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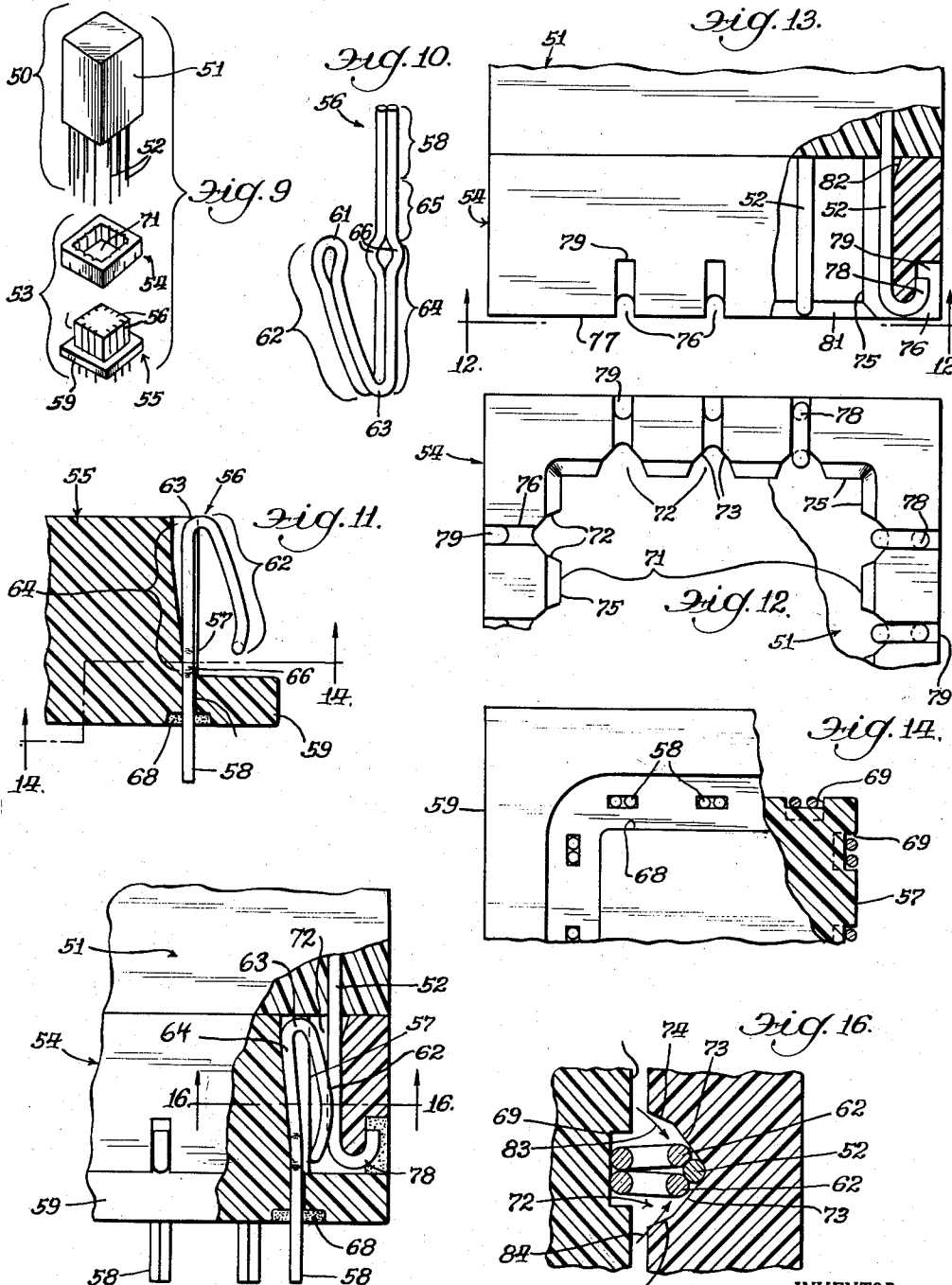
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3,106,435

