

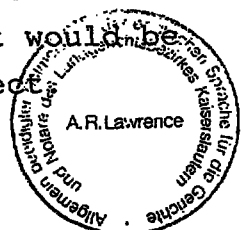
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An electrical connecting Device

The invention relates to an electrical connecting device for the connection of electrical terminals of a component and more particularly of a semiconductor component, with corresponding leads, more especially arranged on a printed circuit board, in accordance with the preamble of claim 1.

Electrical connecting devices of this type are more particularly employed in machines for testing semiconductor components with integrated circuits in order to check out the function of such electronic components on the manufacturer's premises. In this respect the electrical terminals of the component, as for instance the pins of an IC chip, are contacted electrically fully automatically via the electrical connecting means with a printed circuit board connected with the test device itself, such printed circuit board also being termed a DUT board or "device under test board".

Modern testing machines operate at a rate of 3000 semiconductor components per hour. This implies that the positioning and making of electrical contact between the components and the corresponding leads of the DUT printed circuit board must take place extremely rapidly. Furthermore, such operation must be performed with maximum precision, since the semiconductor components may possess up to several hundred pins, which are of correspondingly small size and have a clearance apart of for example only 0.5 to 1 mm. Additionally the creation of the electrical connection must take place absolutely reliably within this short time, because otherwise a false test result would be produced and the component would be deemed a reject.



An electrical connecting device in accordance with the preamble of claim 1 herein is disclosed in the US patent 5,069,629. The electrical connection between the pins of the component to be tested and the corresponding leads of the DUT printed circuit board is in this case produced by means of S-shaped contact pieces attached to the two ends of thin holding tapes extending parallel to each other. At least one of these holding tapes is in this case in the form of an elastomeric, resilient part.

If the ends of the pins of the semiconductor component under test are thrust against the ends, projecting past the top side of the receiving part, of the contact pieces, it is possible for the same to move in a resilient manner within the slots of the receiving part until the lower end of the contact pieces is resting on the corresponding leads of the DUT printed circuit board so that the electrical connection is obtained.

It is a disadvantage in this known design however that contact pieces are necessary whose engagement force is limited by the overall size and which cause an undesired increase in counter-inductance (crosstalk) and coupling capacitance. The contact pieces can only perform relatively small strokes. The elastomeric tapes have only a short length of life and involve substantial difficulties in assembly. Furthermore it has turned out that the relative motion of the contact pieces on the respective leads, that is to say on the electrically conductive contact surface faces of the DUT printed circuit board, results in premature wear and early damage to the leads.

Accordingly one object of the invention is to create an electrical connecting device according to the preamble of claim 1, which possesses improved electrical properties, which enhances the reliability of electrical contacting and which while having a longer working life renders possible higher test rates with a more compact arrangement of the contact pieces.



The object is to be attained using the features of claim 1. Advantageous embodiments of the invention are recited in the dependent claims.

In the connecting device of the invention the spring
5 means is provided between the leads and the movable contact pieces and possesses electrically conductive run-through elements, which at the one thereof are in pressure-loaded contact with the leads and at the other end thereof are pressure-loaded contact with the contact
10 pieces. Furthermore the contact pieces are designed in the form of end-pivoted pressing levers for the spring means.

Using the design in accordance with the invention the contact pieces do not now themselves come into contact
15 with the respective leads of the DUT printed circuit board. Instead of this the electrical connection is produced using the electrically connecting spring means, i. e. via the electrically connecting and flexible run-through elements, same being provided within the spring
20 means. This spring means rests on the leads of the DUT printed circuit board so that at least one electrically conductive run-through element is in electrical contact with a corresponding lead. On the opposite side of the spring means the contact pieces rest on the same in such a
25 manner that also at least one electrically conductive run-through element is connected with a contact piece. If at their free end projecting upward past the slotted receiving part, the contact pieces are thrust downward owing to placement of the pins of the semiconductor
30 component on them, the contact piece will pivot at this end about its terminal pivot axis in a downward direction, the spring means then being compressed at this position and the electrical conductive run-through element arranged here being pressed firmly both against the underlying lead
35 and also against the contact piece. This means that a reliable electrical connection is created. Owing to a design the contact pieces may be made extremely small



and relatively short so that the longitudinal inductance, coupling inductance and coupling capacitance may be reduced. This simultaneously has such an effect that even in the case of a extremely crowded design the possible clock frequency may be substantially increased, for example up to 5 GHz. Moreover a predetermined wave resistance is produced.

