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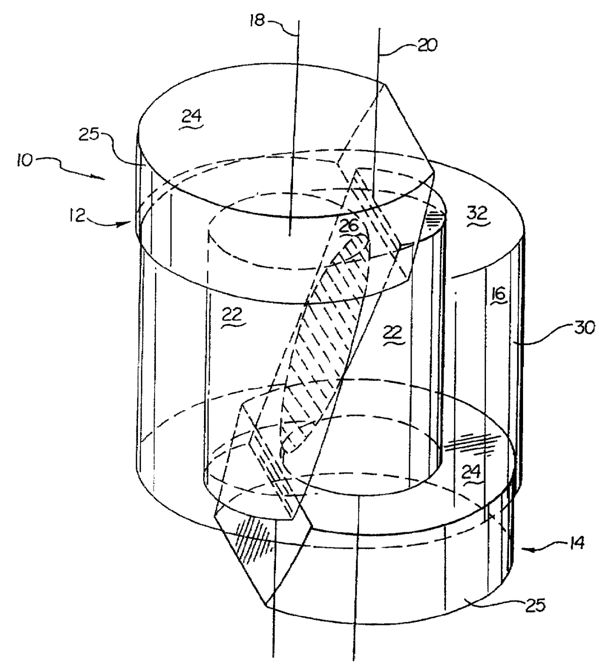
(54) **Interconnect contact**

(57) An interconnect contact device having cooperatively interfacing first and second contact elements and a resilient member enclosing a portion of the elements such that the resilient member biases the first contact element into engagement against, and in a direction relative to, the second contact element so that displacement of the first contact relative to the second contact element occurs so as to accomplish a wiping action at a cooperative interface therebetween. The device thereby provides for an integrated circuit connected thereto: compliance in the z-axis, horizontal translation, a large contact surface, and a compact size.

Fig. 1



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Description

TECHNICAL FIELD

[0001] The present invention deals broadly with the field of electrical interconnect systems, and relates generally to technology, for example, for interconnecting a lead of an integrated circuit device with a corresponding terminal on a printed circuit board interfacing with a test apparatus intended to effect test analysis of the integrated circuit device.

BACKGROUND OF INVENTION

[0002] A plethora of applications exist for effecting electrical contact between two conductors. One significant application is effecting interconnection between leads of an integrated circuit device and conductive pads or terminals on a printed circuit (PC) board which serves to effect an interface between the integrated circuit (IC) device and a test apparatus. Such apparatus are used to evaluate performance of integrated circuit devices.

[0003] Numerous considerations bear upon the structure employed to interconnect the IC and the PC board. These factors include both electrical and mechanical considerations. For typical interconnection systems, special attention must be given to electrical performance, including self inductance and capacitance, the life span requirements, issues of repairability or replacability, the operation temperature environment, coplanarity of the device terminals, mechanical manufacturing limitations, and device alignment, including terminal orientation relative to the interconnection system.

[0004] In a typical semi-conductor production facility, each IC is tested using a test apparatus. The test apparatus may be connected to an interconnection system wherein the leads of an IC are connected to a PC board within the interconnection system. The PC board may then be controlled by the test apparatus for testing the IC.

[0005] The test apparatus may test the functionality and performance of an IC through the interconnection system. Due to manufacturing process variations, some of the IC's may perform at a higher level than other IC's. Therefore, the test apparatus may be used to sort the devices according to their performance characteristics. This is termed "speed grading". Typically, the higher performance IC's will receive a premium price in the market place. It can readily be seen that it is important that the interconnection system not distort the performance characteristics of the IC under test. If it does, a substantial amount of revenue may be lost by the IC manufacturer.

[0006] One objective of an interconnection system is to maintain a "non-distorting electrical interconnection" between the test apparatus and the IC as discussed above. To accomplish this, it is a goal of an interconnection system to have low lead inductance/resistance, low lead-to-lead capacitance, low lead-to-ground capacitance, and a high electrical decoupling factor. These characteristics all reduce the "distorting" nature of the electrical interconnection system.

