United States Patent

Brown

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[54] PIN AND SOCKET CONTACT ELECTRICAL INTERCONNECT SYSTEM

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[52] **U.S. Cl.**.....**339/218 R,** 339/256 R

[51] **Int. Cl.**.....**H01r 9/08**

[58] **Field of Search**.....339/218, 258, 256, 176, 177, 339/17, 18, 217, 252, 65; 317/101 R, 101 C, 101 CC, 101 D, 101 CW

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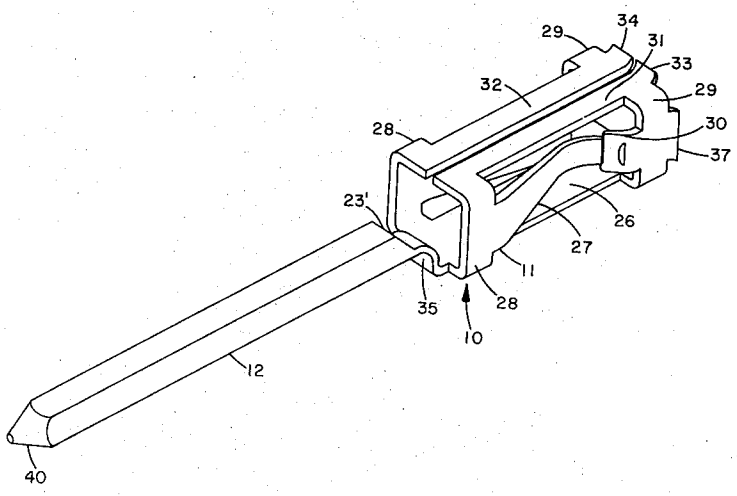
[57] **ABSTRACT**

A combined unitary pin and socket contact, receivable in a housing, designed for providing electrical interconnect between parallel stacked circuit boards, with guided entry of pins into contact sockets, and opposite side spring socket contact arms resiliently engaging opposite sides of an inserted pin throughout the entire range of pin lateral float.