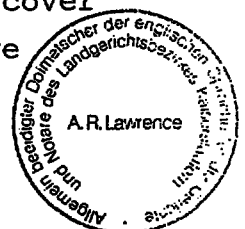
10 A further substantial advantage is that the contact pieces no longer rub against the leads of the DUT printed circuit board, and only a static pressure contact engagement is produced with the spring means. Furthermore the assembly of the contact pieces may be performed in an extremely simple manner and defective contact pieces may be replaced or even replaced separately.

15 A further advantage is that the resilient effect may be changed substantially independently of the arrangement of the run-through elements by, for example, changing the width of the spring means toward one side only.

20 It is an advantage if the spring means comprises a silicone strip, in which a plurality of electrically conductive run-through elements are embedded in a row at predetermined distances apart. In this case the silicone fulfills both the holding and also the insulating function for the electrically conductive run-through elements.

25 A simple way of associating a given contact piece with a lead is provided by one embodiment, in which the run-through elements extend perpendicularly through the plastic strip.

30 In accordance with an advantageous embodiment of the invention the contact pieces possess a bearing limb which at least substantially in the upward direction, that is to say toward the face of the connecting device facing the component, is covered over by a covering plate, which is detachably secured on the slotted receiving part and
35 serves as the top abutment part and bearing part for the bearing limbs. It is possible for instance for the cover plate to be provided on its bottom face with a groove



having a circularly arcuate cross section, into which the convex circularly arcuate sections of the contact pieces are borne for sliding movement. Instead of such a groove it is however possible to provide a corresponding round bead, the contact pieces in this case possessing suitably shaped, concave and circularly arcuate portions on the bearing end, which bear against the round bead. The advantage of such a covering plate is more particularly to be seen in simple assembly of the contact pieces, since, once the cover plate is removed, the contact pieces may be freely inserted from above into the corresponding slots in the receiving part and then following this it is only necessary for the cover plate to be put on and screwed in place. Since a rotary support means is provided in the cover plate for the contact pieces, it is, by using suitable different cover plate, furthermore possible in an extremely simple manner to utilize different contact pieces while the remaining components are not changed so that the connecting device is of universal application.

The invention will now be explained in detail with reference to the drawings by way of example.

Figure 1 is a perspective and partially broken away view of a first embodiment of the connecting device of the invention.

Figure 2 shows a longitudinal section taken through the connecting device of figure 1 along the principal plane of a contact piece in the non-depressed setting.

Figure 3 shows a longitudinal section corresponding to figure 2, the contact piece being illustrated in the depressed position.

Figure 4 is a perspective representation of the contact piece of figures 1 through 3 by itself.

Figure 5 shows a modified design of the contact



piece as in figure 4.

Figure 6 is a perspective foreshortened view of the spring means as in figure 1.

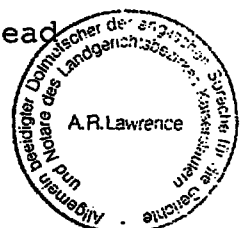
Figure 7 is a longitudinal section taken through the spring means of figure 6.

Figure 8 shows a perspective representation of a second embodiment of the connecting device of the invention.

In figure the reader will see a portion of an electrical connecting device 1 in the form of a contact base on which a DUT printed circuit board 2 is placed. Above the electrical connecting device 1 a small part of a semiconductor component 3 will be seen having electrical leads in the form of pins 4, such pins being brought into a predetermined relative position in relation to the electrical connecting device 1 to test the semiconductor component 4.