[0007] Another objective of the interconnection system is to maintain a consistent and reliable electrical interconnection over many test cycles. In conventional interconnection systems, the contact resistance of the interconnection system may change after continued use. A cause of this resistance change may be solder buildup on the contacts within the interconnection system. Increased contact resistance can distort the performance of the IC and thus reduce the test yield realized.

[0008] Because of tolerances in the manufacturing process, all of the leads of a semiconductor package may not be coplanar. For similar reasons, contacts of the interconnection system itself may not be fully coplanar. Therefore, when the IC and the interconnection system are brought into engagement, some of the leads of the IC package may not be adequately contacted to corresponding contacts within the interconnection system. It is a goal of the interconnection system to compensate for these non-coplanarities.

[0009] To accomplish this, the interconnection system may comprise interconnection contact elements wherein the IC package leads contact and depress a corresponding contact in the interconnection system until the remaining package leads come into engagement with corresponding contacts. An advantage of this arrangement is that the movable contact elements allow each semiconductor lead to have a force applied thereon which falls within an acceptable range to establish a gas-tight connection, despite any non-coplanarity of the semiconductor package and interconnection system.

[0010] One prior art structure which seeks to accomplish the purpose of the present invention is a pogo-pin configuration. A pogo-pin configuration typically consists of a contact tip, a shaft, a barrel, and a spring. The shaft is enclosed within the barrel and biased by the spring to an upward position. Located at the upper tip of the shaft is the contact tip for contacting the lead of a semiconductor package. The shaft generally makes electrical contact with the barrel, and the lower portion of the barrel is connected to a PC board. As a semiconductor package lead comes into contact with the contact tip, the spring allows the shaft to depress downward into the barrel while still maintaining electrical contact with the barrel. The semiconductor package is forced down on the pogo-pins until all of the semiconductor package leads have an appropriate force thereon.

[0011] Although the pogo-pin configuration solves some of the problems discussed above, the leads are generally long and therefore inject a substantial amount of inductance into the interconnection system. Because of this relatively high level of inductance, the pogo-pin configuration may generally be limited to medium to low speed applications. Additionally, the piercing action utilized by the pogo-pin to make contact with a device (i. e., the action produced by the spring action applied to a small area) can be detrimental to the solderability later in the production process.

[0012] Another prior art structure which seeks to accomplish the purpose of the present invention is known as the Yamaichi contact. This type of contact includes an inverted L-shaped support having a cantilevered contacting portion mounted at the distal end of a generally horizontal leg of the inverted, L-shaped support and extending generally parallel to that leg. The distal end of the contacting portion is upwardly turned so that a point thereof is engageable by a lead of an IC device to be contacted. The support, in turn, is engaged in some manner with or through a pad or terminal portion of a printed circuit board. Problems that have been observed with the Yamaichi contact include solder buildup, difficulty of construction, and high inductance. In addition, the Yamaichi contact relies on the flexure of the contact material which creates an offset between the input/output feature on the IC under test and the circuit board.

[0013] Another type of structure which seeks to accomplish the purpose of the present invention is a fuzz button contact. A fuzz button contact typically consists of a specially designed array of resilient knitted wire mesh which is retained within a housing mounted to a PC board. The lead of a semiconductor package may be received by the housing, wherein the wire mesh forms a connection therewith. The fuzz button contact allows for some degree of compression which helps compensate for the non-coplanarity of the semiconductor package and the interconnection system. Due to the close contact of the wire mesh, a low resistance/inductance connection can be realized between the PC board and a lead of the semiconductor device. Typical problems with the fuzz button contact include the loss of compliance of the wire mesh after continued use. Furthermore, the wires within the wire mesh may become fatigued and eventually break. Finally, the wire mesh may become undesirably deformed, particularly if the fuzz button is over compressed. All of these problems limit the reliability and life expectancy of the fuzz button contact configuration.

