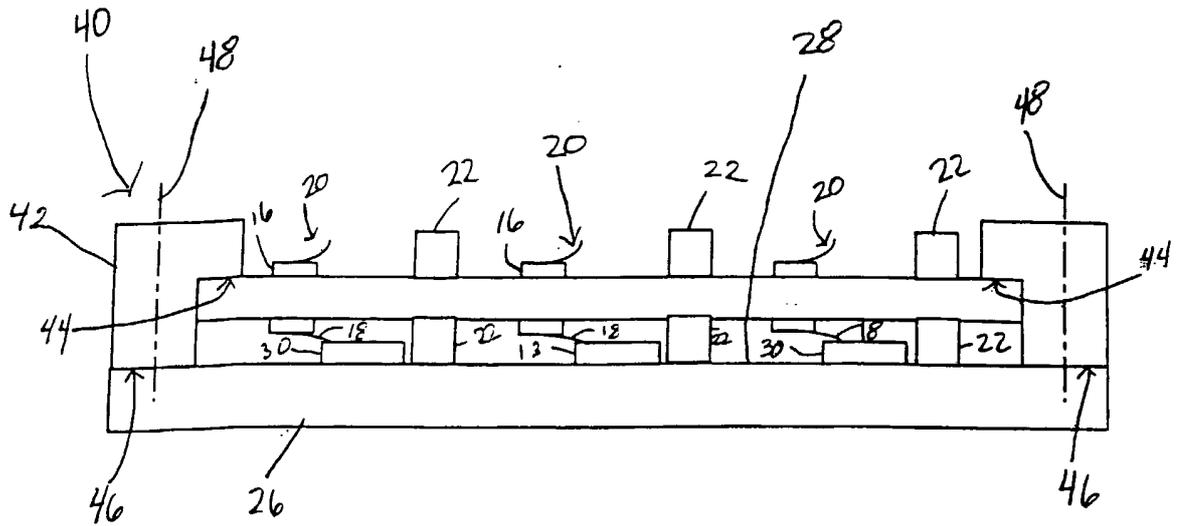
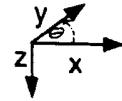


FIGURE 2