19 Claims, 8 Drawing Figures



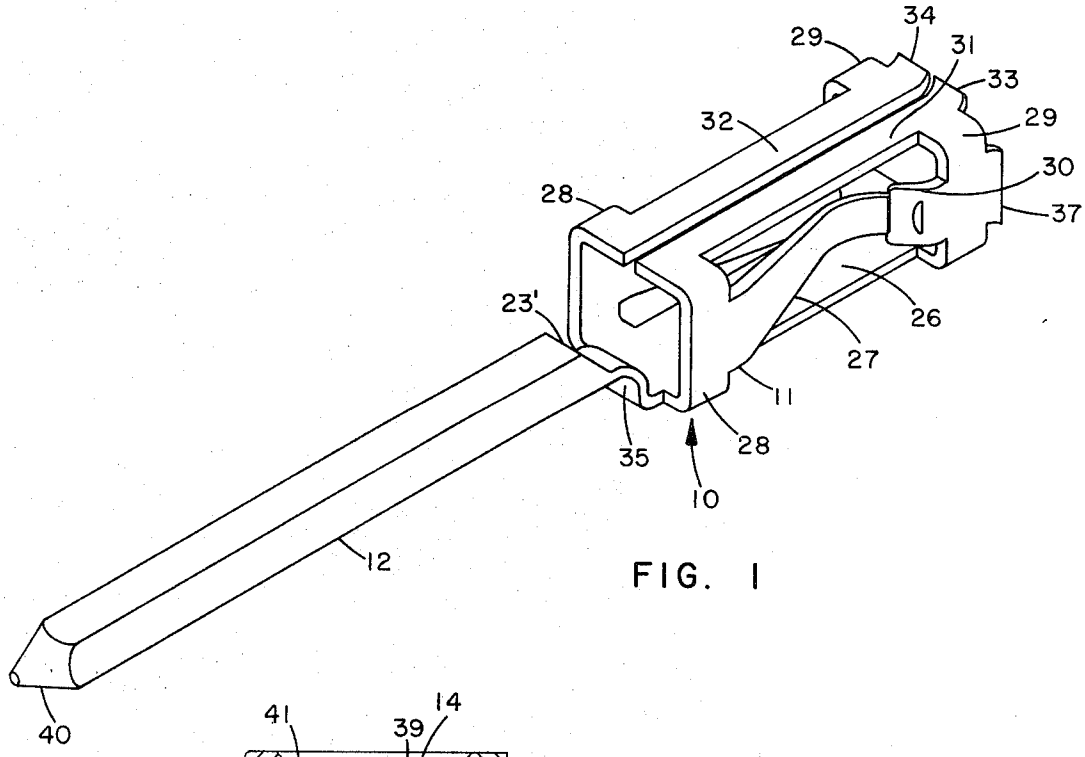


FIG. 1

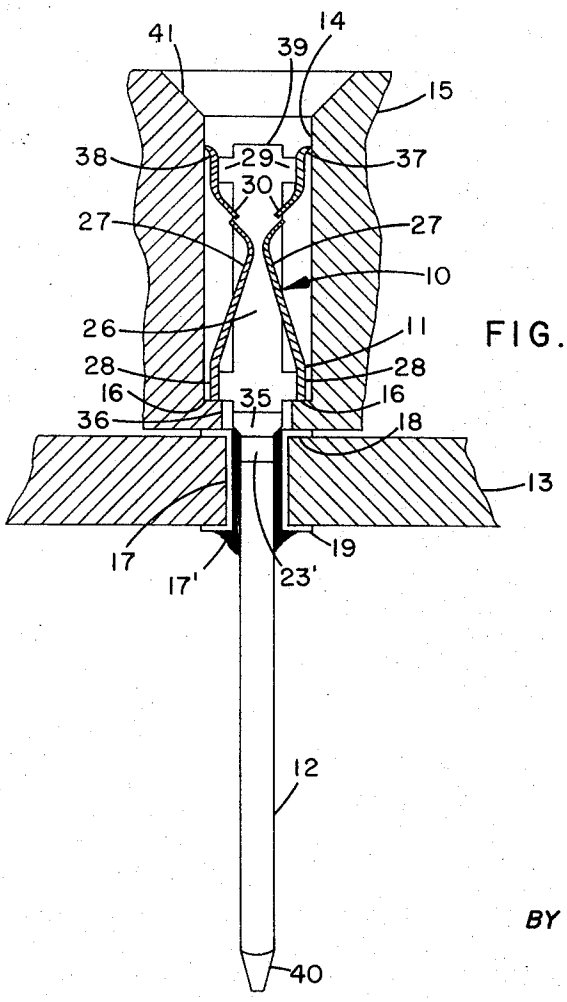


FIG. 2

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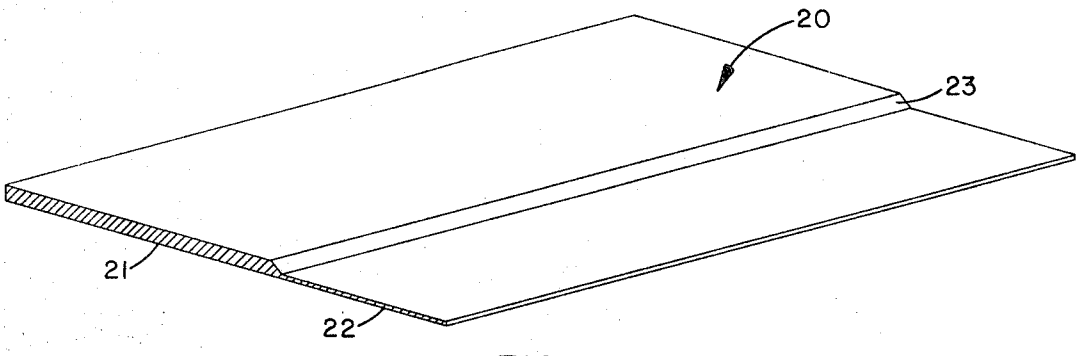

