

- [54] **RECEPTACLES EMPLOYING HIGH DENSITY ARRAY OF OVERLAPPING SELF-ADJUSTABLE CONTACTS**
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- [51] Int. Cl. **H01r 13/14**
- [58] Field of Search **339/17 C, 17 CF, 17 LC, 339/64, 206, 207, 210, 258, 259, 176, 192**

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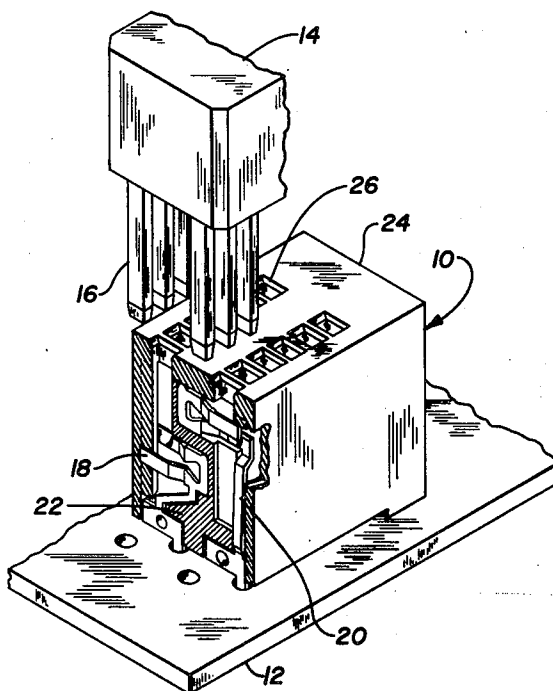
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[57] ABSTRACT

Connector receptacles for mating with a very high density array of male pins employ an insulating housing having female contacts mounted therein. The contacts have mating (nose) portions interconnected by relatively narrow neck portions to a mounting (body) portion. The contacts are spaced on plural levels in the direction of mating in an overlapping arrangement. In a two-level embodiment the contacts have a U-shaped nose portion with offset legs; the U-portion is formed by slotting and has contact areas comprising facing dimple bosses on opposite sides of the respective legs of the U. Alternatively the U-portion may comprise non-offset legs formed by folding. A three-level embodiment has two rows of contacts with U-shaped noses formed by bending. A four-level embodiment comprises three rows of contacts with two levels of contacts in each row and an offset-height center row. Adjacent contacts in each row have overlapping mating portions such that the neck of the upper contact passes through the U-portion of the lower contact and the mating male pin for the lower contact passes through the U-portion of the upper contact. The housings generally comprise an inner core into which the contacts are mounted; the core fits into an outer shell which has ribs for preloading the contacts. The body portion of each contact is rigidly mounted within the housing and the neck and mating portions are free to move, thereby enabling each contact to be self-adjusting to compensate for male pin misalignment.

16 Claims, 12 Drawing Figures



RECEPTACLES EMPLOYING HIGH DENSITY ARRAY OF OVERLAPPING SELF-ADJUSTABLE CONTACTS

CROSS REFERENCE TO RELATED APPLICATION

The present invention is an improvement on the invention described in the application of present coinventor Herbert E. Ruehleemann, filed 7 June 1971, Ser. No. 150,476, now abandoned.

This is a continuation of application Ser. No. 288,809, filed Sept. 13, 1971 now abandoned.

BACKGROUND: FIELD OF INVENTION

This invention relates to electrical connectors and particularly a high density receptacle designed to receive a component or module having freestanding male pins mounted in a high density array.

BACKGROUND: DESCRIPTION OF PRIOR ART

As discussed in the above-referenced Ruehleemann application, prior to Ruehleemann's invention the maximum mounting density in a direction normal to the direction of mating for female contacts of a given strength and size and of the type designed to receive a plurality of freestanding male pins was limited by the cross sectional area of a mated male-female contact pair, plus minimum clearance area between adjacent contact pairs. It was also noted that as a corollary to the foregoing, it was assumed that, prior to Ruehleemann, the cross-sectional area or strength of contacts of this type, when mounted in a maximum density array, could not be increased, assuming contact material and shape were optimized.