ELECTRICAL CONNECTORS

Filed Sept. 19, 1960

3 Sheets-Sheet 2



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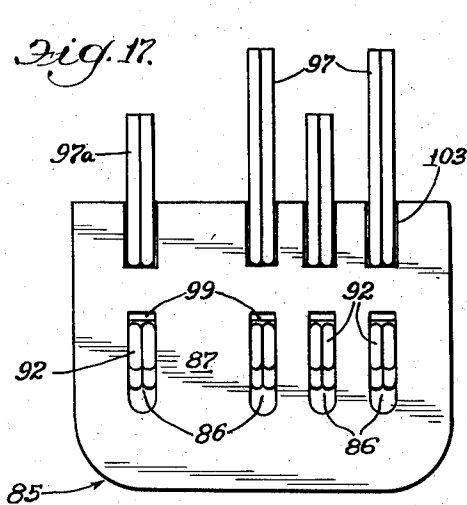
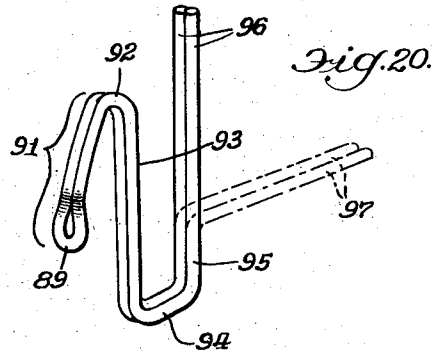
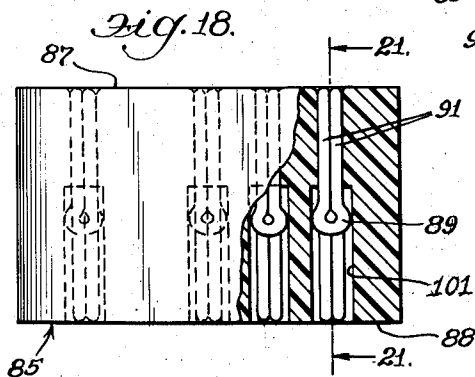
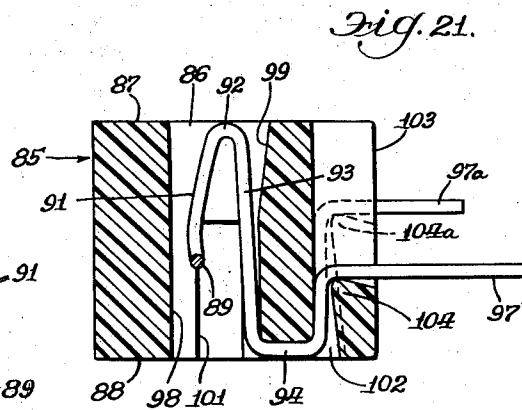
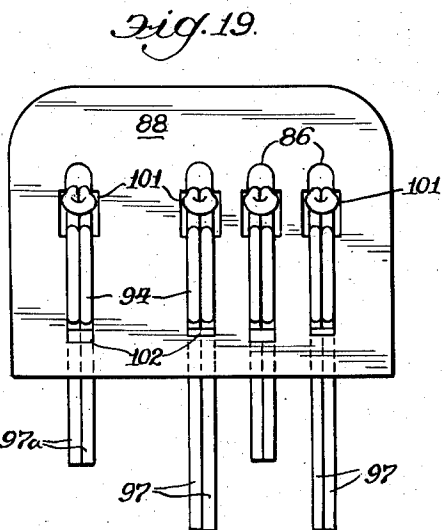
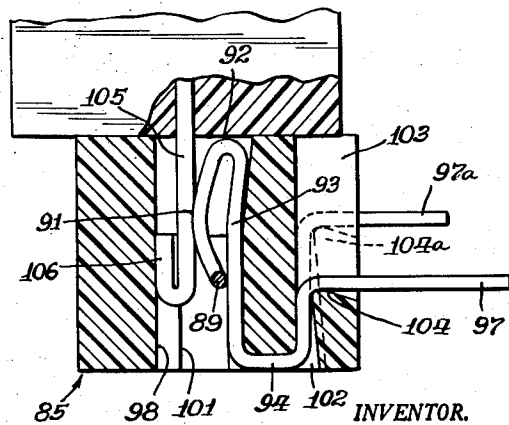
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3 Sheets-Sheet 3



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ELECTRICAL CONNECTORS

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Filed Sept. 19, 1960, Ser. No. 56,898

2 Claims. (Cl. 339-176)

This invention relates to electrical connectors and more particularly to connectors of extremely small physical size, suitable for use in connection with sub-miniature or micro-miniature electronic components.