FIG. 3

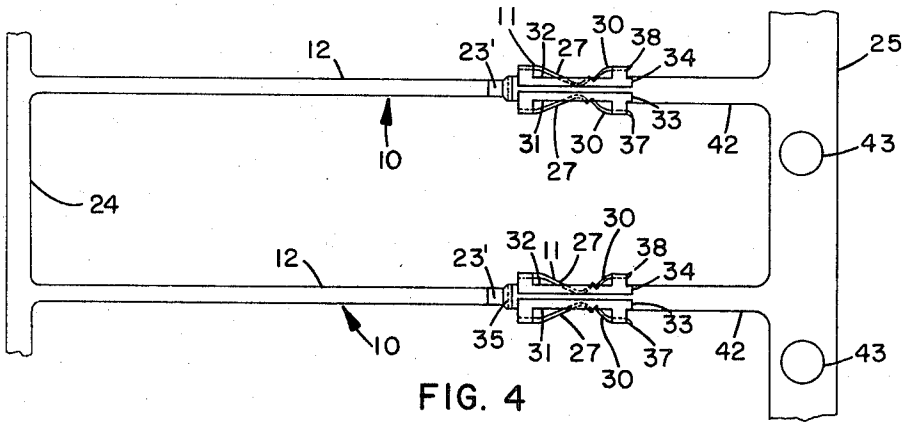

FIG. 4

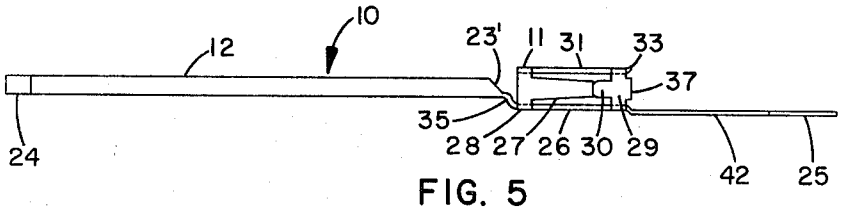

FIG. 5

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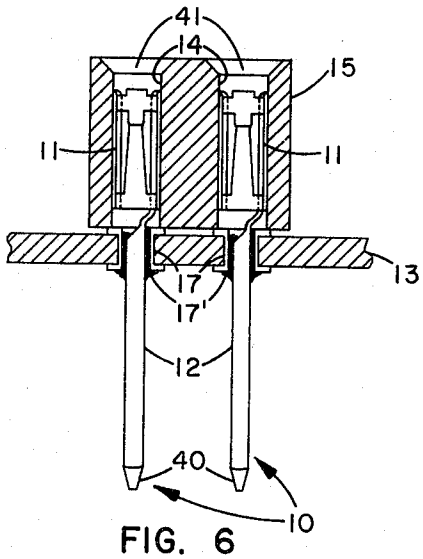

