

SOCKET APPARATUS FOR SEMICONDUCTOR DEVICESField of the Invention

This invention relates generally to a socket used for mounting electrical parts such as semiconductor devices in order to test such devices and more particularly to a socket which is used for such devices having a large number of narrow lead terminals.

Background of the Invention

In manufacturing semiconductor devices, typically, a selected integrated circuit is formed on a silicon substrate and, upon completion of a test in the wafer state, the silicon substrate is divided and the divided silicon substrate is mounted on a lead frame and sealed with resin, ceramic, or the like to form a semiconductor device. The completed semiconductor devices are subjected to functional tests including a burn-in test to determine whether they are satisfactory or unsatisfactory. Since there is a need to handle large numbers of semiconductor devices in such testing, a socket in which the devices can be easily inserted and removed is used. A number of differently shaped sockets for testing purposes are used to accommodate the variously shaped semiconductor devices and leads. The present invention relates particularly to semiconductor devices of the SOJ (small out-line J-lead) type referenced by numeral 200 in Figs. 11a and 11b.

Referring to Figs. 14a through 14c, and Figs. 15a through 15c, a socket 102 made according to the prior art is shown. Socket 102 has a base 116 formed of electrically insulating resin mounting a plurality of electrically conductive contact pins 113. The upper portion of each contact pin 113 mounted in base 116 is bifurcated, with contact parts 114 and 115 being formed at the distal tips, and two leg parts 119 being formed at the bottom portion. A recessed IC seating portion 128 is provided on base 116 and slit partition members 131, spaced from one another at equal distances outside and adjacent to the seating portion, form a plurality of pin receiving gaps or slits. Contact pins 113 are inserted into base 116, legs 119 first, from the top into the slits and are pushed in by a force exerted on leg 117 with legs 119 projecting out the bottom of base 116 in order to connect and fix socket 102 to a printed substrate. Lateral positioning members 121 are provided at the four corners of IC seating portion 128 along with inclined guiding surfaces 122 for positioning and guiding a semiconductor device. SOJ type terminal leads 202 of semiconductor device 200, shown in Figs. 15a-15c, extend out the side of a package 201 and are bent downward and inwardly toward bottom 204 of package 201. Semiconductor device 200 is held horizontally in IC seating portion 128, with top portion 203 facing downwardly and terminal leads 202 facing upwardly (see Fig. 15a). Contact parts 114 and 115 of contact pins 113 stick out of respective slits at two opposed sides of IC seating portion 128. If semiconductor device 200 is lowered vertically with package 201 sliding along guide surfaces 122, terminal leads 202 will engage respective contact parts 114 which are located at the uppermost part of contact pins 113 (see Fig. 15b). When semiconductor device 200 is pressed down from the Fig. 15b position, the side of terminal leads 202 will force contact parts 114 into their respective slits with a result that the side of terminal leads 202 and contact parts 114 rub against one another because of the spring force of contact parts 114, and, therefore, the rubbed surfaces of the terminal leads

202 are cleaned. When package 201 is fitted within the space formed by positioning members 121 to such an extent that it can no longer be pushed in further, semiconductor device 200 is accommodated in IC seating portion 128 and the cleaned surface of terminal leads 202 engage contact parts 115 located below contact parts 114. In this state, terminal leads 202 and contact pins 113 are electrically connected and electric functional tests on the semiconductor device can be carried out. Upon completion of the functional test and the determination of satisfactory or unsatisfactory semiconductor devices, semiconductor device 200 is removed from socket 102, with unsatisfactory devices being discarded and satisfactory devices being sent on to subsequent steps. Since suitable testing of semiconductor devices 200 having a large number of terminal leads 202 can be carried out accurately in the manner described above, sockets capable of accommodating different shapes of various semiconductor devices have been prepared for wide use.