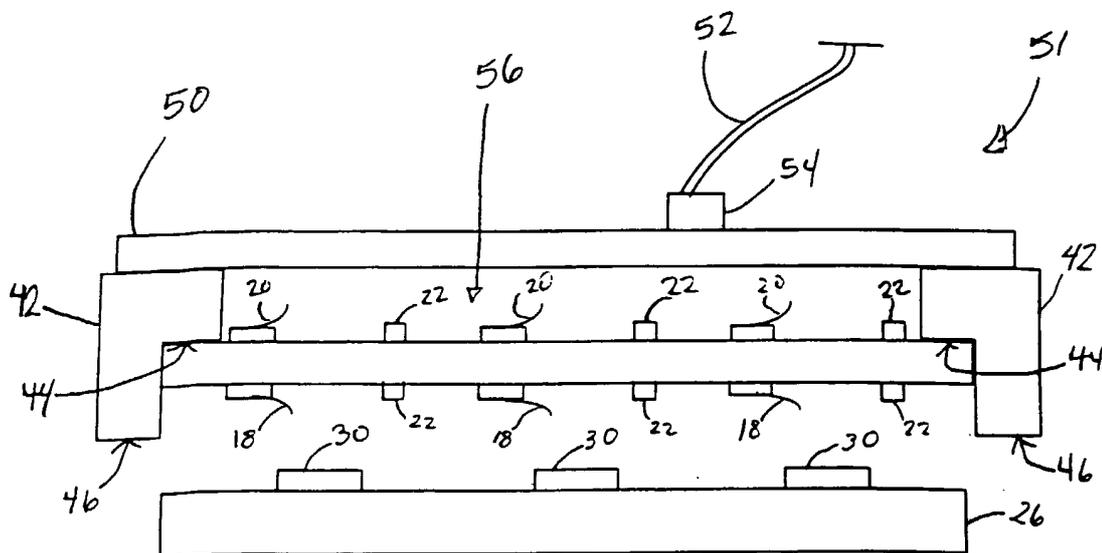
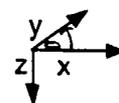
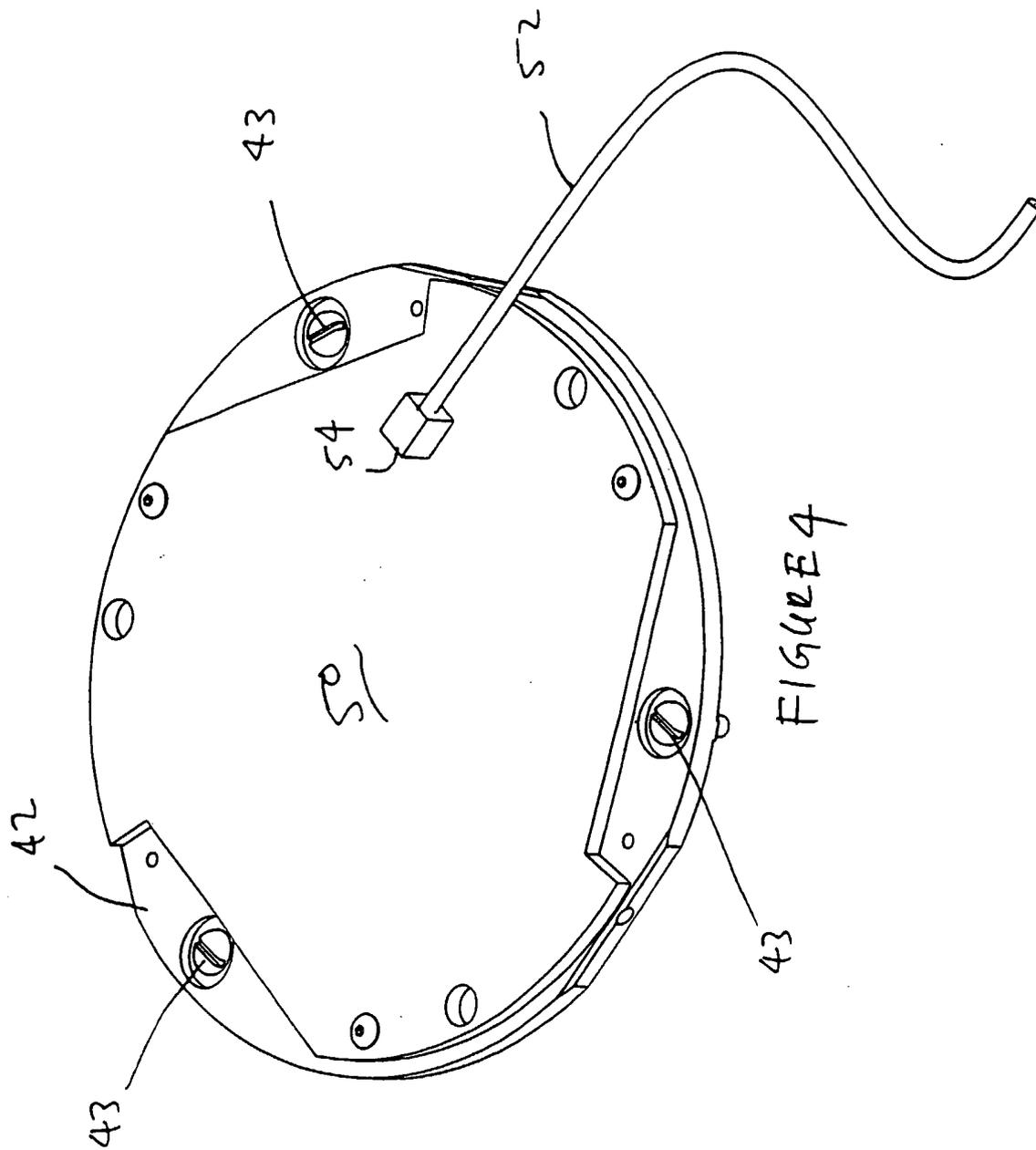