Ruehleemann's invention, by providing contacts having wider mating than neck or body portions and mounting such contacts in a multi-level arrangement, provided a means of either increasing the mounting density of contacts of a given size and strength or increasing the size and strength of contacts mounted in what was thought to be a maximum-density array.

The present invention incorporates the principles of Ruehleemann's invention, but overcomes certain limitations thereof to provide an important improvement thereon.

In the Ruehleemann invention the density of a single row receptacle is increased by positioning the mating portions of the female contacts in different levels with respect to the direction of mating and overlapping a portion of adjacent mating portions. In one embodiment Ruehleemann suggests increasing the density of a receptacle having two staggered rows by overlapping somewhat single beam mating portions between the rows by positioning them in one row at a different level than the other of the staggered rows. In the present invention a substantially greater increase in density is achieved by providing a unique and novel design in which contacts in aligned positions between two or more aligned rows are positioned at different levels to permit substantial overlapping between contacts in aligned rows. A further increase in density is achieved by positioning adjacent contacts within the same row at different levels to permit their mating portions to overlap as well.

The mating or "nose" portions of the contacts of said Ruehleemann application were held relatively rigidly in the insulator housing of the connector. Thus if a mating male pin were slightly misaligned, it would meet the fe-

male contact at an off-center position, overstressing one side of the female contact and making poor or even no contact with the other side thereof. The present invention provides a high density receptacle of the Ruehleemann type which can accomodate misaligned male pins.

Also, each female contact of said Ruehleemann application mated with its corresponding male pin in one step. While not disadvantageous in other applications, this one step mating presents certain disadvantages in the present invention since a high density receptacle contains many contacts which are mated simultaneously, so that one step mating creates a relatively high peak insertion force. The present invention provides a means of reducing peak insertion force for a high density receptacle of the Ruehleemann type.

Additional advantages of the present invention are to provide a female receptacle in which the opening between the two points of contact of each female contact can be zero or even negative without creating problems in the electroplating of such contacts during production, to provide female contacts which can be preloaded easily by the insulator housing in which they are mounted, specifically by the cover thereof, to provide contacts which are very reliable, easy to manufacture, economical, and which can be easily mounted within an insulator housing. Further objects and advantages of the present invention will become apparent from a consideration of the ensuing description thereof.

DRAWINGS

In the drawings, where like parts are designated by identical reference numerals, different aspects of a single embodiment are designated by differently-lettered versions of the same figure number, while the embodiment is referred to in the following text by its figure number only.

FIGS. 1A-E relate to a two-tier substrate-mounted receptacle employing slotted contacts according to a preferred embodiment of the invention, together with a mating element having freestanding male pins. FIG. 1A is an isometric, cutaway view of the receptacle, FIG. 1B is an exploded view thereof, FIG. 1C is a top, cutaway view thereof, FIG. 1D is a detailed isometric view of the contacts thereof, and FIG. 1E is a top view of a mated contact thereof.

FIG. 2 is a side, sectional view of a two-tier, module-mounted receptacle having contacts similar to those of FIG. 1 and plugged onto an array of substrate-mounted, freestanding male pins.

FIG. 3 is a partial isometric view of a folded-nose contact according to an alternative embodiment of the invention.

FIGS. 4A, B relate to a three-tier receptacle employing folded-nose contacts according to an alternative embodiment. FIG. 4A is a top view and FIG. 4B is a side view of such receptacle.

FIGS. 5A-C relate to a four-tier receptacle according to an alternative embodiment. FIG. 5A is a top cutaway view and FIG. 5B is a side sectional view of said receptacle. FIG. 5C is an isometric, cutaway view of the folded-nose contacts employed in said receptacle.

FIG. 1 — SUBSTRATE MOUNTED TWO-TIER RECEPTACLE, SLOTTED NOSES

FIG. 1 shows a preferred embodiment of the invention which comprises a receptacle 10 (FIGS. 1A and

1B) on a substrate 12 and designed to mate with a component or module 14 having a plurality of freestanding male pins such as 16. Substrate 12 is preferably a printed circuit board but can also be a metal plate or any other type of electrical wiring substrate. Pluggable module 14 (FIG. 1A) may be an encapsulated electronic device such as an integrated circuit, a smaller printed circuit board or module card (which would have a different appearance than indicated), a ceramic wafer designed to hold an integrated circuit which is connected to the male pins, or any other electrical member from which a plurality of freestanding male pins extend in a high density array.