According to socket 102 of the prior art, however, a compressive force is added to terminal leads 202 from contact parts 114 and 115 when semiconductor device 200 is disposed in the IC seating portion. Even if the compressive force added to each terminal lead 202 is relatively small, the total force becomes large because of the large number of terminal leads 202 which are used. As a result, when the semiconductor device 200 is to be removed from socket 102, an extremely large force is required to overcome this aggregate holding force. In the above described socket 102, a gap 129 is provided between side 203 of the semiconductor device when seated and base 116. In order to remove semiconductor device 200 from socket 102, a tool is inserted from the side of socket 102 into gap 129 and one end of semiconductor device 200 is levered and pushed up for removal. In this manner, the number of terminal leads 202 that are in engagement with contact pins 113 is reduced with

a resultant reduction in the holding force, thereby making it possible to withdraw the semiconductor device 200 with a smaller force. When one end of the semiconductor device 200 is raised, however, terminal leads 202 will be withdrawn after having been engaged in a skewed orientation relative to contact pins 113 inside socket 102, with a consequence that there will be some terminal leads 202 which can become entangled between contact pins 113. If a semiconductor device 200 in such a state is forcefully removed, terminal leads 202 will be bent or contact pins 113 and terminal leads 202 can be further entangled with each other, thereby exacerbating the removal task.

Moreover, if positioning accuracy has been off vis-à-vis the semiconductor device that has been loaded in the socket or if the semiconductor device is inserted in skewed relation to the socket, there may be an entanglement between the terminal leads of the semiconductor device and the contact pins of the socket, with a resultant possibility of bending of the terminal leads of the semiconductor device.

Summary of the Invention

An object of the present invention is the provision of a socket which overcomes the above noted limitations of the prior art. Another object is the provision of a socket in which the terminal leads of an electric part being inserted and removed will not become entangled with the contact pins of the socket. Other objects, advantages and details of the socket of this invention appear in the following detailed description of the preferred embodiment of the invention.

Briefly stated, a socket made in accordance with the invention comprises a base having a seating portion for the placement of a semiconductor device with a plurality of terminal leads. According to a feature of the invention, the socket mounts a plurality of contact pins for electrical connection to respective terminal leads of a seated semiconductor device in which the effective distance between adjacent contact pins is less than the width of each terminal lead of the semiconductor device to be seated. According to a feature of the invention, the width of the tip part of the contact pins that engage the terminal leads are made wider than the remainder of the elongated spring part supporting the tip part. According to another feature of the invention, members made of an electrically insulating material are arranged between and adjacent to the contact pins. The members can be formed integrally with the main socket body or they can be formed of partition-like insulating film positioned on the main socket body.

As described, the terminal leads of a semiconductor device will not enter into the gap between the contact pins in a socket having a semiconductor device seating portion which seats a semiconductor device having a plurality of terminal leads adjacent to a plurality of contact pins which are electrically connectable with the terminal leads in which the distance between adjacent ones of a large number of contact pins is made smaller than the width of each terminal lead. If the width of the tip part of the contact pins that engage the terminal leads is made wider than the remainder of the spring part supporting the tip part, the area for engagement with the terminal leads becomes larger with a result that the electrical connection becomes more accurate.

Placement of an electrically insulating member between adjacent contact pins will conveniently prevent any possible short-circuiting therebetween. If the insulating members are formed as slit partitions integrally formed with the main

socket body, the socket production steps can be simplified. If the insulating member is made from a partition-like insulating film that has been positioned on the main socket body, it becomes possible to bring the contact pins closer together.

Brief Description of the Drawings

Fig. 1 is a side elevational view of a contact pin which is used in a socket made according to a first embodiment of the invention and Fig. 1a is an enlarged perspective view of a portion of Fig. 1;

Figs. 2a is a top plan view of a socket made in accordance with the invention, Fig. 2b is a partial cross section taken along line A-A of Fig. 2a, and Fig. 2c is a cross section taken along line B-B of Fig. 2a;

Figs. 3a through Fig. 3c are cross sectional views shown for the purpose of describing details relating to the insertion of a semiconductor device into the socket;

Fig. 4a shows an enlarged front elevational view of partition members and contact pins of the socket and Fig. 4b shows a similar view of partition members and contact pins of a socket made according to the prior art;

Fig. 5 is a full cross section similar to Fig. 2b showing a semiconductor device partially removed from a socket made in accordance with the first embodiment;

Fig. 6 is a side elevational view of a contact pin used in a socket made in accordance with a second embodiment of the invention and Fig. 6a is an enlarged perspective view of a portion of Fig. 6;

Figs. 7a and 7b are side cross sectional views showing a semiconductor device seated in a socket made in accordance with the second embodiment with the contacts in the open and in the closed positions, respectively;