FIGURE 3





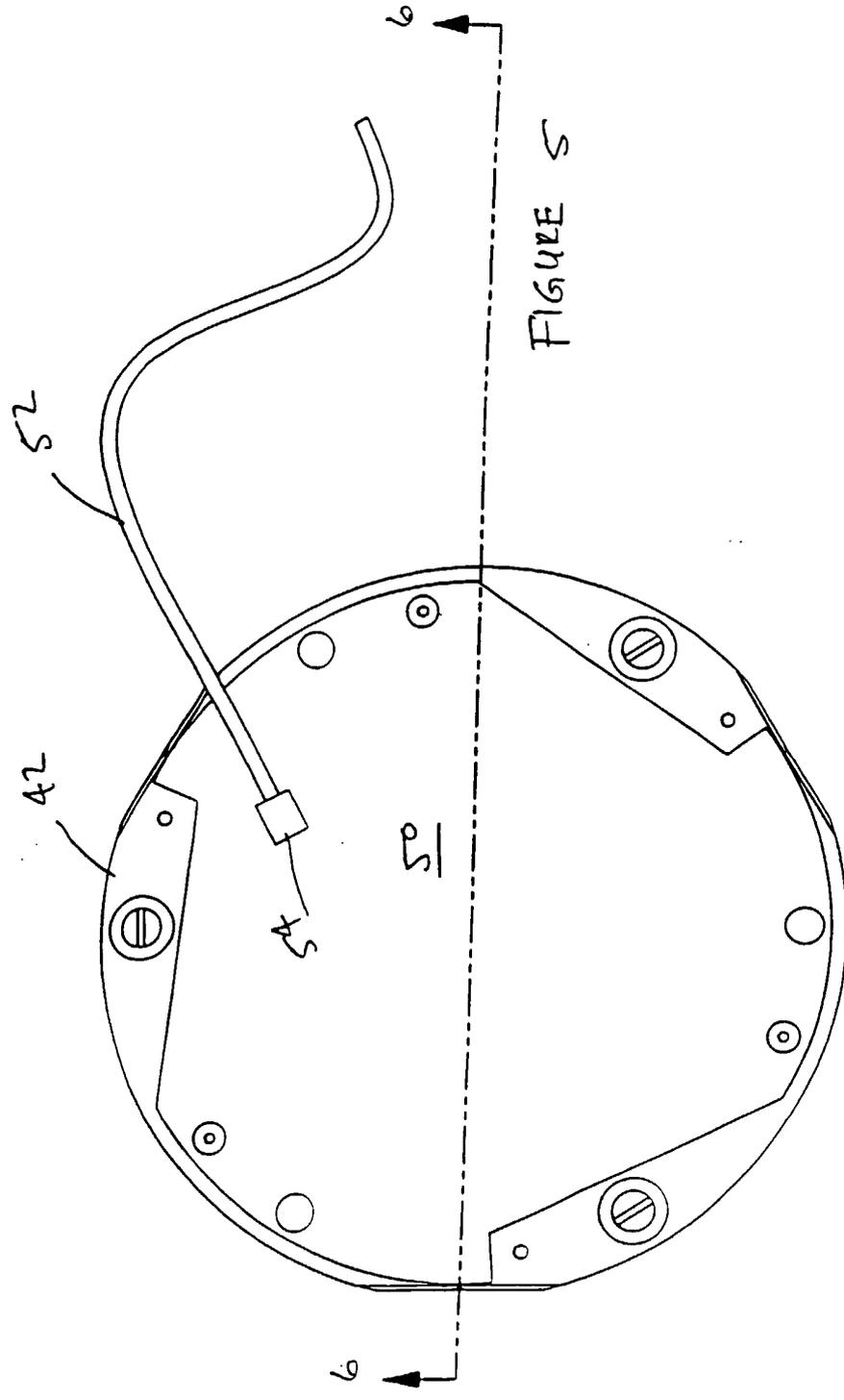


FIGURE 5

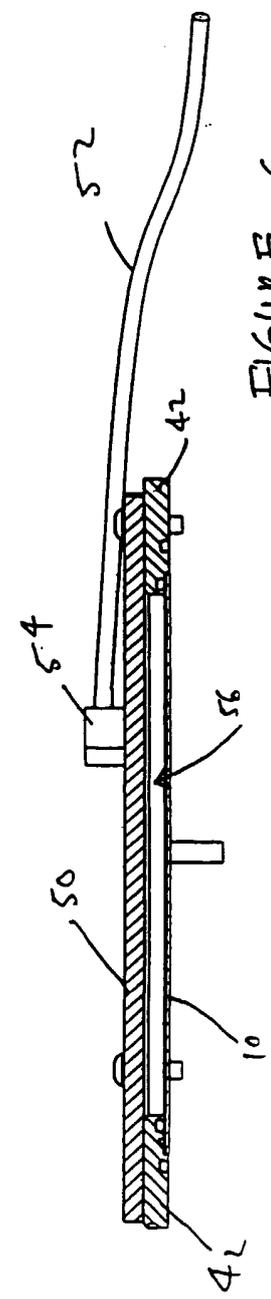