On the top side of the DUT printed circuit board 2 leads 5 are provided, which comprise a multiplicity of adjacent flat printed wiring elements. Such leads 5, which are insulated from each other in a known manner, are electrically connected in a manner not illustrated here with a testing machine for checking the electrical properties of the semiconductor component 3.

The electrical connecting device 1 comprises as its main parts a platform-like receiving part 6, in which a plurality of vertical through slots 7 is provided. These slots 7 are all have of the same size and in the arrangement depicted in figure 1 are arranged in a row parallel and adjacent to one another. The slots 7 serve for movingly receiving and guiding the electrically connecting contact pieces 8 and hold the same with a mutual distance between them equal to the distance apart of the pins 4. Furthermore the slots 7 are so arranged that when the receiving part 6 is placed on the printed circuit board 2, they are located above the leads 5, one respective slot 7 being aligned with one respective lead



5. The length of the slots 7 is made of such a size that same extend in their length direction past the front and rear end of the leads 5.

The slots 7 and consequently the contact pieces 8 set in them, are partly covered over by a covering plate 9. This covering plate 9 is set in a corresponding recess 10 provided on the top side of the receiving part 6 so that the top side of the covering plate 9 is flush and coplanar with the rest of the top side of the receiving part 6. The covering plate 9 and consequently the recess 10 extend in the longitudinal direction of the slots 7 from the outside for somewhat more than half of the length of the slots 7, whereas the remaining part, not covered by the covering plate 9, of the slots 7 is open in an upward and downward direction. The covering plate 9 is screwed by means of screws 11 to a clamping member 12 yet to be described, which is located underneath the covering plate 9 on the lower side of the receiving part 6.

On the lower side of the receiving part 6 and in the region above the leads 5 a recess 13 is provided, which extends athwart all slots 7. A spring means in the form of a silicone strip 14 is set in this recess 13, such strip being illustrated in figures 6 and 7 in detail. The silicone strip 14 comprises a resilient silicone body 15 with a rectangular cross section, in which a plurality of electrically connecting run-through elements 16 are embedded. The run-through elements 16 comprise fine wires, which are arranged in a row parallel to each other along the silicone body at an extremely small distance apart. The run-through elements 16 project slightly past the top and bottom sides of the silicone body 15, that is to say the length of the run-through elements 16 is slightly larger than the height of the silicone body 15. The silicone body 15 serves on the one hand for holding the run-through elements 16 and on the other hand for insulating same from each other. Moreover the distance between the run-through elements 16 is of such a size that



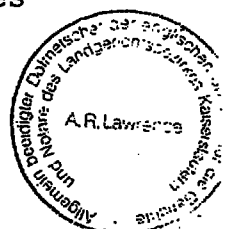
when the silicone strip 14 is placed on the leads 5 at least one electrically connecting run-through element 16 is in electrical contact with one respective lead 5.

To one side the silicone strip 14 abuts a
5 corresponding side wall of the recess 13 and is thrust from its opposite side or end toward such side wall by the clamping member 12. The clamping member 12 lies in a recess 17, which is also located on the bottom side of the receiving part 6, which adjoins the recess 13 and extends
10 parallel to same.

On the one hand the clamping member 12 serves for fixing the silicone strip 14 in position in the recess 13 and on the other hand for transmission of the contact making forces of the contact pieces 8 to the slotted
15 receiving part 6. This happens because the clamping member 12 is connected with the covering plate 9 via the screws 11, a horizontal portion 18 of the slotted receiving part 6 being clamped between such parts. If, as will be explained
20 infra, the contact pieces 8 are thrust downward by the pins 4 of the semiconductor component 3 to be tested, an upwardly directed force is produced in the bearing region of the contact pieces 8 tending to lift the covering plate 9 upward from the receiving part 6. This upwardly directed force is transmitted via the screws 11 to the
25 clamping member 12 and by same to the horizontal portion 18 of the slotted receiving member 6.