Fig. 8 is a side elevational view of a contact pin used in a socket made in accordance with a third embodiment of the invention and Fig. 8a is an enlarged perspective view of a portion of Fig. 8;

Fig. 9 is a top plan view of a socket made in accordance with the third embodiment of the invention;

Fig. 10 is a partial cross section taken along line C-C of Fig. 9;

Figs. 11a and 11b are top and bottom perspective views, respectively, of an SOJ type semiconductor device with which the socket of the first embodiment is used;

Fig. 12 is a top perspective view of a semiconductor device of the TSOP type with which the socket of the second embodiment of the invention is used;

Fig. 13 is a top perspective view of a semiconductor device of the QFP type with which the socket of the third embodiment of the invention is used;

Fig. 14a is a top plan view of a socket made according to the prior art, Fig. 14b is a partial cross section taken along line I-I of Fig. 14a, and 14c is a partial cross section taken along line II-II of Fig. 14a; and

Figs. 15a through 15c are side cross sectional views of the Fig. 14a socket shown for the purpose of describing the manner in which a semiconductor device is inserted into its socket.

Detailed Description of Preferred Embodiments

The first embodiment of the invention will be described by referring to Figs. 1 through 5. Socket 2 is to be used for testing semiconductor devices of the SOJ type in the same manner as the aforementioned socket 102. Socket 2 comprises a base 16 formed of suitable electrically insulating material which mounts in a bottom wall thereof a plurality of contact pins 13 formed by punching from a metal plate. The metal plate is preferably made of a copper alloy whose thickness is approximately 0.4 millimeters with width "a" of the contact, as seen in Fig. 1a, being 0.4 millimeters. Contact pin 13 has a pedestal 11, as shown in Fig. 1, with two contact parts 14 and 15 being flexibly supported respectively at the free distal end of elongated spring parts 18₁ and 18₂ extending upwardly from pedestal 11. A leg part 19, for connection to a printed substrate, extends downwardly from the pedestal. Contact part 14 extends further from pedestal 11 than contact part 15 so that it is disposed higher than contact part 15. Contact part 14 has a tip which is formed wider than the remainder of the spring parts by bending and deforming and has a width "b" of approximately 0.55 millimeters. An IC accommodating recess 28 is formed at the center of base 16 where an IC device seating portion is formed. A plurality of slit forming members or partitions 31 made of electrically insulating resin, formed integrally with the base 16, are

arranged along two opposed sides of recess 28 spaced equally from one another on each side. With reference to Fig. 4a, slits 32 are shown formed between partitions 31 with a contact pin 13 mounted in each respective slit but with spring part 18₁ and part 17 omitted for purposes of illustration. Slits 32 are arranged in two rows on base 16 on opposite sides of recess 28 in such a way as to accommodate the lead terminal arrangement of the semiconductor device to be tested. Contact pins 13 are inserted into respective slits 32 from the top with leg part 19 extending through the bottom wall of base 16. The width c (thickness) of partitions 31 is approximately 0.3 millimeters, however, width d of the top part is reduced to approximately 0.15 millimeters and the pitch of partitions 31 is approximately 0.8 millimeters. Therefore, the width of slit in the upper part is approximately 0.65 millimeters and the width of the slit in remainder is approximately 0.5 millimeters. Spring parts 18₁ and 18₂ are located where the width of the slit between adjacent partitions is 0.5 millimeters and contact part 14 is located where the width of the slit is 0.65 millimeters. The pitch of the contact pins 13 is also approximately 0.8 millimeters so that the distance between spring parts 18₁ and 18₂ of adjacent contact pins is approximately 0.4 millimeters and the distance f between the contact parts 14 is approximately 0.25 millimeters. Thus, spring parts 18₁, 18₂ and contact parts 14 can move out of and into slits 32 without engaging slit member 32. Spring parts 18₁, 18₂ and contact parts 14, 15 of each contact pin lie in a plane and are movable in the plane toward and away from the IC device seat.