FIG. 6

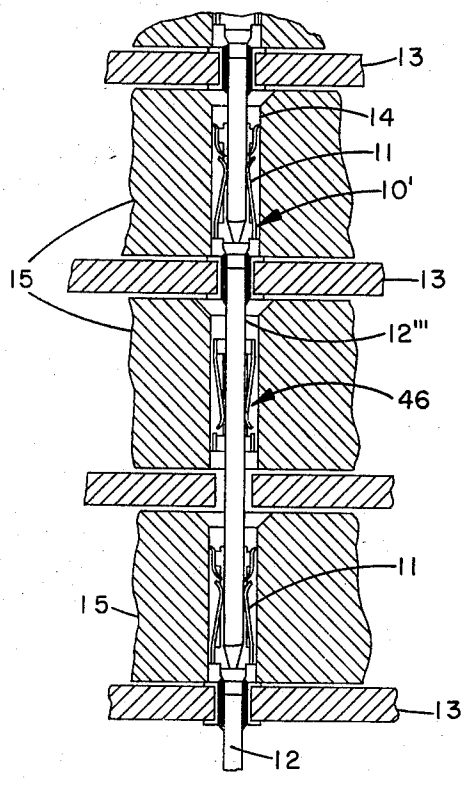

FIG. 8

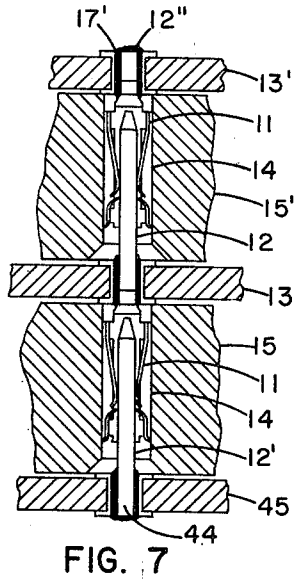

FIG. 7

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PIN AND SOCKET CONTACT ELECTRICAL INTERCONNECT SYSTEM

This invention relates in general to pin and socket contacts, and in particular, to a combined unitary pin and socket contact mounted in a housing associated with a circuit board with the pin projecting therefrom for insertion in the socket portion of another contact mounted in a housing of another circuit board.

It has become advantageous, in many instances, to be able to stack circuit boards in spaced parallel relation with allowance for circuitry including discrete components mounted on boards and to have good reliable electrical interconnect between boards as desired. This entails a desired uniformity of connector resistivity factors and for these to be at relatively low resistivity value through each mated connector. Pin to connector housing insertion hang-up problems must be minimized if not eliminated and current leakage between closely spaced pin connectors must be minimized. Further, compatibility interconnect with existing feed through box contacts is desirable. High stack by increments is a requirement with some units to allow for different component heights on circuit boards. Ease of single contact unit replacement is also highly desired.

It is therefore, a principal object of this invention to provide a combined unitary pin and socket contact, mounted in a housing of a circuit board and having circuit interconnect with circuitry carried by the board, adapted for pin to socket inserted electrical contact with another such contact mounted in a like manner on another circuit board stacked in parallel spaced relation to the first mentioned circuit board.

Another object is to provide mounting of the box socket within a housing mounted on a circuit board with the pin unitary with the box socket extended from the housing and through the circuit board mounting the housing.

A further object is to provide guided relatively free connector pin insertion to box sockets without hang-up.

Another object is to limit connector inserted pin lateral float within a box socket.

Still a further object is to insure substantially uniform balanced opposite side spring socket contact arm resilient engagement with an inserted pin throughout the entire range of pin lateral float.

Features of the invention useful in accomplishing the above objects include, in a pin and socket electrical interconnect system, a combined unitary pin and box socket contact with the box socket in a housing within a housing cavity and the pin extended from the housing and through a circuit board mounting the housing. This is with box sockets recessed within housing cavities to have recessed closed pin entry ends along with housing socket cavity beveled entries and connector pin pencil point chamfered ends, in combination, preventing hang up of connector pins during connector pin insertion. Opposite side coined relatively stiff tabs are provided adjacent the entry end of the box sockets that guide pins being inserted to proper entrance between opposite side resilient spring pin engaging contact arms. Further, the opposite side coined tabs are relatively short inwardly sloped stiff tabs subject to minimal deflection by connector pins being inserted into the box socket and provide mechanical over-stress protection for the resilient spring pin engaging contact arms. The opposite side tabs inner ends overlap the contact pin entrance ends of the spring contact arms that may be tapered in both width and thickness for optimized shortness of spring length with uniform stress therealong.

A specific embodiment representing what is presently regarded as the best mode of carrying out the invention is illustrated in the accompanying drawings.

In the drawings:

FIG. 1 represents a perspective view of applicant's unitary pin and socket contact;

FIG. 2, a side elevation cutaway and sectioned view with the contact box socket installed in place in the cavity of a dielectric material housing mounted on a circuit board and with the connector pin projecting through a plated through hole in the circuit board;

FIG. 3, a length of dual thickness beryllium copper strip stock used for forming a joined ribbon of the unitary pin and socket contacts;

FIG. 4, a two contact section of joined contact ribbon formed from the dual thickness strip stock of FIG. 3;

FIG. 5, a side elevation view of a unitary pin and socket contact in a ribbon joined state such as indicated in FIG. 4;