FIGURE 6

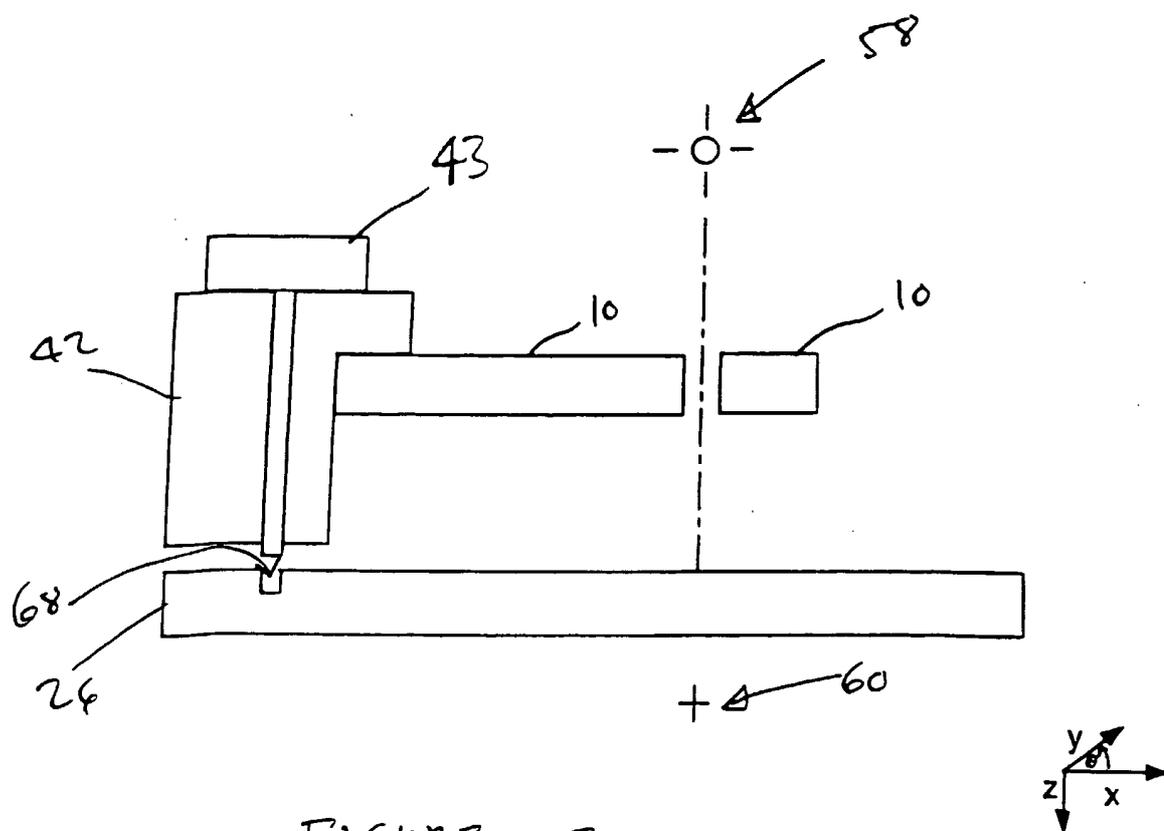
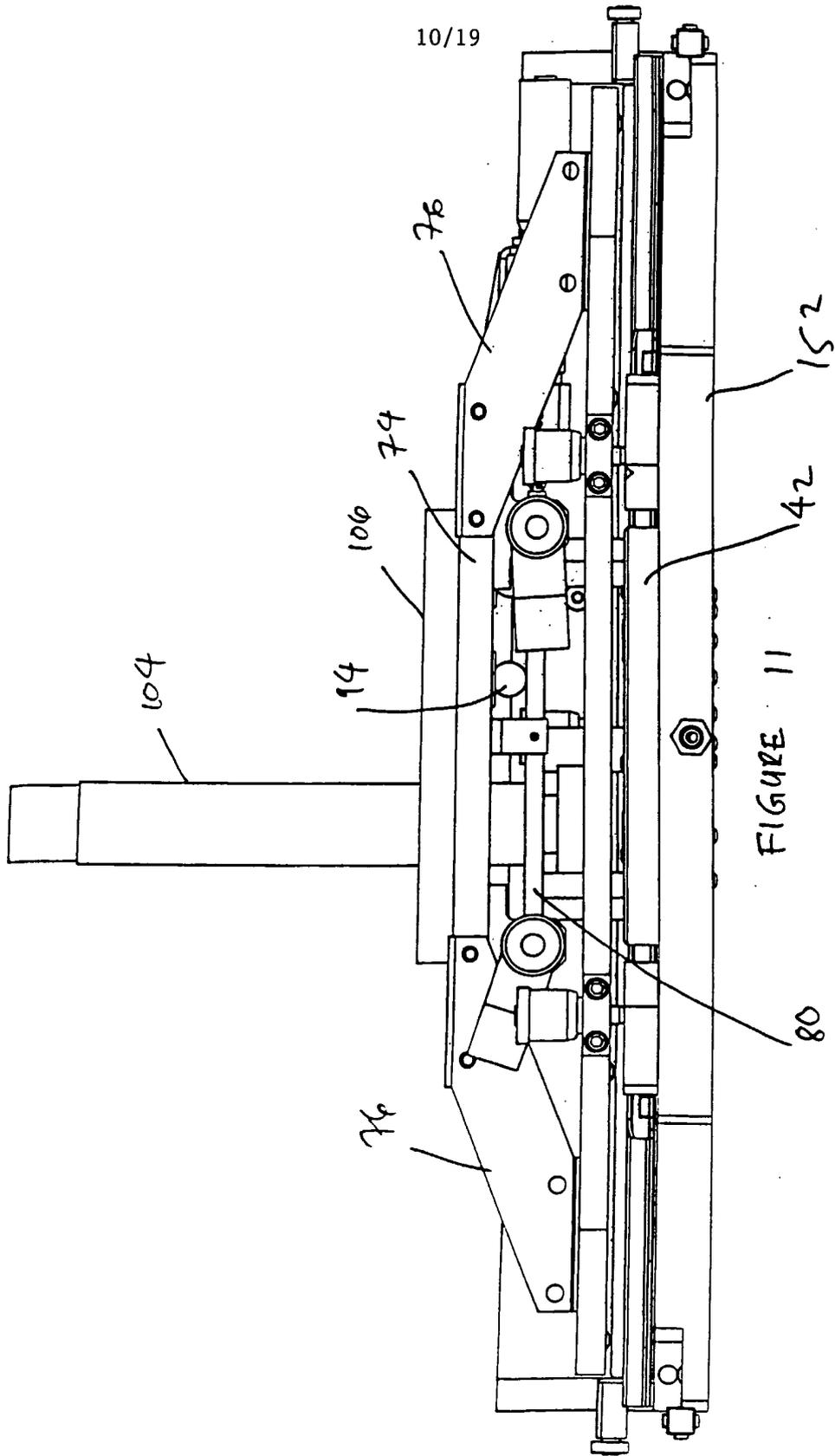