Semiconductor device 200, shown in Figs. 11, 12, is inserted in socket 2 with its top 203 facing downwardly, held horizontally at the IC accommodating recess 28 (refer to Fig. 3a) and lowered vertically from that position. In this manner, terminal lead 202 first engages contact part 14 located at the top of contact pin 13. If semiconductor device 202 is pushed down from that position,

the side of terminal leads 202 slide on the widely-formed part of contact parts 14 which are biased against the terminal leads by spring parts 18₁, with a consequence that the slidably rubbed faces are cleaned. Upon receipt of semiconductor device 200 on IC device seat 28, contact parts 15 engage the side of terminal leads 202 with contact pins 13 and respective terminal leads 202 electrically connected, thereby ushering in a state where an electrical test can be conducted. Upon termination of the electrical test, one end of semiconductor device 200 is lifted by using a tool to tilt the device, thereby facilitating withdrawal and removal of semiconductor device 200 from socket 2.

Dimensions of terminal leads 202 of semiconductor device 200 are such that the width of each is approximately 0.47 millimeters at the root part 205 but it is reduced toward the tip part 206 to a width of 0.26 millimeters (see Fig. 5). As mentioned above, the distance *f* between contact parts 14 of contact pins 13 is 0.25 millimeters so that even tip parts 206 which are in engagement with contact parts 14 will not become entangled in the gap between contact parts 14 when one end of the semiconductor device 200 has been raised as shown in Fig. 5. Accordingly, there is no possibility for terminal lead 202 to be bent or entangled preventing semiconductor device 200 from being withdrawn at the time of removal.

According to sockets of the prior art as described above, the width of each partition or slit forming member 131 is 0.3 millimeters, as shown in Fig. 4b. In addition, the width of contact pin 113 is 0.4 millimeters not only at the contact parts 114 and 115 but also at the remainder of the spring support part and the pitch of slit members 131 and contact pins 113 is 0.8 millimeters. Therefore, the gap between contact parts 114 is 0.4 millimeters, with a result that the tip portion 206 of the terminal lead 202 can easily get caught.

In the case of a socket of this invention, no such inconvenience is experienced and semiconductor device 200 in a skewed orientation can easily be withdrawn. Since terminal lead 202 slides against the widened part of contact part 14, the side of terminal lead 202 is cleaned without fail to provide an optimum electrical connection.

The second embodiment of the invention will be explained below by referring to Figs. 6 and 7. Socket 3 of the second embodiment comprises a base 46 formed of suitable electrically insulating material, a cover 56 placed on base 46 and biased upwardly by a spring, not shown, and contact pins 43 shown in Fig. 6 mounted in base 46. Each contact pin 43 has a pedestal part 41, with a spring part 48 extending generally upwardly therefrom. A contact part 44 and a trigger portion 42 are formed at distal bifurcated ends of spring part 48. A leg part 49, used for connection with a printed substrate, extends downwardly from pedestal part 41. Contact pin 43 is formed by stamping from a metal plate with the tip of contact part 44, being bent and deformed to increase its width. Contact pin 43 has a width a' of approximately 0.2 millimeters, the same as spring part 48 and width b' of the wider part of approximately 0.4 millimeters. An IC device accommodating recess 58 is formed with partition members 61, formed integrally with base 46, arranged on opposed sides equally spaced from one another with a slit being formed between respective slit members. A contact pin 43 is inserted in respective slits with leg part 49 inserted first from above and, as the force receiving part 47 is pushed down, the contact pin is placed in the bottom wall of base 46 with leg part 49 extending downwardly from the bottom of base 46 for connection with a printed substrate and fixation of socket 3 as a whole thereto. When cover 58 is pressed down in opposition to the spring force, the result will be as shown in Fig. 7a. In this state, trigger part 42 of contact pin 43

serves as a follower and is cammed outwardly by cam member 57 formed in cover 56, thereby moving contact part 44 upwardly and outwardly. The thickness and the pitch of partitions 61 are the same as in the above described socket 2, with the top of partitions 61 being reduced in thickness. When trigger parts 42 are moved by cam 57, the widely-formed part of contact parts 41 will be received in respective slits formed between partitions 61. If semiconductor device 300 is dropped vertically through the opening provided at the center of cover 56 into the IC accommodating recess 58 of base 46, followed by the raising of cover 56 by means of the spring, cam member 57 moves upwardly as shown in Fig. 7b allowing each contact part 44 to move into electrical connection with a respective lead terminal 302 as a result of the spring force of spring parts 48.

If the orientation of the semiconductor device is skewed when loaded into a prior art socket, the contact pins can be inserted between the terminal leads, thereby making it impossible to obtain electrical connection.