Receptacle 10 comprises a plurality of female contacts such as 18 and 20 (FIG. 1B) and a two-piece insulator housing comprising a core section 22 and a cover section 24. Receptacle 10 is assembled by inserting contacts 18 and 20 into respective slots in core 22 as indicated by the broken lines and thereafter assembling cover 24 over "loaded" core 22. As indicated, each slot in core 22 is configured to closely match the shape of its contact 18 or 20. Cover 24 is retained to core 22 by suitable means (not shown for purposes of simplification) such as a detent locking ledge, ultrasonic welding, adhesive means, force fit, etc.

Cover 24 includes apertures such as 26 in the top thereof to provide access to the female contacts. Cover 24 also includes preloading ridges such as 28 and 30 which, as explained infra, partially spread and thereby preload the mating portions of the female contacts when cover 24 is assembled over core 22. Each preloading ridge has a tapered lead-in portion as indicated at 32 in order to facilitate its insertion between the legs of the mating portion of the female contact.

Female contacts 18 and 20, although generally similar (FIG. 1D), have points of significant difference. To facilitate explanation, only "upper" contact 20 will be described in detail and only those portions of "lower" contact 18 which differ from corresponding portions of contact 20 will be described. The portions of contact 18 which have identical counterparts in contact 20 are given identical reference numerals and points of difference are given primed reference numerals.

Contact 20 comprises a primary mating or nose portion 34, an interconnection or neck portion 36, a body or mounting portion 38, and a secondary connection or tail portion 40. Nose portion 34 is designed to mate repeatedly with a male pin such as 16, neck portion 36 is designed to interconnect the body and nose portions and support nose portion 34 in a flexible manner, body portion 38 is designed for mounting the contact and holding it rigidly within insulator core 22, and tail portion 40 is designed to interconnect the contact with conductors associated with substrate 12, such as printed wiring on the underside of substrate 12. Tail portion 40, when attached to substrate 12, also holds entire receptacle 10 to the substrate. Tail portion 40 may take other forms than as shown, for example it may be a press-fit portion which has a gripping shank designed to make interference fit with a plated-through hole in substrate 12, also it may be much longer to facilitate wire-wrapped type interconnections (trade-marked Wire-Wrap), clip type interconnections (trade-marked Termipoint), or it may be designed to be "shaved" on opposite sides in order to form curl portions to hold it to the underside of substrate 12.

Body portion 38 contains a stamped dimple boss 41 which is designed to make a press or interference fit in the bottom portion of respective slot of core 22. Neck portion 36 is designed to allow nose portion 34 to flex with respect to body portion 38 (according to the invention) when the body portion is rigidly mounted. Insulator core 22 (FIG. 1B) is designed to allow neck portion 36 and nose portion 34 to move to a limited extent therewithin to facilitate such flexure. In lower contact 18, since nose portion 34' is much closer to body portion 38, neck portion 36' extends from one end of portion 38 in a sloping direction to nose portion 34' in order that neck portion 36' may be approximately the same length in contact 18 as is neck portion 36 of contact 20 so that the nose portion 34' will be able to flex to the same extent in both contacts.

Nose portion 34 has a U-shaped configuration formed by slotting, i.e., removing a central strip from the nose portion to form the two legs and bight portion of the "U." The end of the lower leg 42 of the U is integral with neck portion 36 and the end of the upper leg 44 of the U is free. At the end of each leg of the U is a contact dimple boss as illustrated at 46 in the upper contact and at 48 at the lower contact, the respective opposing dimple bosses being similar but not visible in the illustration. These dimple bosses are designed to mate with the sides of male pin 16, as illustrated in FIG. 1E.

The legs of the U are spread out of the normal plane of the U (FIG. 1E) in order to enable male pin 16 to be inserted between the legs of the U in the manner indicated. When the male pin is inserted, the legs are spread further apart and away from the normal plane of the U.