It is the primary object of the present invention to provide an electrical connector having its contact members, as well as the mounting elements therefor, of such design and construction as to permit the use of a comparatively large number of mating contacts in closely grouped relation, yet with the coating parts of the connector designed and constructed in a manner to achieve positive, low resistance electrical unions between the mating contacts without sacrifice of essential mechanical characteristics.

It is one of the more specific objects of the invention to provide an electrical connector of the micro-miniature type, wherein both the metallic contacts and the insulating mountings in which they are carried are of such design that the electrical continuity existing between mating parts of the contacts will not be adversely affected by misalignment of the mating contact members (or by variations in the spacing therebetween) even when these variations may be a substantial percentage of the physical size of the contacts involved.

A further specific object of the invention is to provide electrical connectors in extremely small size ranges with the parts so designed as to be capable of long repeated coupling and uncoupling operations without undue changes in the insertion and withdrawal forces characteristic of the connector and without appreciable changes in the microvolt drop between the mating pairs of contacts.

A still further object of the invention is the provision of an improved micro-miniature electronic connector wherein the interengaging surfaces of all contacts are smoothly rounded surfaces, free from exposed edges or sharp corners. By this expedient, the contacts may be repeatedly engaged and disengaged without tendency to scratch, scrape or wear the precious metal plating from the individual contact members, notwithstanding their extremely small physical dimensions.

A still further object of the invention is the provision of an electrical connector adaptable to use in connection with extremely small and closely spaced contacts wherein each mating pair of contacts engages the other at two different and separate areas of contact, notwithstanding that the individual contact members may be of a diameter of about .01 inch or less.

A still further object of the invention is the provision of a connector, and contacts therefor, of such design and construction that the contacts may directly engage the relatively stiff wire leads conventionally provided in transistors and various other miniaturized circuit components, but are equally suited to engagement with leads of soft, non-resilient metal as sometimes provided in "packaged circuit" modules.

Another object of the invention is to provide miniaturized contacts suitable for use in connection with transistor sockets or circuit module connectors with simplified, yet positive, means for mounting the contacts in the connectors.

Additional objects of the invention are the provision of contacts of improved design arranged to flex adequately to accommodate themselves to comparatively wide variations in the size, spacing and alignment of the

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mating contacts of the connector, yet to accomplish these desirable aims without unduly complex structures and with a design wherein both the conducting and insulating portions of the connector are adapted to inexpensive methods of manufacture.

The objects of the invention are accomplished by the unique arrangements of contacts and mountings described in the following disclosure, from which it will appear that the novel contacts of the invention may be conveniently utilized in the socket or the plug of the connector, while being equally adaptable to an arrangement whereby a plurality of leads formed integrally with a module circuit unit are arranged to mate with receptacle contacts according to the present teaching. In any case, the conductive contacts employed and the insulating mountings provided therefor are so arranged that a comparatively large flexing range is achieved, notwithstanding the extremely small physical size of the contacts involved. This is in part because the interengaging contacts are designed to distribute the flexing along a relatively long spring base, but it is also largely due to the unique arrangement disclosed hereinafter wherein the combination of a double-wire spring base and blade portion of the contacts not only permits lateral flexing, but simultaneously allows limited spreading of the wires to fit varying diameters of the mating contact element, coupled with a considerable degree of swinging or pivotal movement to provide for variations in contact alignment or spacing.

In the drawings of the present specification, the invention is illustrated in three variations, including a plug-and-socket connector, a circuit module connector wherein the conventional flexible leads extending from a circuit module are utilized as the contacts of a connector receptacle, and an application of contacts formed according to the invention in a transistor socket.