[0014] Another prior art structure which seeks to accomplish the purpose of the present invention is a wire contact. A wire contact consists of a wire which is held in place by a housing. A first end of the wire is in contact with a PC board, and a second end of the wire is in contact with a lead of a semiconductor package. As the lead of the semiconductor package is forced down upon the second end of the wire, the center portion of the wire is bent in a lateral direction. The properties of the wire may be selected to provide the desired stiffness and deflection force.

[0015] Yet another prior art structure is a solid post contact (i.e., a conductive block or cylinder). Although electrical performance afforded is superior, such structures typically do not provide z-axis compliance or scrub. This puts the IC at risk for damage or signal decradation.

[0016] It thus remains highly desirable to provide a device that improves upon known methods, techniques and devices by providing: compliance in the z-axis, horizontal translation, large contact surface, and compact size. It is to these dictates and shortcomings of the prior art that the present invention is directed.

SUMMARY OF THE INVENTION

[0017] An interconnect contact device having cooperatively interfacing first and second contact elements and a resilient member disposed relative to the elements such that the resilient member biases the first contact element into engagement against the second contact element for responsive displacement of the first contact relative to the second contact element so as to accomplish a wiping action at the cooperative interface therebetween. The device thereby provides for an integrated circuit connected thereto: compliance in the z-axis, horizontal translation, a large contact surface, and a compact size.

[0018] More specific features and advantages will become apparent with reference to the DETAILED DESCRIPTION OF THE INVENTION, appended claims, and the accompanying drawing figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a front perspective view of the interconnect contact of the subject invention;

FIG. 2 is sectional view of a device test apparatus outfitted with an interconnect contact of the subject invention as used in a ground application, particularly illustrating a device under test in initial, partial engagement with the contact;

FIG. 3 is a sectional view of the interconnect ground contact of the apparatus of FIG. 2, particularly illustrating the relationships between the contact elements while in a "passive" condition; and,

FIG. 4 is a sectional view of the interconnect ground contact of the apparatus of FIG. 2, particularly illustrating the relationships between the contact elements while in an "active" condition.

DETAILED DESCRIPTION OF THE DRAWINGS

[0020] The structure of the present interconnect contact device is generally presented and best seen in FIG. 1, with its relationship to a test apparatus best seen in FIG. 2. The general operation and function of the contact device is best understood from a comparison of FIG. 3, wherein the device is shown in a "passive" state (i.e., no IC load/test), and FIG. 4, wherein the device is shown in an "active" state (i.e., under an IC load/test). Presented hereafter is a discussion of the structure of the contact device as employed for a grounding function, alone and in relation to its environment, followed by a discussion of the general principles of operation, and function of the device.

[0021] Referring to FIG. 1, the interconnect contact device 10, which is shown as being used in grounding application, includes, in its most general sense, cooperatively interfacing first 12 and second 14 contact elements, and an elastomeric member 16 resiliently retaining the first contact element 12 in engagement against the second contact element 14 and biasing the first element 12 relative to the second element 14 to a desired relative disposition so as to accomplish a wiping action at a cooperative interface therebetween. It may be fairly said that the cooperating first 12 and second 14 contact elements of the device 10, as shown in the "passive" condition or state of FIG. 1, somewhat resemble an obliquely bisected (i.e., from the bottom left to top right as shown in FIG. 1) aligned spool or dumbbell whose halves laterally shift (i.e., the ends thereof move out of axial alignment). Preferably, but not necessarily, the contact elements 12 and 14 are structured equivalently, with the device 10 being configured such that one contact element is "inverted" relative to the other, one substantially but not necessarily directly atop and in substantial alignment with the other contact element. This configuration, generally the engagement of the contact elements for responsive displacement of one with respect to the other, is resiliently maintained by the elastomeric member positioned about the interfacing contact elements.