Nose portion 34' of lower contact 18 is similar to that of upper contact 34, except that the upper end of neck portion 36' is attached integrally to the bight portion of the U, rather than the end of its leg.

The bight portion of each contact has an extending boss 50 formed by upsetting; boss 50 is designed to hold upper leg 44 of the U away from the undersurface of the top of cover 24, thereby to allow said upper leg to pivot freely during mating.

Contacts 18 and 20 appose each other when mounted in core 22 (FIG. 1A and 1D). The nose portions of the contacts overlap in order to provide maximum mounting density, as discussed in the above Ruehleman patent application. The nose portion of lower contact 18 thereby is mounted closely adjacent the neck portion of upper contact 20. The upper and lower contacts alternate in each row (FIG. 1C), also to provide maximum mounting density according to the Ruehleman principle. Thus the adjacent pair of contacts on either side of contacts 18 and 20 illustrated in FIG. 1A would be reversed in relation to that shown in FIG. 1A, as illustrated in FIG. 1C.

As discussed, when contacts 18 and 20 are mounted in core 22 and cover 24 is assembled thereover, preloading ridges 28 and 30 of cover 24 will be inserted between the legs of the U portions of the nose of each contact and will partially spread such legs wider than their freestanding positions. Broken lines 52 (FIG. 1E) indicate the freestanding position of the contact legs, broken lines 54 indicate the preloaded position of the contact legs prior to insertion of a male pin 16, and the full lines illustrated indicate the positions of the legs after insertion of male pin 16. As is well-known, the ad-

vantages of preloading or partially stressing a contact prior to mating are to provide a guaranteed minimum deflection force and thereby adequate normal force during mating, to provide more accurate and uniform contact positioning and thus more predictable mating conditions, to facilitate insertion of the male pin by providing a wider spread and thus a smaller insertion angle, and to eliminate the possibility of contact motion when subjected to vibration in an unmated condition.

Since the upper and lower legs of the nose portion are staggered in the direction of mating, when male pin 16 (FIG. 1D) is inserted it will first meet and deflect upper leg 44 and thereafter meet and deflect lower leg 42. Since the deflection of the upper and lower legs occurs in sequence, rather than simultaneously, a lower peak insertion force is encountered. This facilitates mating, which is often difficult due to the large number of contacts usually used in high density connectors.

Neck portion 36 allows entire nose portion 34 to move with respect to rigidly mounted body portion 38. This enables both tines or legs of nose portion 34 to be deflected during mating with a male pin which is not aligned along the center or optimum axis of the female contact, whereby the entire contact nose 34 can move to accommodate the misaligned pin. If contact nose 34 were not able to so deflect, a misaligned pin might deflect one tine of the contact nose beyond its elastic limit and might not even contact the other tine which, as will be recognized by those skilled in the art, is a very undesirable condition. By allowing the entire contact nose to flex, the contact can align itself with misaligned pins and thereby optimize mating with such pin.

FIG. 2 — MODULE MOUNTED RECEPTACLE

In situations where male pins are mounted on a substrate in a high density array and a modular component is to be plugged onto such pins, the arrangement of FIG. 2 is suitable.

In FIG. 2 a plurality of male pins such as 70 are mounted to the motherboard with the aid of a supporting substrate 72. Pin 70 may be soldered to a printed circuit line such as 74 on the underside of the substrate by solder 76. The lower part 78 of each pin is circular and the upper part 80 thereof may have a cross section similar to that of pin 16 of FIG. 1A.

A printed circuit board, a ceramic wafer, or other modular component to be electrically and mechanically connected to pins such as 70 on substrate 12 is indicated at 82. A receptacle 10' according to the invention is similar to that of receptacle 10 of FIG. 1A, except that the tail portion of each female contact, instead of constituting a simple elongated member, extends inwardly as indicated at 84 and contains two gripping fingers 86 and 88 which engage both sides of card 82. The tails of all contacts are thus effectively arranged in a single row.