In the drawings,

FIGURE 1 is a perspective view of a sub-miniature connector receptacle according to the present invention (shown without conductors or sealing resin thereon), and FIGURE 2 is a similar perspective view of a sub-miniature plug adapted to be received in the receptacle of FIGURE 1.

FIGURE 3 is a greatly enlarged perspective view of one of the preformed wire contacts as used in the receptacle of FIGURE 1, and

FIGURE 4 is a similarly enlarged perspective view of a preformed wire contact as used in the plug.

FIGURE 5 is a greatly enlarged cross-sectional view of an assembled plug and receptacle;

FIGURE 6 is a fragmental front end view of the plug;

FIGURE 7 is a greatly enlarged side elevational view of the plug, shown partly in section, and

FIGURE 8 is a fragmental back view of the plug of FIGURE 7.

FIGURE 9 is an exploded perspective view of the component parts of the aforementioned circuit module connector according to the present invention, showing the relationship of the connector plug and receptacle to a sub-miniature packaged circuit module for which they are specifically designed;

FIGURE 10 is a greatly enlarged perspective view of one of the contacts used in the connector of FIGURE 9;

FIGURE 11 is a greatly enlarged fragmental cross-sectional view of the plug portion of the assembly of FIGURE 9;

FIGURE 12 is a similarly enlarged fragmental bottom plan view of a receptacle flange such as utilized in connection with the assembly of FIGURE 9;

FIGURE 13 is a fragmental side elevational view showing a sub-miniature packaged circuit module with a connector receptacle frame according to the present

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invention attached thereto, with the view partially broken away to illustrate the manner in which the terminal leads of the module are used as contacts of the connector;

FIGURE 14 is a bottom plan view of the connector plug, with portions of the structure broken away as indicated by the line 14—14 of FIGURE 11;

FIGURE 15 is a fragmental side elevational view of a sub-miniature packaged circuit module with connector plug and receptacle flange attached thereto, with the structure being partially broken away to show the relationship of the plug contacts and the receptacle leads in assembled position; and

FIGURE 16 is a further enlarged detail cross-sectional view taken substantially on the plane of the line 16—16 of FIGURE 15;

FIGURE 17 is a greatly enlarged plan view of a transistor socket designed to utilize preformed wire contact members as contemplated by the present invention;

FIGURE 18 is a front elevational view of the transistor socket of FIGURE 17, the view being partially broken away to show the contacts therein;

FIGURE 19 is a bottom plan view of the transistor socket of FIGURES 17 and 18;

FIGURE 20 is a greatly enlarged perspective view of one of the preformed wire contacts utilized in the socket of FIGURES 17 to 22, inclusive;

FIGURE 21 is a transverse cross-sectional view taken substantially on the plane of the line 21—21 of FIGURE 18, and

FIGURE 22 is a cross-sectional view similar to FIGURE 21, but showing the position assumed by the wire contacts of the socket upon the insertion of the terminal wires of a transistor therein.

As heretofore indicated, it is one of the objects of the present invention to provide sub-miniature multiple contact releasable connectors of general applicability, adapted to use in any type of circuitry requiring connection of a relatively large number of interconnected circuits by an unusually compact device.

According to the present invention, the connector receptacle (FIGURE 1), may include a marginal frame and socket adapted to receive the plug assembly (FIGURE 2), which consists of a molded dielectric member 11 including a central, generally square upright body portion 12 integral with the molded flange 13, with a keyed post 14 cemented within an appropriately shaped aperture 15 of the plug body and having a threaded screw hole 16 at its forward (upper end).

The contacts 17 are mounted alongside the sides of the upright body 12 in apertures 18 which pass through the flange 13 and meet a groove 19 in which they may be secured by epoxy resin or other adhesive.

The conformation of the plug contacts is best seen in FIGURE 4 from which it will be apparent that each of the contacts is a single length of slender spring wire, doubled upon itself along its entire length to form a hairpin bend 21 at the end, from which a blade portion 22 consisting of paired wires extends to a return bend 23 and thence to a straight back spring which includes a free-standing upright 24 separated from a mounting shank 25 by a bulged limit stop 26. The mounting shanks 25 extend through the flange 13 (FIGURE 7), and through the groove 19, to the terminal end portions 27 of the contacts. Preferably, the generally parallel paired wires of the blade portion 22 are curved to present a convex slide face best shown in FIGURES 4 and 7 and adapted to slidably engage a mating contact. The individual contacts are mounted in the plug with their shanks 25 extending through the apertures 18 and their free-standing back spring portions 24 disposed in a series of generally parallel tapered slots 28 formed along the opposite face walls of the upright body of the plugs.