As an alternative to this it is also possible to omit the clamping member 12 and to screw the covering plate 9 directly to the receiving part 6 or to the DUT
30 printed circuit board 2. The clamping member 12 does however offer a simple way of fixing the silicone strip 14 in position and furthermore renders possible the use of silicone strips 14 of different widths, it being only necessary in this case to utilize clamping members 12 with
35 different widths.

As shown in figures 1 through 4, the contact pieces 8 comprise thin plates with an essentially L-like



configuration. The contact pieces 8 comprise a substantially straight, somewhat longer bearing limb 19 and a somewhat shorter upwardly projecting limb 20. In the mounted state of the contact pieces 8, the limb 20 is
5 located in the run-through part, not covered by the covering plate 9, of the slots and stands proud of the surface of the receiving part 6 so that the pins 4 are rested on the top edge portion of the limb 20 and may thrust same downward a certain distance. At the opposite
10 end of the contact piece 8 the bearing limb 19 possesses an end portion 21 with a circularly arcuate outer form, the diameter of the end portion 21 being larger than the height of the remaining part of the bearing limb 19. The end portion 21 accordingly projects upward past the
15 remaining part of the bearing limb 19. This circularly arcuate end portion 21 serves for rotatably supporting the contact pieces 8 within the slots 7.

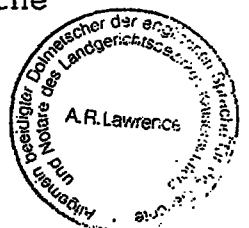
As shown in figures 1 through 3, the contact pieces 8 are so set within the slots 7 that they extend athwart
20 the silicone strips 14, the middle part of the bearing limb 19 having its bottom side bearing against the silicone strip 14. The width of the contact pieces 8 is made of such a size that at least one electrically connecting run-through element 16 is in electrical contact
25 with the bottom side of the bearing limb 19. The silicone strip 14 is the sole part by which the contact pieces 8 are supported from below. Moreover each contact piece, as already explained, is pivotally mounted in the circularly arcuate end portion 21 within the receiving part 6. For
30 this purpose the contact pieces 8 have one end portion 21 in a groove 22 having a corresponding circularly arcuate cross section, such groove being provided in the bottom side of the covering plate 9. Furthermore in the condition illustrated in figure 2, in which the contact
35 pieces 8 are not pivoted downward, the contact pieces 8 are urged or supported in an upward direction at the bearing limb 19 by the bottom side of the covering plate 9



and held in the horizontal position depicted in figure 2, since the silicone strips 14 biases the bearing limb 19 against the covering plate 9.

If the pins of the semiconductor component 3 are placed on the respective contact pieces 8, the contact piece 8 will rock, as indicated in figure 3, about its circularly arcuate end portion 21 downward, the silicone strip 14 being compressed. When this happens the electrically connecting run-through elements 16 are thrust more strongly downward onto the leads 5 and upward against the contact pieces 8 so that a reliable electrical connection is produced between the contact piece 8 and the lead 5. The contact pieces 8 consequently act as pivoting and pressing levers pivoted at one end. The upwardly directed force occurring during this pivoting movement at the groove 22, will, as also indicated, be transmitted by means of the screws 11 and the clamping member 12 to the slotted receiving part 6. In order not to obstruct the pivoting movement of the contact pieces 8, the clamping member 12 is made somewhat lower in height than the silicone strip 14.

Figure 5 shows an alternative embodiment of a contact piece 8'. The main difference between this contact piece 8' and the contact piece 8 illustrated in figures 1 through 4 is that the end portion, producing the pivot bearing function, of the bearing limb 19 is not curved convexly, but has a concave circularly arcuate portion 23, that is to say a recess with a concavely curved surface. These contact pieces 8' may be utilized for an alternative embodiment, not illustrated, of an electrical connection device, in the case of which, instead of a groove 22 in the bottom face of the covering plate 9, there is a projecting bead having a correspondingly circularly arcuate external face. The contact piece 8' has the advantage over the contact piece 8 of having a smaller area, this meaning that the longitudinal inductance, the coupling inductance and the



coupling capacitance may be still further reduced.