FIG. 6, a partially cutaway and sectioned view of two of the unitary pin and socket connectors in place in housing cavities with the pins projecting through a circuit board and the connector units shown in 90° rotated orientation from the connector position of FIG. 2;

FIG. 7, the parallel stacked relation of two circuit boards mounted in interconnected relationship from a side board with a side board pin inserted box socket engaging connection to the first adjacent circuit board and the unitary pin of the connector of the first adjacent circuit board projecting through that circuit board and into box socket engaging contact with a like box socket of the next parallel positioned circuit board; and

FIG. 8, a plurality of circuit boards in interconnected relation showing a double length pin of one unitary pin and box socket connector extended through a conventional through socket contact of an intermediate circuit board to inserted electrical contact with a box socket of a further spaced parallel circuit board.

Referring to the drawings:

The combined unitary pin and box socket contact **10** of FIG. **1** is formed from a unitary piece of metal with a box socket **11** and a connector pin **12** as an extension therefrom generally in longitudinal alignment with the center axis of the box socket **11**. These unitary pin and socket contacts **10** are intended for use with circuit boards or cards **13**, such as illustrated in FIG. **2**, with the box socket **11** inserted within a connector cavity **14** of a dielectric material housing **15** with the box socket **11** of the connector **10** seated on spaced parallel cavity ledges **16** in the fully inserted box socket seated position. This is with the connector pin **12** extended from housing **15** through a plated through hole **17** of the circuit board **13** where it is structurally and electrically conductively fixed in place by solder **17'**. Please note that the plated through hole **17** is provided with an upper pad **18** and a lower flange **19** either of which may be connected to circuitry of the copper clad photo-etched type or any other conductive elements of circuitry that may be connected thereto, and with the pad **18** providing a small degree of spacing for the dielectric material housing **15** from the circuit board **13** the housing **15** is mounted on. Housing **15** may include a plurality of relatively closely spaced, parallel connector cavities in single row, two row or plurality row relation, and is mounted on circuit board **13** as by rivets (detail not shown).

Unitary pin and socket contacts **10** as an item of manufacture are formed from a length of dual thickness beryllium copper strip stock **20**, such as shown in FIG. **3**, with a 0.025-inch thick strip portion **21** for the forming of the pins **12** and a 0.008-inch thick strip portion **22** for the forming of the box sockets **11** with a 45° transition bevel **23** that forms the pin beveled ends **23'** at the box socket connected end of the pins **12**. While beryllium copper has been the strip material employed for forming the contacts **10**, other suitable strip material could also be used with the strip material being die formed initially to dual opposite end ribbon **24** and **25** interconnected unitary pin and socket contacts **10** as shown in FIGS. **4** and **5**. The unitary pin and box socket contacts **10** are initially stamped and die formed by progressive die and stamping steps to have a box socket base side strip **26** from which opposite side inwardly directed spring arm **27** mounting base opposite side strap sections **28** extend, and from which opposite side box socket entrance end strap sections **29** extend, and with the entrance end strap sections **29** mounting inserted connector pin lateral float limiting opposite side inwardly sloped tabs **30**.

The box socket base end strap sections **28** and entrance end strap sections **29** are die formed to extend up at substantially 90° from the base side strip **26** and are then, from opposite side tops, bent inwardly at substantially 90° and terminated in spaced parallel longitudinally extended strips **31** and **32** interconnecting respective box socket end straps **28** and **29** and extending generally the length of the box socket **11** from the base thereof to the entrance end where they are terminated in outwardly formed tab ends **33** and **34**.