[0022] Each of the contact elements 12 and 14 generally has a negative of surface normal axis (i.e., first axis 18 for the first contact element 12 and second axis 20 for the second contact element 14) and includes joined body 22 and base 24 components that can be cylindrical in shape, as shown, the base 24 being of larger diameter than the body 22 and aligned therewith. The bodies 22 of the contact elements 12 and 14 engage each other to thereby generally form a cooperative interface therebetween, while the bases 24 thereof engage and indirectly conductively join, via the cooperative interface, the contacts to a device for test and a test board. In all cases, the base 24, 25 of each contact element 12 and 14 preferably extends farther from its axis 18 or 20 than the body component 22 , and is preferably integral with the body component 22.

[0023] In addition to body 22 and base 24 components, each contact element 12 and 14 has a face (typically planar) or surface 26 obliquely extending, relative to the element's axis 18 or 20, across its body 22. Extension of surface 26 preferably continues across the base component 24 of the contact element 12 or 14. In as much as the bodies 22 of the contact elements 12 and 14 are in engagement, it is the engagement of the partially aligning planar faces 26 that form or define the cooperative interface between the first 12 and second 14 contact elements.

[0024] The elastomeric member 16 can be generally band like (as illustrated) , and can be tubular in character, having an inner surface 28, engaging the contact elements 12 and 14, and an outer surface 30 adjacent the test apparatus. The objective of the resilient member is to maintain the orientation of the cooperatively interfacing first and second contact elements and bias elements 12 and 14 to their "passive" condition. The member 16, which is generally an elastomeric material such as silicon rubber or polyethylene, is positioned about the contact element bodies 22 for compression thereof. Responsive displacement of one relative to the other can thereby be permitted, and the many benefits accruing therefrom (as discussed with respect to FIGS. 3 & 4) can be achieved. Preferably, the elastomeric member 16 is dimensioned such that its outer surface 30 is substantially flush with the base "facing" 25 (i.e., the maximum dimension of the elastomeric member 16 is about equal to the maximum dimension of the base components 24 of each of the contact elements 12 and 14).

[0025] The dimensions of the contact device, particularly the base diameters of the contact element engagement areas, are predicated upon the package and its pad size. However, each of the base components of the contact elements provides an appreciable contact area for the IC and PC board, particularly when compared to pogo-pins, etc.

[0026] The contact elements are preferably fabricated from a beryllium/copper (Be/Cu) composite, although other known conducting materials are likewise contemplated and embraced. The elastomeric member is illustrated as being generally cylindrical or tube-shaped. Such a shape is not, however, required.

[0027] Referring to FIG. 2, the contact device 10 is shown as part of a test assembly 40, which orients the invention with respect to the surface to which the test assembly is mounted. The assembly 40 also orients the contacts 12 and 14 relative to the IC device which is to be inserted into the assembly for testing purposes. Generally, the test assembly 40 includes an alignment. plate 42 having a socket 44 for receiving an IC intended for testing, an underlaying housing or layer 46 overlying a PC board (not shown), and the contact device 10 positioned for conductively joining a device under test 48 within the socket 44 to the PC board. As shown, the device under test 48 initially engages the first contact element 12 of the device 10.

[0028] Referring to FIGS. 3 & 4, the interconnect contact device 10 is shown in cross section. Upon insertion, the I/O components of the IC impinge on the first (i.e., "upper") contact element 12 of the device 10, and specifically the base component 24 thereof. As the IC is pressed into the assembly, denoted in FIG. 4 by the downward pointing upper arrowhead, the first contact element 12 is forced to slide down and across the planar face or surface 26 of the underlying "stationary" second (i.e., "lower") contact element 14, which is in conductive communication with the PC board (not shown)

[0029] Although the face 26 for each contact element 12 and 14 generally extends across the body 22 thereof, it preferably extends across both the body 22 and the base 24 components, depending upon specific application objectives and constraints. With such a configuration, there exists, during back and forth sliding of the first contact element 12 upon the second contact element 14, clearance for the first body component 22 relative to the second contact element structure 14 to permit a maximum sliding travel distance for the first contact element 12. As the first contact element 12 slides across the second 14, z-axis compliance is provided, as well as lateral translation in the plane of the lower surface of the IC. The two dimensional sliding or "wiping" motion affords two benefits: z-axis compliance protects the IC from damage that might otherwise occur if the contact element or elements were rigid, and the horizontal translation scrubs the I/O component of the IC to clean them of debris and oxides that might degrade electrical signal quality.