The distance between adjacent contact parts of socket 3 made in accordance with the invention is approximately 0.25 millimeters, which is smaller than the width (0.26 millimeters) at the tip of terminal lead 302. Therefore, there is no possibility for the terminal lead 302 to become entangled in the gap between contact parts 44, with a result that semiconductor device 300 can be easily removed. The width of the parts which engage terminal leads 202 is made relatively large so that contact pin 302 will not be damaged.

The third embodiment of this invention will be described by referring to Figs. 8 through 10. Reference numeral 4 in Figs. 9 and 10 indicates a socket to be used in an electrical test or a burn-in test of semiconductor devices 400 of the

QFP (quad flat package) type. Contact pin 73, shown in Fig. 8, is used in socket 4. Figs. 9 and 10 are a top plan view of socket 4 with the cover removed and a partial cross section taken on line C-C of Fig. 9, respectively. Contact pin 73 has a pedestal 71, with a contact part 74 that is flexibly supported by spring part 78 extending upwardly from pedestal 71. A leg part 79 extends downwardly from pedestal 71 for connection with a printed substrate. Contact pin 73 is formed by stamping from a metal plate with the width of the top of contact part 74 increased by means of bending and deforming as in the case of the previously described contact pins 3 and 13. The width a'' at places other than the widened part and the width b'' in the widened part are approximately 0.3 millimeters and 0.55 millimeters, respectively. Socket 4 has a base 76 formed of electrically insulating material with an IC accommodating recess 88 formed at the center of base 76. Partition members 91, formed integrally with base 76, are arranged and spaced equally from each other around IC accommodating recess 88 with a slit being formed between respective partitions 91. Contact pins 73 are inserted in respective slits from above base 76 with leg part 79 extending out the bottom of base 76. Contact parts 74 are arranged to be positioned above the slits and, as semiconductor device 400 is dropped from the loading mechanism and guided by positioning parts, generally indicated at 81, into IC accommodating recess 88, the tops of terminal leads 402 are made to engage the widened part that has been formed on contact part 74. If the tips of terminal leads 402 are pressed from above by means of a loading member, not shown in the drawing, an electric connection between each terminal lead 402 and a respective contact pin 73 occurs. Since the width of the top of partition 91 is decreased in the same manner as in the previously described embodiments, the width of the slits is large at the top but small at the bottom. The width of the top part of the slits is made larger than the widened part of contact part 74 at the top so that the widened part of contact parts 74 are enabled to be received in respective slits

when contact part 74 has moved down. If the downward force that has been added to the tips of terminal leads 402 is removed after the completion of an electrical test on semiconductor device 400, contact parts 74 return to a position above the slits. Semiconductor device 400 can be lifted vertically and easily removed. However, there are many instances where the orientation in which semiconductor device 400 is held is unsatisfactory, that is, where semiconductor device 400 is skewed.

Since the distance between the contact parts of the contact pins which are located in the slit is larger than the width of terminal lead 402 in a conventional prior art socket, there have been cases where the tip of terminal leads 402 become entangled between the contact parts when the orientation of semiconductor device 400 is skewed.

In a socket made according to this embodiment of the invention, the distance between the widened parts of the contact pins that are located above the slits is approximately 0.25 millimeters as in the case of the previously described socket 2, which is smaller than the width of 0.26 millimeters at the tip of terminal leads 402. Accordingly there is no possibility for terminal leads 402 to become entangled between contact parts 74, with a result that the semiconductor device 400 can be easily removed.

Partition members 91 are used in base 76 to form slits, however; if desired, an insulating film or the like may be inserted between the contact pins instead of using the partitions. In such case, the insulating film could be adhered on the side of the contact pins using an adhesive or grooves could be formed in the base with insulating films supported in the grooves.

By avoiding the entanglement of terminal leads of the semiconductor device between contact pins of the socket pursuant to the invention, it becomes possible to prevent bending of the terminal leads in connection with the removal of the semiconductor device from the socket. Further, since the parts which engage the terminal leads are relatively wide, the accuracy of the electric connection is enhanced. Since the widened part of the contact parts can be moved in and out of the slits by decreasing the width of only a portion of the partitions, the strength of the partitions will not be adversely affected.