Thus, the box socket **11** is formed, however, with metal removed during the stamping and forming operations so that there is relief space at the corners of the box socket **11** with only strap sections **28** and **29** extending through the 90° corners of the box socket. Further, other than in the area of base side strip **26** where an extension transition interconnect **35** thereof forms the connective transition therefrom to the pin **12** of the unitary pin and box socket connector, portions of the outer end edges of base end strap sections **28**, forming the bottom of the box socket **11**, seat on spaced parallel ledges **16** within the cavity **14** of housing **15**. The transition interconnect **35** between the base side strip **26** of the box socket **11** and the connector pin **12** extends through extension opening **36** from the level of the ledges **16** in cavity **14** within housing **15** and supports the pin **12** generally in longitudinal alignment with the box socket **11** it is an extension of. In addition to the outwardly formed tab ends **33** and **34** at the entrance end of box socket **11**, the box socket is also formed with opposite side outwardly formed tab ends **37**, **38**, and **39** with outwardly formed tabs **37** and **38** extended from opposite side entrance end strap sections **29**, that mount connector pin lateral float limiting opposite side inwardly sloped tabs **30**, and with outwardly formed tab **39** an entrance end extension of box socket base side strip **26**. With a box socket **11** fully inserted within a cavity **14**, all the outwardly formed tab ends **33**, **34**, **37**, **38**, and **39** are sufficiently down within the rectangular walled portion of cavity **14** that pencil point chamfered pin end **40** of a connector pin **12** being inserted therein does not encounter any insertion bind or hang-up. Further, the cavities **14** are provided with beveled entrance sections **41** to further enhance mating insertion of connector pins **12** to box sockets **11**. On pin **12** insertion, the chamfered pin end **40** may come into guided sliding contact with an inwardly sloped surface of a tab **30** to be further guided to proper entrance to the pin electrical contact throat between contact opposite side spring arms **27** just after the outwardly flaired sloped entrance ends thereof.

Please note that the opposite side inwardly sloped spring arms **27** are tapered both in width and in thickness from their base connections with base end strap sections **28** slope inwardly from their base end mountings to a throat constriction terminating in an outward turned sloped flare, and are coin formed for uniform stress in resiliently gripping an inserted pin **12** therebetween with substantially uniform resiliently maintained contact engaging force throughout the range of lateral pin **12** float movement permitted between the inner ends of tabs **30** that are also coin formed tabs to provide the desired closed entry for the connector pins **12** as relatively stiff substantially nondeflectible tabs that thereby prevent mechanical overstress of the spring arms **27**. Furthermore, coining of the springs **27** along with the coin forming or swaging of tabs **30** provide a small degree of protective overlap of the spring arm **27** outwardly flared pin entrance ends and the inner tips of tabs **30** to thereby ensure that there be no occurrences of connector pin **12** insertion hang-up on the insertion end of pin contact arms **27**. Please note further, that these beryllium copper unitary pin and box socket connectors **10** after being die formed may be heat treated for structural strength and spring arm resilient spring force and then plated with corrosion resistant materials such as silver and/or gold, and that the space between the spaced parallel longitudinally extended strips **31** and **32** and end overlap relatively narrow clearance space provided between the entrance end extremities of spring arms **27** and the adjacent inner ends of overstress tabs **30** insures that all surfaces within the combined unitary pin and box socket connector end be properly plated with corrosion resistant material being plated thereon. The process of applying a corrosion resistant material is presently undertaken while the unitary pin and box socket contacts are still connected to the ribbons **24** and **25** in which form they are fed into and passed through corrosive resistant material plating baths with the ultimately severed and pencil point chamfered pin end **40** not being a critical metal area with respect to requiring a corrosive resistant material coating. This is also applicable with respect to the tab **39** cutoff area from the connective material extension **42** to the ribbon **25** that is provided with sprocket pin receiving openings **43** for the process feeding of the ribbon with the unitary pin and box socket connectors during plating processing thereof and/or for installation feeding thereof during a cutoff and insertion process handling thereof for the unitary pins and box socket connectors **10**.