In the modified illustrated working embodiment of the novel connection device the receiving part 6' extends toward that side, which in terms of figure 8 is to the rear, only as far as the end of the slots 7, whereas the portion behind is exposed above the DUT printed circuit board 2. This offers the advantage that any dirt possibly present may readily drop out to the rear from the slots 7, and not impair the free running properties of contact pieces 8 within the slots 7. In other respects this connection device is designed like the one illustrated in figure 1.

In figures 1 and 8 only one part of a row of slots 7 and contact pieces 8 is illustrated. It is however quite possible to provide not just one such row in the electrical connection device of the invention, but also several rows, same being arranged in conformity with the arrangement of the pins 4 of the semiconductor component 3 to be tested. It is for instance possible to provide four such rows forming a complete or closed rectangle, each pin 4 being able to be electrically contacted by one corresponding contact piece 8 and 8'.



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Claims

1. An electrical connection device for the
10 connection of electrical terminals (4) of a component and
sure more particularly of a semiconductor component (3), with
corresponding leads (5), more especially arranged on a
printed circuit board (2), comprising a receiving part (6
and 6') provided between the electrical terminals (4) of
15 the component (3) and the leads (5), for contact pieces (8
and 8'), such receiving part being provided with slots (7)
within which the contact pieces (8 and 8') are guided for
motion, the contact pieces (8 and 8') being supported by a
spring means (14) and being able, by pressing contact, to
20 be brought into a contact position creating an electrical
connection with the leads (5), characterized in that the
spring means (14) is provided between the leads (5) and
the movable contact pieces (8 and 8') and possesses
electrically connecting run-through elements (16), which
25 at one end thereof are in pressing contact with the leads
(5) and at their other ends are in pressing contact with
the contact pieces (8 and 8') and in that the contact
pieces (8 and 8') are designed in the form of pivoted
pressing levers for the spring means (14).

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2. The connecting device as claimed in claim 1,
characterized in that the spring means (14) comprises an
insulating plastic strip, and more particularly a silicone
strip, in which a plurality of electrically connecting
35 run-through elements (16) is embedded in row and at a
predetermined distance apart.





3. The connecting device as claimed in claim 2, characterized in that said run-through elements (16) extend perpendicularly through the spring means (14).

5 4. The connecting device as claimed in any one of the preceding claims, characterized in that the contact pieces (8 and 8') extend athwart the longitudinal axis of the spring means (14) and may be pivoted about a pivot axis, which is possible to the longitudinal axis of the
10 spring means (14).

5. The connecting device as claimed in any one of the preceding claims, characterized in that the pivot bearing means of the contact pieces (8 and 8') is provided
15 by means of a terminal convex or concave circularly arcuate portion.

6. The connecting device as claimed in any one of the preceding claims, characterized in that the contact
20 piece (8 and 8') possess a bearing limb (19), which at least substantially in the upward direction, that is to say toward the face of the connecting device (1) facing
← the component (3), is covered over by a covering plate (9), which is able to be detachably secured on the slotted
25 receiving part (6 and 6') and serves as the top abutment part and bearing part for the bearing limb (19).

7. The connecting device as claimed in claim 6, characterized in that on its bottom side the covering
30 plate (9) is provided a groove (22) having a circularly arcuate cross section and in which the convex circularly arcuate portions of the contact pieces (8) are guided for motion.

35 8. The connecting device as claimed in claim 6, characterized in that on its bottom side the covering plate (9) is provided with a bead with a circularly





arcuate external form, on which the concave circularly arcuate portions (23) of the contact pieces (8') are slidingly supported.

- 5 9. The connecting device as claimed in any one of the claims 6 through 8, characterized in that the contact pieces (8 and 8') are biased by means of the spring means (14) against the bottom side of the covering plate (9).