It should be understood that although the preferred embodiments of the invention have been described in order to illustrate the invention, the invention includes various modifications and equivalents to the disclosed embodiment. It is intended that the invention include all modifications and equivalents falling within the scope of the appended claims.



What is Claimed

1. Socket apparatus for removably mounting an electronic package having a plurality of terminal leads comprising:

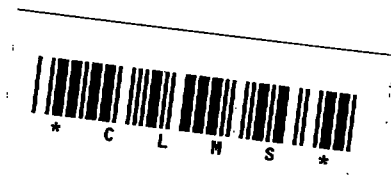
a base having a bottom wall,

an electronic package receiving seat disposed in the socket,

a plurality of contact pins mounted in the bottom wall along at least two opposed sides of the electronic package seat, the pins each having an elongated flexible spring part with a free distal contact tip extending upwardly from the bottom wall, each elongated flexible spring part lying in a plane and being movable in the plane toward and away from the electronic package seat, the spring part have a first width forming a surface facing the electronic package seat and the contact tip formed with a second width, greater than the first width, facing the electronic package seat for engagement with a respective terminal lead of the electronic package.

2. Socket apparatus according to claim 1 in which a second elongated spring part of each contact pin extends upwardly from the bottom wall having a free distal end lying in the plane and having a width equal to the first width forming a surface facing the electronic package seat, the contact tip being disposed further from the bottom wall than the free distal end so that the terminal leads of an electronic package are first wiped by the contact tip and then engaged by the free distal end upon inserting an electronic package into the electronic package seat.

3. Socket apparatus according to claim 1 further comprising a cover formed with a centrally disposed opening therethrough, the cover movably



Claim 3 continued:

mounted toward and away from the base, a cam surface formed on the cover and each contact pin having a trigger follower portion attached to the elongated flexible spring part and engageable with the cam surface for moving the spring part upon movement of the cover.

4. Socket apparatus according to claim 1 in which the terminal leads are arranged in rows and are equally spaced from one another in each row and the second width of the contact tip is greater than the spacing between adjacent terminal leads.

5. Socket apparatus according to claim 1 in which the terminal leads are arranged in rows and each terminal lead has a tip with a given width taken in the direction of the respective row, the contact pins are arranged in rows and are equally spaced from one another in each row, the spacing between adjacent contact tips of the second width being less than the given width of the tips of the terminal leads.

6. Socket apparatus according to claim 1 further comprising electrically insulating partitions extending from the bottom wall to an upper portion disposed between the elongated flexible spring parts of adjacent contact pins forming elongated flexible spring part receiving slits and the thickness of the upper portion of the partitions being decreased to provide sufficient space from reception of respective contact tips having the second width.

7. A socket comprising a semiconductor device seat for the placement of a semiconductor device having a plurality of terminal leads each having a tip



Claim 7 continued:

with a given width and a plurality of contact pins mounted in the socket adjacent the semiconductor device seat, the contact pins each having a contact tip which is electrically connectable to a respective terminal lead of a seated semiconductor device, the distance between adjacent contact tips being less than the given width of the tip of each terminal lead of the seated semiconductor device.

8. A socket comprising a semiconductor device seat for the placement of a semiconductor device having a plurality of terminal leads each having a tip with a given width and a plurality of contact pins having a contact tip with a selected width mounted in the socket adjacent the semiconductor device seat which are electrically connectable to a respective terminal lead of a seated semiconductor device, the selected width of each contact tip being larger than the distance between the adjacent terminal leads.

9. A socket according to claim 7 in which the plurality of contact pins are each formed of a contact tip and a remainder part, the remainder part having a width, the given width being greater than the width of the remainder part.

10. A socket according to claim 8 in which the plurality of contact pins are formed of a tip part and a remainder part, the remainder part having a width, the given width being greater than the width of the remainder part.

11. A socket according to claim 7 further comprising insulating members made of an electrically insulating material, a said insulating member being disposed between adjacent contact pins.



12. A socket according to claim 8 further comprising insulating members made of an electrically insulating material, a said insulating member being disposed between adjacent contact pins.

13. A socket according to claim 11 in which the socket has a body and in which the insulating members are partitions integrally formed with the body.

14. A socket according to claim 12 in which the socket has a body and in which the insulating members are partitions integrally formed with the body.