FIGURE 7



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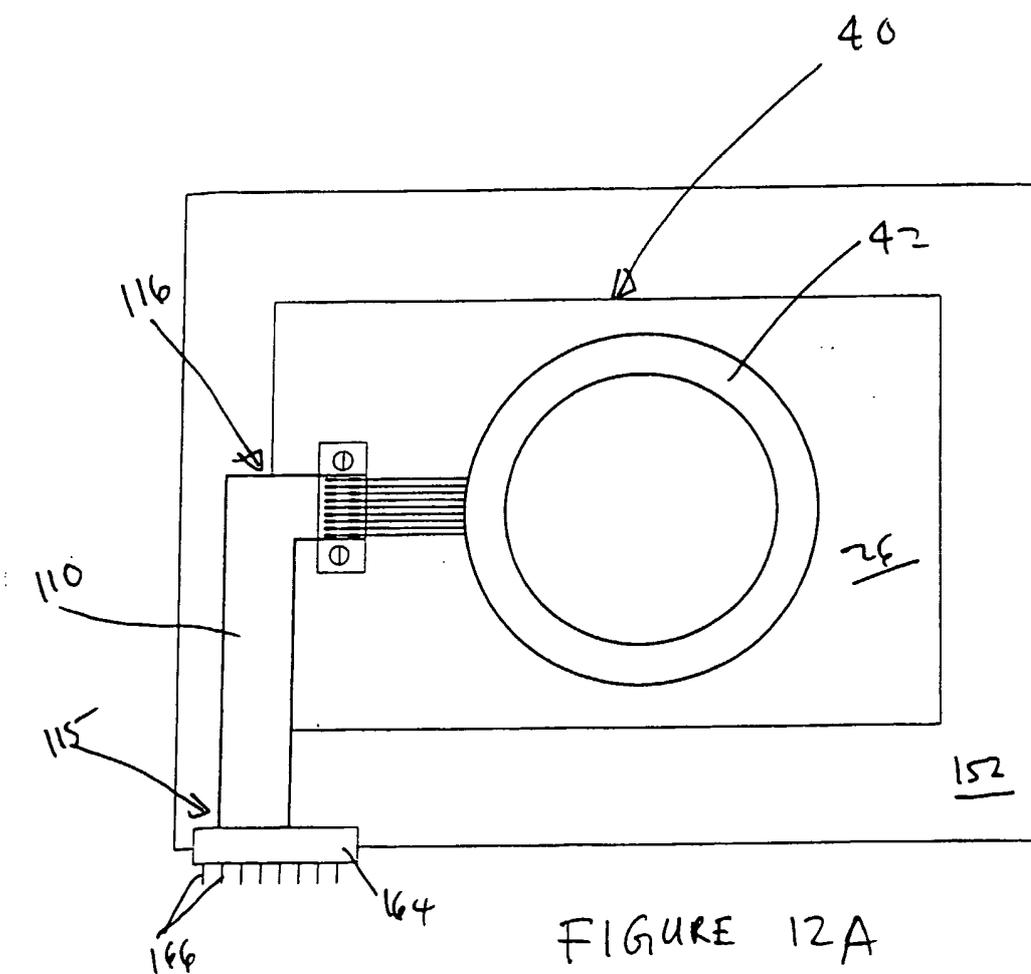


FIGURE 12A

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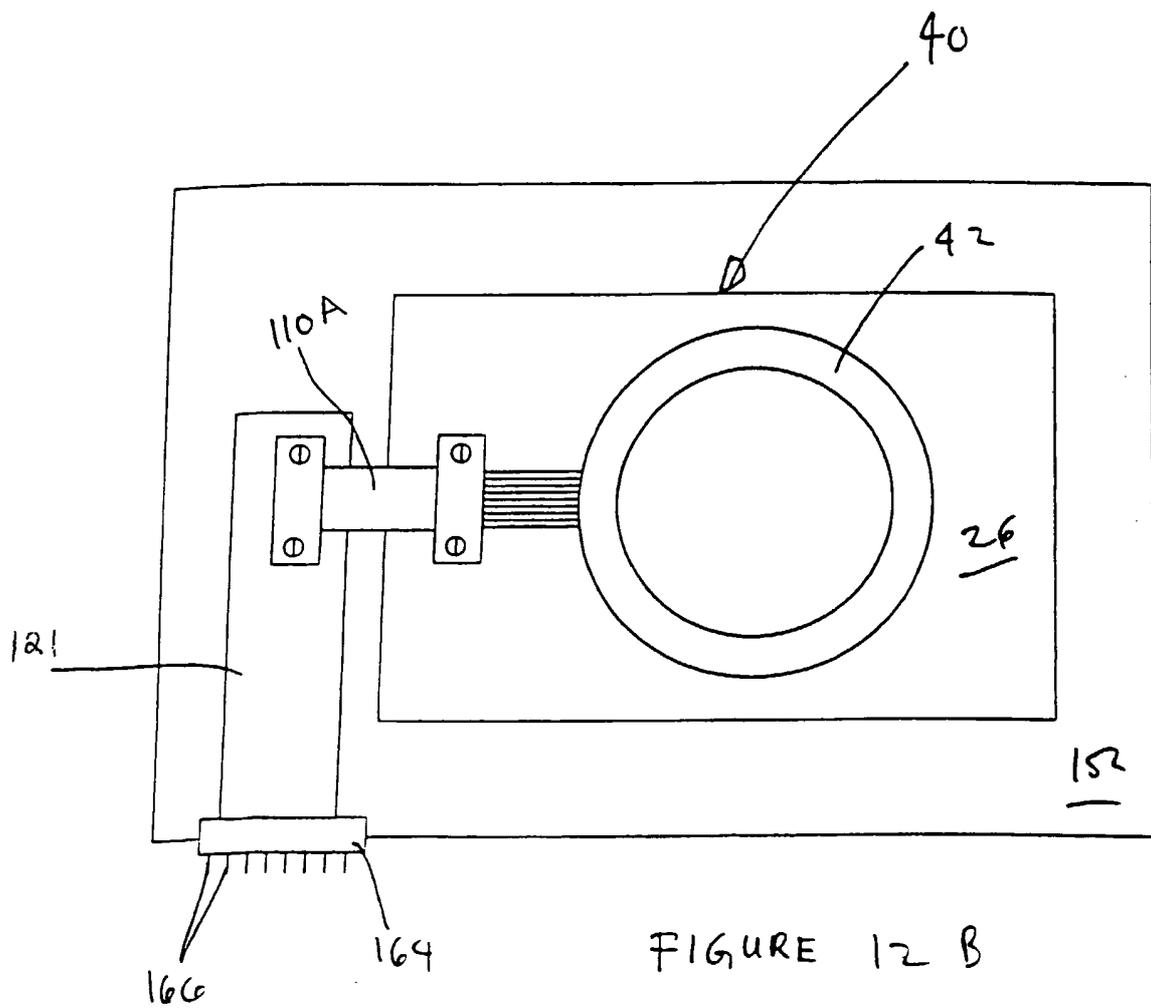