FIG. 3 — FOLDED NOSE CONTACTS

FIG. 3 shows an alternative version of the contacts of FIG. 1A in which the nose portion of the contact is U-shaped but is formed by folding, rather than slotting. Thus the legs of the U are not staggered as in the FIG. 1A arrangement so that the mating boss 46 of one leg opposes the mating boss (not shown) of the opposite leg. Suitable modifications must of course be made in the contact receiving slots of core 22 (FIG. 1B) in order to accommodate folded nose section 90.

The arrangement of FIG. 3 is desirable in receptacles where receptacle height is a consideration since by not staggering the legs of the U, the height of the contact, and hence the receptacle, is significantly reduced.

FIG. 4 — THREE-TIER RECEPTACLE, FOLDED NOSE CONTACTS

The folded nose contact of FIG. 3 is used in the three-tier embodiment of the invention illustrated in FIG. 4. In this arrangement the receptacle comprises a core 100, a cover 102, and short, medium, and tall female contacts 104, 106, and 108.

The contacts are arranged in two rows with each row containing retaining recurring sets of short, medium, and tall contacts as indicated. The apposing contacts of the opposite row are staggered with respect to their counterparts of the first row and overlap the contacts of the other row, both horizontally and vertically when viewed in the direction showed in FIG. 4A.

The arrangement of FIG. 4, by providing three tiers of contacts in the direction of mating, reduces peak insertion force and also provides greater wall thickness in the insulator core 100 between adjacent contacts.

FIG. 5 — FOUR-TIER RECEPTACLE

The arrangement of FIG. 5 is a four-tier receptacle in which contacts similar to that of FIG. 3, but using nose portions wherein the U is wider and has inwardly bent, parallel free ends. The insulator housing comprises three parts, a bottom 120 (FIG. 5B), a middle portion 122, and a cover 124. These portions are suitably bonded together by any means well known in the art.

The nose portions of all contacts are substantially identical, but the contacts have four different tail lengths. The contacts are mounted in three rows 126, 128, and 130 (FIG. 5A) with the contacts in each row being mounted in apposing pairs such as 132 and 134. Each apposing pair contains an upper contact 132 and a lower contact 134 wherein the leg (rather than the bight) portions of the U-shaped nose sections overlap. Thus tail 136 (FIG. 5C) of upper contact 132 passes through nose portion of lower contact 134 and the male pin 138 which mates with lower contact 134 passes through the nose portion of upper contact 132. The tail portion of each contact is offset as indicated at 140 in order that tail portion 136 of upper contact 132 will pass through the center of nose portion of lower contact 134 and the tail portion 142 of lower contact 134 will be aligned with the tail portion of contact 132.

Male pin 144, which is designed to mate with upper contact 132, is shorter than that of male contact 138 so that it will not contact offset tail portion 140 of upper contact 132.

The left apposing pair of contacts in row 126 (FIG. 5A), partially illustrated at 146, contains two contacts similar to contacts 132 and 134 and arranged in the same orientation such that the lower contact will lie on the right and its bight portion will be overlapped by the bight portion of contact 132 of the right pair of contacts of row 126.

In addition to overlapping the adjacent pair of contacts in the same row, each pair of contacts overlaps the adjacent pair of contacts in the next row. Thus contacts 132 and 134 of row 126 overlap the adjacent pair of contacts in row 128 immediately above contacts 132 and 134. The contacts in center row 128 (FIG. 5B)

are mounted at a lower elevation than the contacts in outer rows 126 and 130 in order to permit such overlapping and hence maximum density mounting.

Although only three rows of four contacts each are illustrated in FIG. 5A, the arrangement can be extended indefinitely with adjacent rows being mounted at different heights and each contact of apposing pairs in each row being mounted at different heights, thus using contacts with four different tail lengths. This necessitates that the male pins of a mating element 148 have four corresponding different lengths (not shown).

As in the other arrangements, the tail portions of the contacts of FIG. 5 are rigidly mounted by embedding them in lower insulator portion 120 and the nose portions are free to move, thereby to accommodate misaligned male pins in a manner aforesaid.

While the above description contains many specificities, these are not intended to limit the scope of the invention, but merely to exemplify several preferred embodiments thereof. Many other embodiments according to the invention are possible. Accordingly the full scope of the invention is intended to be indicated by the subject matter of the appended claims and their legal equivalents.