In the form of the invention illustrated, the connector receptacle is formed of a rectangular body flange 31 of molded dielectric material having a central upright 32

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with keyed socket 33 to receive the upstanding keyed post 14 of the connector plug. A screw 34 and washer 35 are supplied to secure the plug and receptacle to each other.

The receptacle contacts (FIGURE 3) are mounted in an open marginal frame generally designated by the numeral 36 and provided with a plurality of grooved contact channels 37 spaced along its inner walls (FIGURE 5), and passing through notches around its lower edge surface 38 to exterior notches 39. These channels and notches are shaped in the manner more fully described hereinafter in connection with FIGURES 12 and 13.

The receptacle contacts, best shown in FIGURES 3 and 5, each consist of a single preformed piece of wire 40 including a blade portion 41 having a 180° bend forming a hook 42 at its extreme end, with a lateral offset portion 43 extending from the blade to a shank portion 44 leading to a terminal loop 45. As seen in FIGURE 5, the receptacle contacts are assembled in spaced locations along the inner walls of the frame member 36, with the blade portions 41 of each of the contacts lying in one of the several channels 37 corresponding to the contacts 17 of the connector plug. The hook portions 42 of the individual contacts extend through notches in the lower edge 38 of the rectangular frame and are seated in the exterior notches 39 therein, while the laterally offset portions 43 extend outwardly through notches 46 communicating with the slots 47 through which the shank portions 44 extend to the terminal loops 45. These terminal loops are, of course, interconnected to flexible conductors 48 and, if desired, the junctions may be sealed within a layer of resin or other dielectric compound 49.

As heretofore mentioned, the present invention may be utilized to provide a multiple contact releasable connector particularly adapted to use with sub-miniature packaged circuit modules, which may include a relatively large number of interconnected internal circuit components such as resistors, capacitors and transistors, in an extremely compact unit. A typical module may have the appearance indicated at 50 in FIGURE 9 of the drawings, the module shown including a housing or case 51 from which about twelve slender wire terminal leads 52 project.

According to the present invention a connector assembly generally designated 53 is provided which, in the form of the invention illustrated in the drawings, includes a molded dielectric receptacle frame 54 and a molded dielectric plug 55. The receptacle is notched and grooved in a manner such that the terminal wires 52 of the circuit module 50 function as the receptacle contacts, while the plug 55 is provided with a series of contacts 56 arranged on the upright faces 57 with their terminal portions 58 extending through a marginal bottom flange 59 (FIGURES 11 and 15).

The conformation of the plug contacts is best seen in FIGURES 9 and 10, from which it will be apparent that each of the contacts 56 is a single length of slender spring wire, doubled upon itself along its entire length to form a hairpin bend 61 at the end, from which a blade portion 62 consisting of paired wires extends to a return bend 63 and thence to a straight upright which includes a free-standing post 64 leading to a bulged limit stop 66 and a mounting shank 65 extending through the flange 59 (FIGURE 11), thence to the terminal portion 58 of the contact. Preferably, the generally parallel paired wires of the blade portion 62 are curved to present a convex slide face best shown in FIGURE 11 and arranged for sliding engagement with the receptacle contact, as shown in FIGURE 15. The individual contacts are mounted in the plug with their post portions secured in apertures through the plug flange 59 by epoxy resin in the groove 68, with the free-standing portions of their shanks disposed in a series of generally parallel slots 69 formed along the opposite face walls 57 (FIGURE 14).