FIGURE 12 B

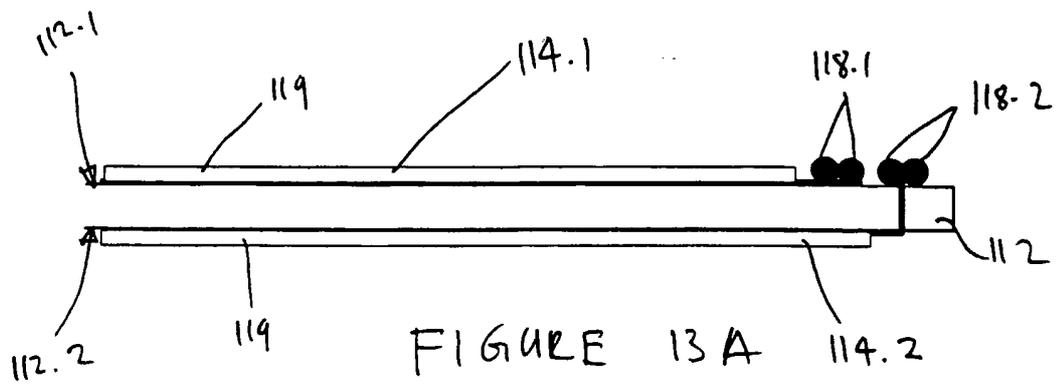


FIGURE 13A

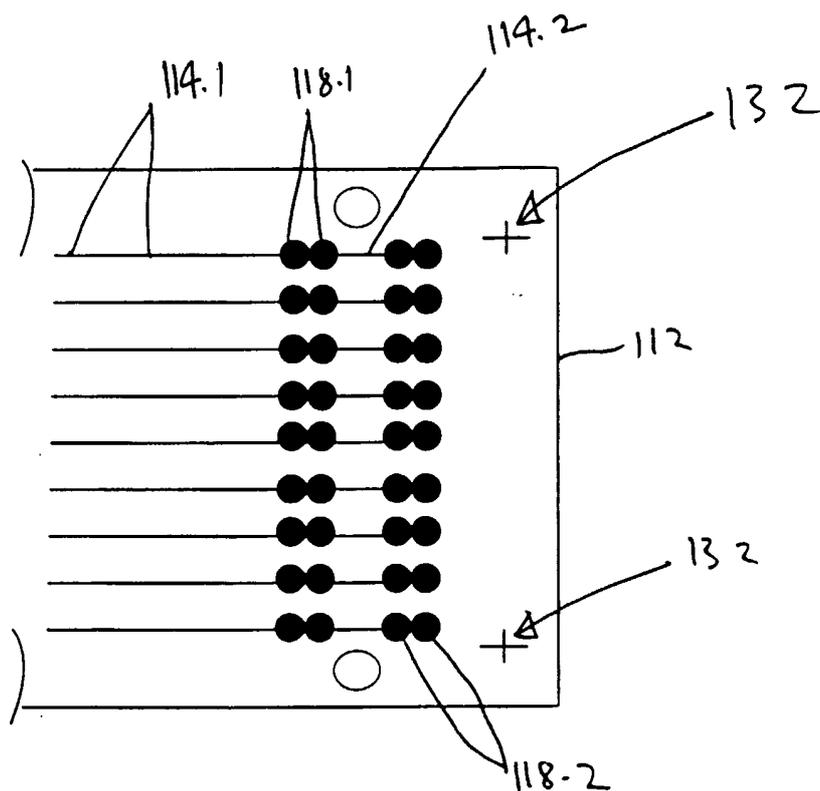


FIGURE 13B