We claim:

1. In a receptacle including an insulator housing and two rows of female contacts therein for receiving a plurality of male pins arranged in two rows when said pins are moved along an axis of engagement the improvement comprising:

positioning said female contacts in said insulator housing such that; adjacent contacts in each row are at different levels along said axis and overlap each other when viewed along said axis, the contacts of one row are at different levels along said axis and overlap corresponding contacts of the other row when viewed along said axis, whereby the contacts are spaced closer together than the minimum spacing required if said contacts were in the same level, each row having at least one contact at a higher level than some contact of the other row.

2. The improvement of claim 1 wherein each of said female contacts includes two opposing contacting members for engaging opposite sides of a male pin, said opposing contacting members being located at different levels along said axis thereby reducing insertion forces.

3. The improvement of claim 1 wherein each of said female contacts includes a mating portion, a body portion, and a supporting neck portion extending between said mating and body portions, and is formed from sheet metal.

4. The improvement of claim 2 wherein said contacting members are formed by the legs of a U-shaped mating portion, which lies in a plane parallel to said axis.

5. The improvement of claim 1 wherein said insulator housing includes an inner core having cavities into which said female contacts are positioned, and an outer shell surrounding said inner core.

6. The improvement of claim 5 wherein said outer shell includes integral means for preloading said female contacts.

7. In a receptacle including an insulator housing and at least two aligned rows of female contacts therein for receiving a plurality of male pins arranged in two

aligned rows when said pins are moved along an axis of engagement the improvement comprising:

providing pairs of female contacts, each pair having a first contact from one of said rows and a second contact from another of said rows said first contact having a mating portion at a first level along said axis, and said second contact having a mating portion at a second level spaced from said first level, said pairs of contacts being positioned with said mating portions overlapping between aligned positions in said two rows when viewed along said axis, the mating portions of adjacent contacts within each row also being in different levels, and each of said mating portions including two opposing contact areas positioned at spaced levels along said axis.

8. The improvement of claim 7 wherein said mating portions of adjacent contacts within each row also overlap when viewed along said axis.

9. The improvement of claim 7 wherein each of said mating portions is U-shaped having two legs and a bight portion, said bight portion extending parallel to said axis, and said legs including said opposing contact making areas.

10. The improvement of claim 7 wherein each of said female contacts further include neck means for flexibly supporting said mating portions, said neck means of said first and second contacts being made substantially the same length to provide the same flexibility by having said neck means extend diagonally on one of said contacts.

11. The improvement of claim 7 wherein said insulator housing includes an inner core having cavities into which said pairs of contacts are positioned and an outer shell surrounding said core.

12. The improvement of claim 11 wherein said outer shell includes integral means for preloading said female contacts.

13. In a receptacle including an insulator housing and a plurality of female contacts therein for receiving a plurality of male pins when said pins are moved along an axis of engagement, each of said female contacts having a mating portion with two integral opposing contact making areas for engaging opposite sides of a male pin, the improvement comprising:

providing said two opposing contact making areas at different levels along said axis by forming each of said mating portions in a U-shape having a bight portion extending parallel to said axis, and two legs extending transverse to said axis with said legs being said opposed contact making areas.

14. The improvement of claim 13 wherein each of said female contacts further includes a body portion and a supporting neck portion extending between said mating and body portions, and wherein said female contacts may be formed from sheet metal.

15. The improvement of claim 13 wherein said female contacts are arranged in at least one row with adjacent contacts being disposed at different levels within said insulator housing along said axis.

16. In a receptacle including an insulator housing and a plurality of female contacts therein for receiving a plurality of male pins when said pins are moved along an axis of engagement, each of said female contacts having a mating portion with two integral opposing contact making areas for engaging opposite sides of a male pin, the improvement comprising:

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providing said two opposing contact making areas at different levels along said axis, arranging said female contacts in at least one row with adjacent contacts being disposed at different levels within said insulator housing along said axis, and providing each of said female contacts with neck means for flexibly supporting said mating portions, said

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neck means of contacts disposed at different levels in said insulator housing along said axis being made substantially the same length to provide substantially the same flexibility by having said neck means extend diagonally on some of said contacts.

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