[0030] As is noted by comparison of FIGS. 3 & 4, during engagement of the IC with the contact device (i.e., the "active" state of FIG. 4), the resilient member 16 is forced to deform outwardly as the contact element "constrained" within the elastomeric member radially expands. That is, in going from a passive to an active condition, the negative of surface normal axes 18 and 20 of the contact elements 12 and 14 are driven apart to radially compress the elastomeric member 16. Upon conclusion of testing and removal of the IC from the socket 44 (i.e., a return to the passive state of FIG. 3), the elastomeric member 16 returns to its original state and thereby permits return of the first 12 and second 14 contact elements to their passive, at-rest positions.

[0031] It will be understood that, in addition to the previously noted functions of maintaining the positioning of the contact elements and providing upward and compressive radial forces to the elements, the elastomeric member further shields the sliding surfaces of the contact elements from debris. This enables a high degree of isolation of the device to thereby minimize cross talk.

[0032] It will be understood that this disclosure, in many respects, is only illustrative. Changes may be made in details, particularly in matters of shape, size, material, and arrangement of parts without exceeding the scope of the invention. Accordingly, the scope of the invention is as defined in the language of the appended claims.

Claims

1. An interconnect contact device for interconnecting spaced leads, comprising cooperatively interfacing first and second contact elements and a resilient member disposed relative to said elements such that said resilient member biases said first contact element into engagement against, and in a direction relative to, said second contact element, wherein displacement of said first contact relative to said second contact element occurs so as to accomplish a wiping action at a cooperative Interface therebetween as a lead engages said first contact element and overcomes the bias.

2. The device of claim 1 wherein the displacement comprises sliding, said sliding providing z-axis compliance with respect to an integrated circuit lead engaging the device.

3. The device of claim 2 wherein each of said contact elements has a negative of surface normal axis.

4. The device of claim 3 wherein the sliding of said first contact element relative to said second contact element laterally moves the negative of surface normal axis of said first contact element from the negative of surface normal axis of said second contact element.

5. The device of claim 4 wherein each of said contact elements comprises a body and a base component, said base component being joined to said body and extending farther from the negative of surface normal axis than said body extends therefrom.

6. The device of claim 5 wherein the bodies of the contact elements define the interface between said contact elements.

7. The device of claim 6 wherein the cooperative interface defines a plane angularly spaced from said negative of surface normal axes.

8. The device of claim 7 wherein a portion of each of said contact elements is enclosed by said resilient member, and wherein said portion includes the bodies of each of said contact elements.

9. The device of claim 8 wherein said resilient member abuts each base of said contact elements.

10. The device of claim 9 wherein the bodies of said contact elements generally define a cylinder.

11. The device of claim 10 wherein said resilient member comprises an elastomeric tube.

12. The device of claim 11 wherein an inner diameter of said elastomeric tube is substantially equivalent to the lateral extent of the base cylinder defined by said contact elements.