Two of the unitary pin and box socket connectors **10** are shown in FIG. **6** mounted in side by side relationship in two row connector housing **15** with the two connector pins **12** thereof cut off to a one connector engaging pin chamfered end **40** length. FIG. **7**, on the other hand, illustrates how these unitary pin end box socket connectors **10** are utilized in contact engaged relationship with a pin **12'** mounted in a plated-through opening **44** of a side board **45** is inserted into electrically conductive connection relation with the box socket **11** that is contained within cavity **14** of housing **15** mounted on circuit board **13** with the pin **12** extension thereof in turn also connectively inserted into a box socket **11** contained in cavity **14** of housing **15'** mounted on a circuit board **13'** with respective to which the pin **12''** extensions may be inserted into plated-through holes **17** and cut off instead of in turn being inserted in another box socket **11**. In the circuit board stackup illustrated in FIG. **8**, an interconnect relation is shown using a unitary pin and box socket connector **10'** with a double length pin **12'''** that is connected through an intermediate conventional through socket contact **46** of an intermediate circuit board to inserted electrical contact with the box socket **11** of a further spaced parallel circuit board. Please note that the box socket **11** configuration presented as well as combination unitary connector pin and box socket connectors may be mounted in parallel to a circuit board installation in attaining additional connector system flexibility (detail not shown). Further, a box socket that has been produced in accord herewith approximately 0.165 inches long for receiving 0.025-inch square connector pins provides highly reliable excellent operational service. This is with such pin and socket connections presenting a resistivity factor generally in the range of three to ten milliohms averaging approximately 5 milliohms and with the connectors rated at 3 amperes.

Whereas this invention is herein illustrated and described with respect to several embodiments hereof, it should be realized that the various changes may be made without departing from essential contributions to the art made by the teachings hereof.

I claim:

1. In a contact for use in an interconnect system, a box socket in the form of an elongate housing with connector pin entrance and base ends; first and second strap portions at opposite ends of said housing; a pair of spring members projecting inwardly from opposite sides of said housing and extended from connection to the housing adjacent the housing base end generally in the direction of the housing entrance end; said pair of spring members having outwardly flared free ends; said pair of spring members being tapered from larger cross section at the spring member mounting ends to relatively smaller cross section at a connector pin engaging electrical contact throat area between the pair of spring members; a pair of tabs projecting inwardly from opposite sides of said housing with connections to the housing integral with the inner edge of the strap portion and sloped to spaced ends for guided entrance of a connector pin and limiting lateral movement of a connector pin inserted to contact engagement between said pair of spring members; and wherein relatively narrow space is provided

between the tip ends of said spring members and the inner tip ends of adjacent respective tabs of said pair of tabs.

2. The contact of claim 1, wherein electric circuit connective means extends externally from said box socket and includes a connector pin extension configured for mating electrical contact inserted connection with another unit of said box sockets.

3. The contact of claim 2, wherein said box socket and said electric circuit connective means is, as an article of manufacture, a combined unitary connector pin and box socket contact adapted for stacking interconnect with the connector pin of one unitary connector pin and box socket contact receivable into inserted contact mating relation with the box socket of another contact unit.

4. The contact of claim 3, wherein said box socket is generally rectangular transversely to the elongate axis of the box socket housing; and said connector pin of said unitary connector pin and box socket contact is substantially in line with and extended generally along the extension of the elongate axis of the box socket housing.

5. The contact of claim 1, wherein each of said spring members is tapered both in width and thickness.

6. The contact of claim 1, wherein the tip ends of the said outwardly flaired free ends of said pair of spring members overlap respectively the outer side of the inner tip ends of said pair of tabs.

7. In a contact for use in an interconnect system, a box socket in the form of an elongate housing with connector pin entrance and base ends; first and second strap portions at opposite ends of said housing; a pair of spring members projecting inwardly from opposite sides of said housing and extended from connection to the housing adjacent the housing base end generally in the direction of the housing entrance end; said pair of spring members having outwardly flared free ends; said pair of spring members being tapered from larger cross section at the spring member mounting ends to relatively smaller cross section at a connector pin engaging electrical contact throat area between the pair of spring members; a pair of tabs projecting inwardly from opposite sides of said housing with connections to the housing integral with the inner edge of the strap portion and sloped to spaced ends for guided entrance of a connector pin and limiting lateral movement of a connector pin inserted to contact engagement between said pair of spring members; wherein relatively narrow space is provided between the tip ends of said spring members and the inner tip ends of adjacent respective tabs of said pair of tabs; electric circuit connective means extends externally from said box socket and includes a connector pin extension configured for mating electrical contact inserted connection with another unit of said box sockets; wherein said box socket and said electric circuit connective means is, as an article of manufacture, a combined unitary connector pin and box socket contact adapted for stacking interconnect with the connector pin of one unitary connector pin and box socket contact receivable into inserted contact mating relation with the box socket of another contact unit; and wherein said unitary connector pin and box socket contact is, as an article of manufacture, stamped and die formed from a dual thickness ribbon of conductive metal strip stock.