In the form of the invention illustrated, the rectangular

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receptacle frame 54 has an open central recess generally designated by the numeral 71, with a plurality of grooved contact channels 72, each having a portion of their side walls lying at an obtuse angle to each other as indicated at 73, with the outer portions 74 of the side walls lying at an acute angle to each other as best seen in FIGURES 12 and 16. The channels 72 are spaced along the inner walls 75 of the receptacle frame in a manner corresponding to the positioning of the terminal wires 52 of the packaged circuit module with which the connector is to be used, and the receptacle frame can accordingly be conveniently attached to the packaged circuit by slipping the receptacle frame over the projecting wires 52 and seating upper face of the frame flush against the bottom of the module case 51. The ends of the individual lead wires 52 are then bent outwardly through notches 76 on the lower edge surface 77 of the receptacle frame and doubled back upon themselves, with the ends clipped off so that the wires form hooks 78 seated in the outside notches 79 (FIGURE 13). The notches 79 may then be filled with epoxy resin to insulate the ends of the contacts, if desired. Also, the receptacle frame may be beveled at 81 and 82 to facilitate insertion of the leads 52 in the channels 72 and to facilitate insertion of the plug of the connector into the receptacle.

When the plug is inserted into the receptacle, the parts assume the position illustrated in FIGURES 15 and 16. From these figures it will be seen that the contact arrangement is such that the receptacle contacts, that is, the portions of the wire leads 52 lying in the angularly tapered grooves 72, will be fairly well restrained against any substantial lateral movement, both by the tapered side walls 73 of the grooves 72 (FIGURE 15), and by the 180° hooks 78 seated in the notches 79. The plug contacts, however, are formed and mounted in such a manner that the convex slide surfaces of their engaging blade portions 62 have considerable freedom in three different paths of movement. As a result, the contacts 56 may flex inwardly, swing angularly, or spread their paired wires enough to conform to the leads 52, and to thus positively engage the leads irrespective of considerable variation in the spacing or alignments of the leads. For example, it will be noted from FIGURE 15 that the flexing of the contacts is not limited to the blade portion 62 of the wire, since they are also free for flexing in the return bend 63 and all of the free-standing portion 64 of the shank above the upper face of the flange 59. This movement, moreover, may take place in several ways; for example, inward lateral movement of the contact from the position of FIGURE 11 to the position of FIGURE 15 is permitted by the free-standing post portion 64 and reverse bend supporting the blade, coupled with the slight taper of the inner walls of the contact channels 69. Swinging movement of the contact blade is also permissible, in either of the two directions indicated by the arrows 83 and 84 of FIGURE 16. In addition, it is clear that the yieldability of the wire in the zone of the hairpin bend 61 will permit the two generally parallel wires in the blade portions 62 of the contact to spread apart from each other in the manner illustrated in FIGURE 16, so that the individual wires of the contact will separately engage and pinch the conductor 52, thus establishing two points of frictional engagement and, of course, two points of electrical union between each contact of the plug and the corresponding contact of the receptacle. It follows that although these members are extremely small in physical size, they are so designed that the parts will operate properly without the necessity of unreasonably exacting manufacturing tolerances and thus with a high degree of reliability, even under adverse conditions of use.

A transistor socket constructed in accordance with the teachings of the present invention is illustrated in FIGURES 17 to 22, inclusive. In accordance with these figures, which are greatly enlarged in the drawings, it is practicable to manufacture and assemble small transis-

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tor sockets and the like with the socket body comprising a single molded piece of dielectric insulating material and the contacts consisting of relatively simple preformed shapes of plated spring wire similar to those heretofore described, yet with the parts so designed that the contacts not only are positively retained in operating position in the socket body but are mounted in such a manner as to provide an extremely long spring base in relation to the size of the contacts and the amount of movement required. To this end, the body portion of the socket may be a dielectric insulating molding 85 having a plurality of cored openings 86 in its upper face surface 87 with the individual openings 86 extending entirely through the molding from the upper face 87 to the bottom surface 88 thereof (FIGURES 18 and 21). The contacts of the socket are preformed of plated spring wire of the conformation illustrated in FIGURE 20 including a hairpin bend 89 at the unsupported end of a blade portion 91 of the contact with a return bend 92 uniting the blade portion 91 with a relatively long vertical upstanding back spring 93 generally parallel with the blade portion 91.