13. The device of claim 1 wherein said resilient member is elastomeric.

14. The device of claim 13 wherein said resilient member is rubber.

Fig. 1

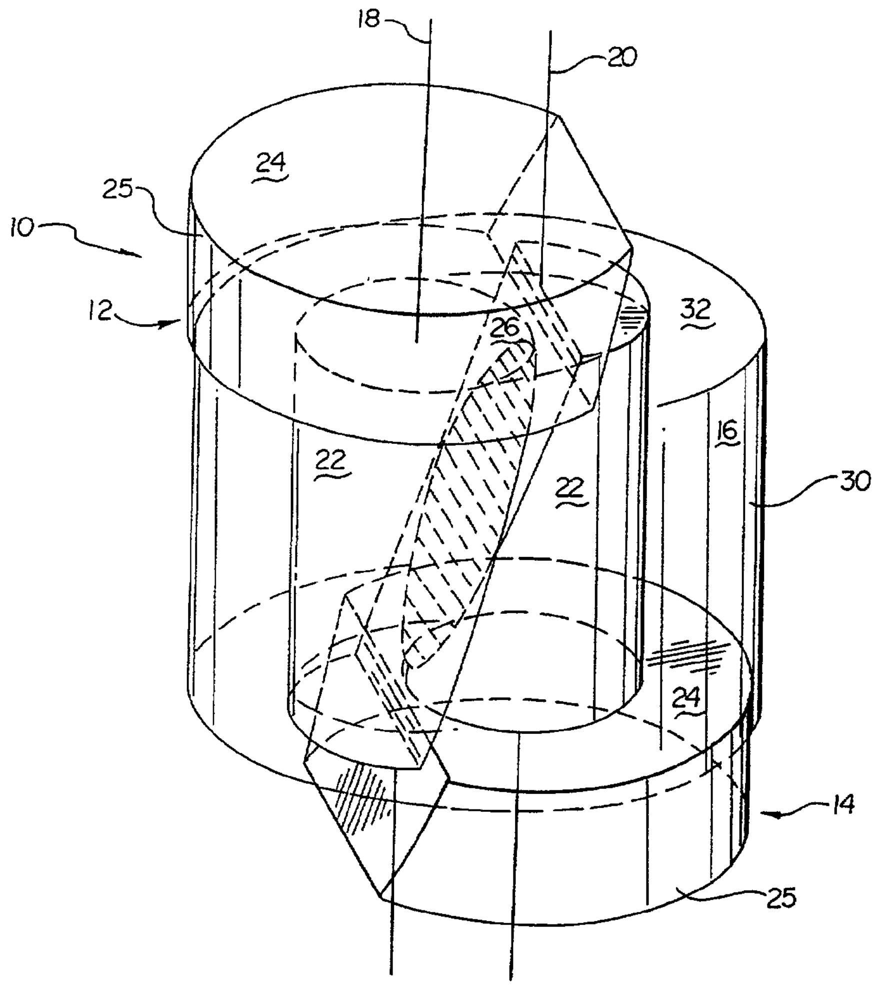

Fig. 2

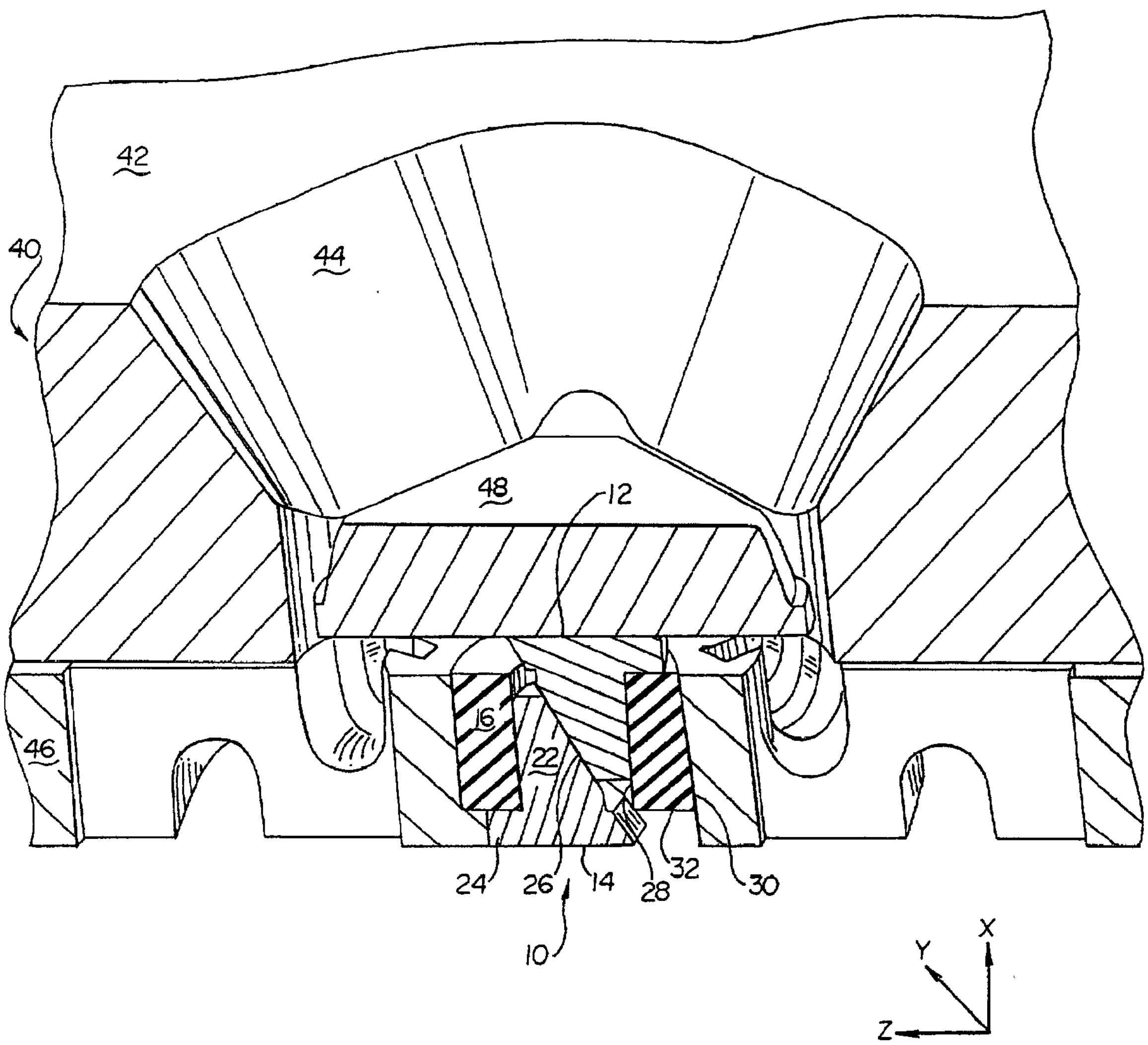

Fig. 3

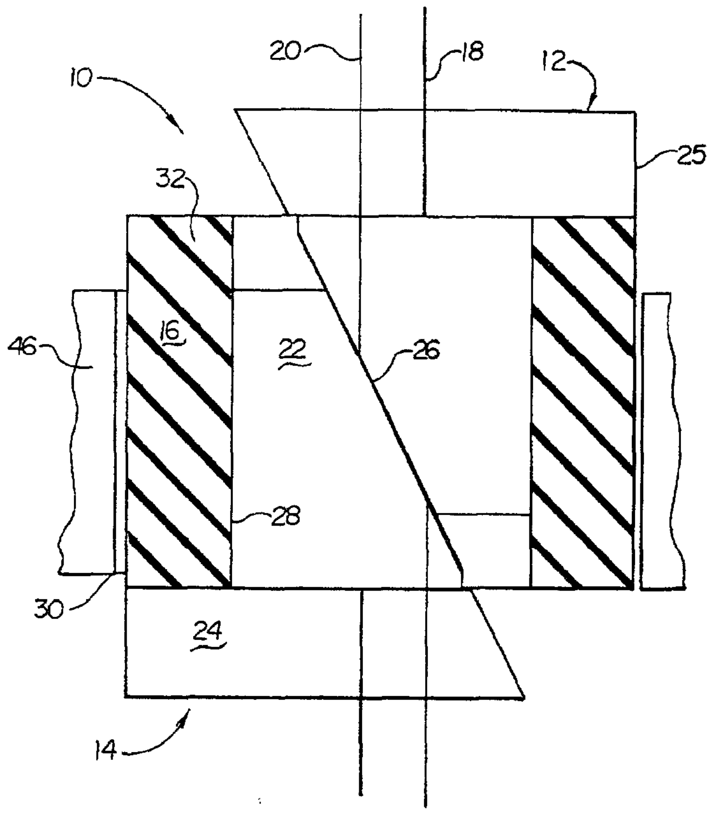

Fig. 4