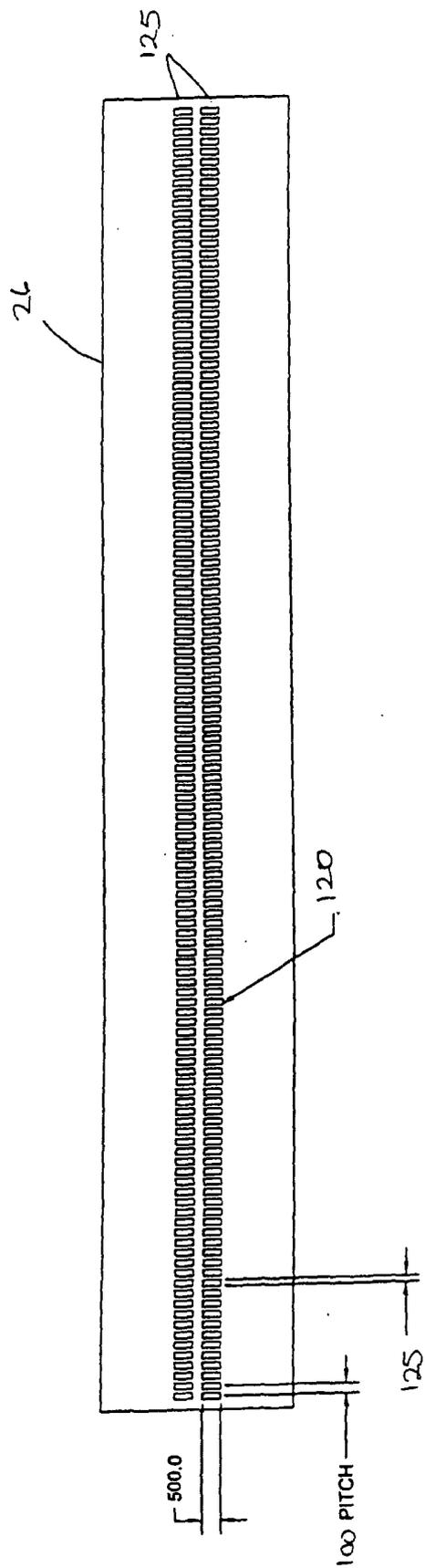


FIGURE 14

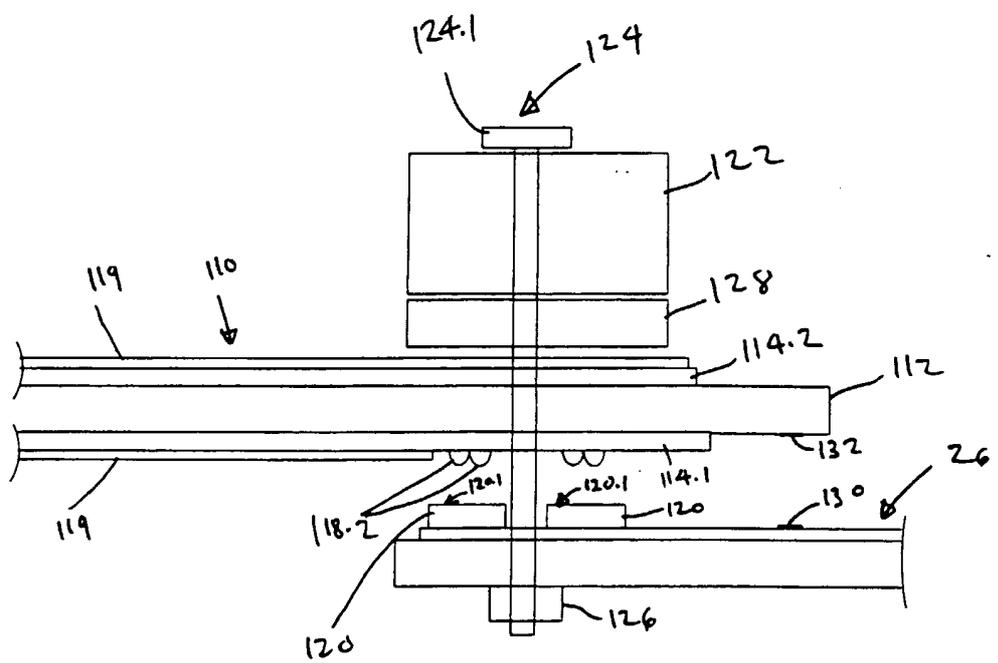


FIGURE 15

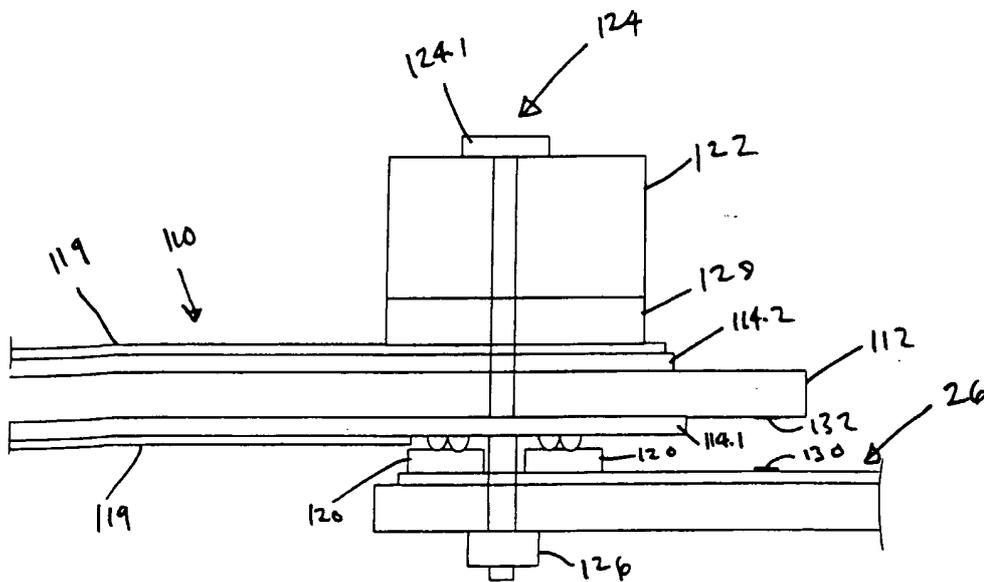