8. The contact of claim 7, wherein at an intermediate state of manufacture said unitary connector pin and box socket contacts are interconnected by ribbon means left from said dual thickness ribbon of conductive metal strip stock.

9. The contact of claim 8, wherein said ribbon means includes two ribbons, a first ribbon connected to connector pins, and a second ribbon connected to the box socket housings of said unitary connector pin and box socket contacts.

10. The contact of claim 8, wherein said ribbon means is a ribbon connected to extensions of said box socket housings.

11. The contact of claim 7, wherein said pin is formed from the thicker portion of said dual thickness ribbon; and said box socket housing is formed from the thinner portion of said dual thickness ribbon of conductive metal strip stock.

12. The contact of claim 11, wherein said dual thickness ribbon of conductive metal strip stock includes an intermediate bevel transition between the two thicknesses of the dual thickness ribbon strip stock; and said bevel provides a box socket housing adjacent beveled end on said connector pins.

13. In a contact interconnect system for electrically interconnecting circuit boards stacked in spaced parallel relation: a box socket in the form of an elongate housing with connector pin entrance and base ends; first and second strap portions at opposite ends of said housing; a pair of spring members projecting inwardly from opposite sides of said housing and extended from connection to the housing adjacent the housing base end generally in the direction of the housing entrance end; said pair of spring members having outwardly flared free ends; said pair of spring members being tapered from larger cross section at the spring member mounting ends to relatively smaller cross section at a connector pin engaging electrical contact throat area between the pair of spring members; a pair of tabs projecting inwardly from opposite sides of said housing with connections to the housing integral with the inner edge of the strap portion and sloped to spaced ends for guided entrance of a connector pin and limiting lateral movement of a connector pin inserted to contact engagement between said pair of spring members; with relatively narrow space provided between the tip ends of said spring members and the inner tip ends of adjacent respective tabs of said pair of tabs; and a dielectric material housing with a box socket connector holding cavity mounted on a circuit board.

14. The contact interconnect system of claim 13, wherein said box socket is part of a combined unitary connector pin and box socket contact, with an extension from the box socket an interconnection to a connector pin extended through an opening in the circuit board mounting said dielectric material housing.

15. The contact interconnect system of claim 14, wherein said connector pin is an elongate connector pin extended substantially along an extension of the longitudinal axis of said box socket.

16. The contact interconnect system of claim 15, wherein the box socket has a rectangularly shaped entrance end formed with outwardly directed tabs from all four sides of the rectangular entrance end; and with the box socket positioned in place in said box socket connector holding cavity said outwardly directed tabs being located below said beveled entrance section within the cavity.

17. The contact interconnect system of claim 13, wherein said box socket includes shoulder means at the box socket housing base end; and said box socket connector holding cavity in a dielectric material housing includes ledge means positioned to be engaged by said box socket shoulder means.

18. The contact interconnect system of claim 17, wherein the box socket connecting holding portion of said box socket holding cavity in said dielectric material housing is rectangular with two pairs of spaced parallel walls; and opening extends from said ledge means to the circuit board side of said dielectric material housing; and said extension from a box socket, fully inserted to the seated state in said dielectric material housing, extending into said opening extended from said ledge means.

19. The contact interconnect system of claim 15, wherein said connector pin is an extended length pin sufficiently long to establish mated electrical contact with a box socket mounted on a circuit board not adjacent to the circuit board, mounting the unitary connector pin and box socket contact with the extended length pin, in a stack of spaced parallel electrically interconnected boards.

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