FIGURE 16

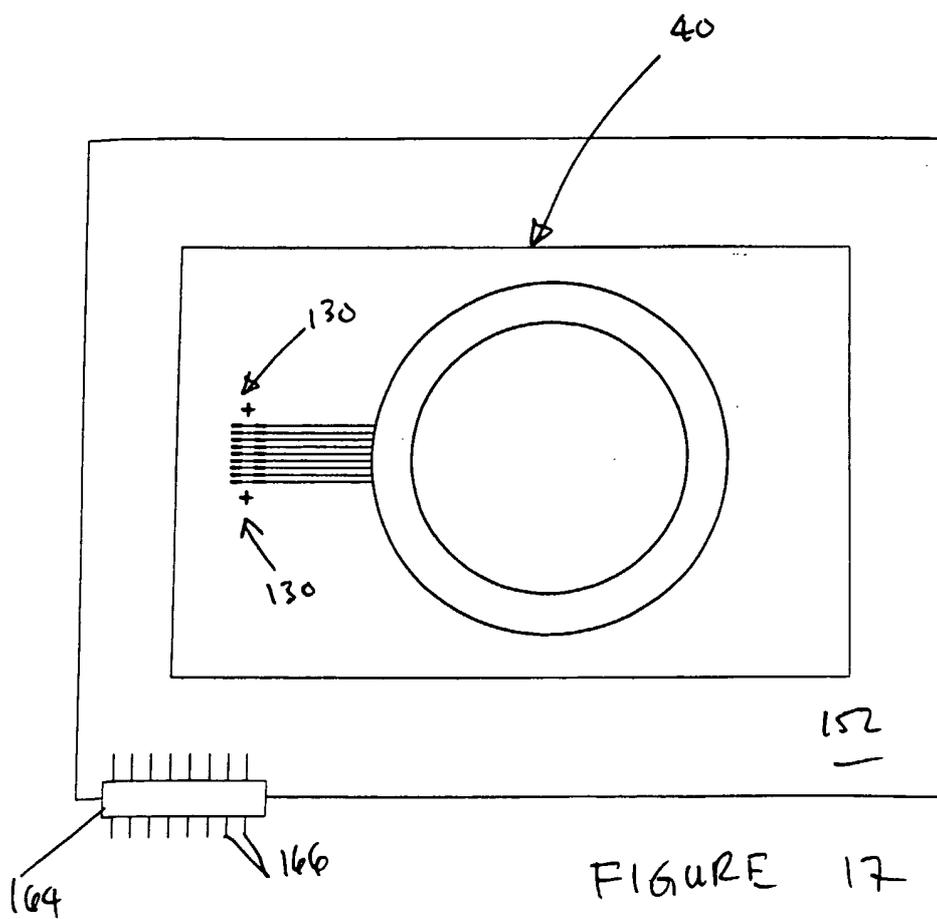


FIGURE 17

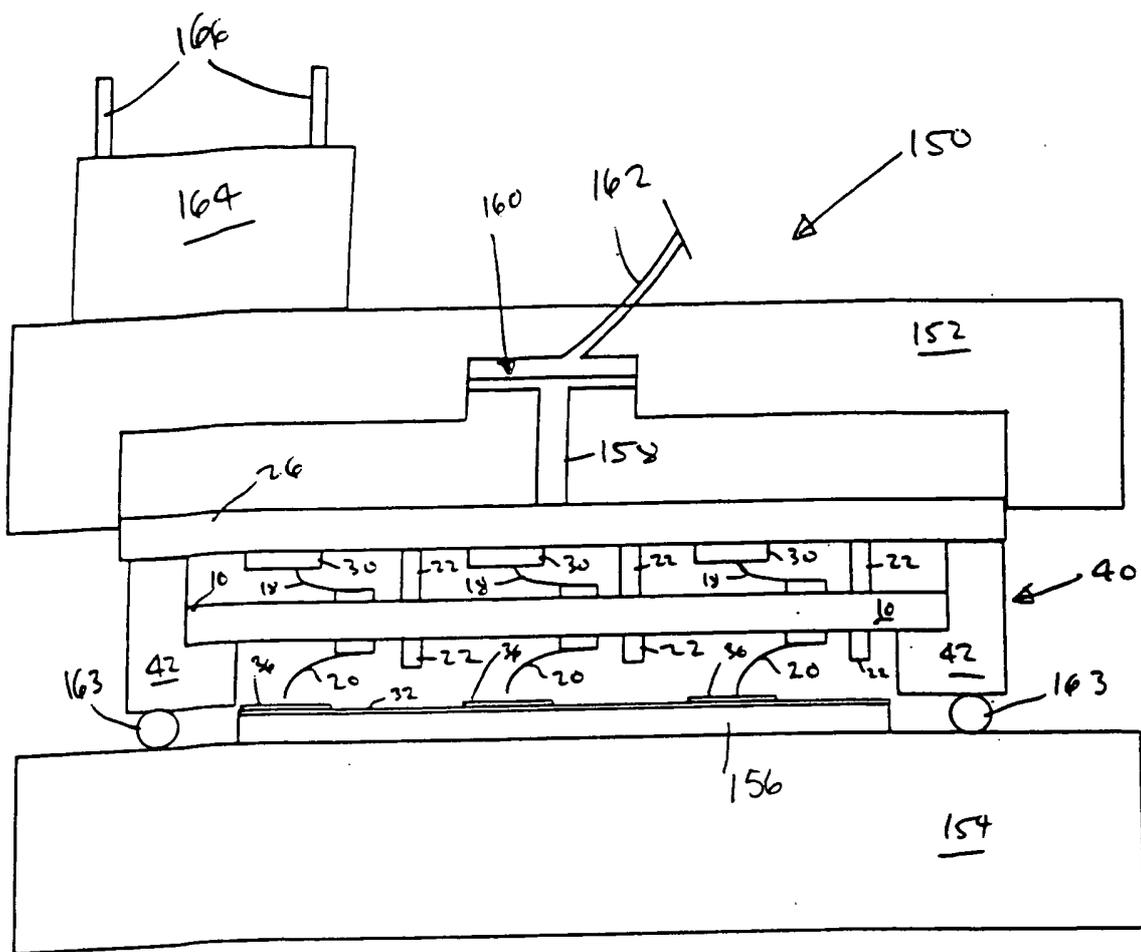


FIGURE 18