As thus far described, it will be apparent that the contacts of the transistor socket, shown in FIGURES 17 to 22, are substantially identical with the contacts of the forms of the invention illustrated in FIGURES 1 to 16, inclusive; but in the transistor socket it has been found advantageous to provide a lateral offset 94 at the lower end of the spring portion 93 leading to an upstanding mounting shank portion 95 from which the paired wires of the connector extend straight upwardly, as shown at 96, before assembly, but are arranged to be bent over in the manner indicated at 97 after the contacts have been inserted in the apertures 86 of the socket dielectric. It will be observed from FIGURE 21 that while the forward wall 98 of the openings 86 is preferably a straight vertical surface, the rearward wall of the cavities may be tapered outwardly at 99 to facilitate spring action of the contacts. Also, the cavities 86 are preferably formed with channels or grooves 101 along their side walls to give freedom of movement for the hairpin loop portions 89 of the individual contacts.

The contacts are maintained in position in the socket dielectric by passing the upright portions 96 of the individual contacts upwardly through apertures 102 where they are locked in position by bending their terminal portions 97 through the slots 103 and over the shoulder portions 104, as illustrated in FIGURES 21 and 22. In practice, the shoulders 104 are placed at slightly different elevations for adjacent contacts so that the shoulders will be offset as 104 and 104a, with the outwardly bent portions of adjacent contacts correspondingly offset as indicated at 97 and 97a.

The operation of the contacts of the connector is best illustrated by comparison of FIGURES 21 and 22 of the drawings, from which it will be seen that in idle position the contacts are so mounted that the upstanding backing spring portion 93 is slightly inclined outwardly from the back wall of the aperture 86 with the contact blade portions 91 supported only by the bend 92 at its upper end and with the hairpin loop 89 free to move within the space provided by the side grooves 101. When the contact pins of a transistor are inserted in the socket, however, the pins 105, which may be doubled upon themselves as indicated at 106, will engage the spring blade portion 91 of both of the wires of the contact as the pin slides along the forward wall 98 of the aperture, flexing the contact backwardly against the back wall 99 and establishing an electrical connection, in the same manner as heretofore illustrated. The length of the spring wire subject to flexing is sufficiently long to avoid any possibility of imparting a permanent set to the metal, and the design and arrangement of the contacts is such that when the contact pins 105—106 enter the cavities 86, the double wire blades 91 of the contacts may swing back or forth as required, may spread apart, and may otherwise flex along

the entire length of the spring area of the contacts to compensate for any misalignments and dimensional variations that may exist, not only in the spacing or alignment of the pins 105, but also to accommodate pins within any reasonable range of dimensional variations.

From the preceding description it should be apparent that the present invention provides connector contacts and mountings designed to cooperate in a manner such that the electrical continuity existing between mating pairs of the contacts will not be adversely affected, even by comparatively large variations in spacing or alignment of the mating contact members, and that the flexible parts of the contacts are sufficiently long to be capable of repeated coupling and uncoupling operations without undue changes in the insertion and withdrawal forces. Nevertheless, the construction permits the use of a large number of contacts closely grouped with respect to each other, and achieves positive low resistance electrical unions between mating contacts, even in connectors of extremely small physical size suitable for use in connection with sub-miniature or micro-miniature electronic components.

The contacts are quite compliant in that they are arranged to flex adequately to accommodate themselves to comparatively wide variations in the size, spacing and alignment of the mating contacts of the connector, yet are simple in design and do not require complex mounting structures. Moreover, both the conducting contacts and insulating mounting portions are adapted to inexpensive methods of manufacture.

Further, the design is such that the unique form of contacts disclosed may be used on either the plug or receptacle of a connector or may even directly engage the relatively stiff wire leads conventionally provided in transistors and other miniature components, while being equally suited to engagement with the more flexible connections conventionally provided in packaged circuits.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

1. An electric connector comprising, in combination, 40
a receptacle consisting of a peripheral frame including opposed upright walls around an open socket with a plurality of parallel channels formed along the inside walls of said frame; a plurality of relatively stationary connector lead wires disposed in parallel relation and lying within said channels, with one end of each of said lead wires bent around one edge of a wall of the frame and anchored; the mating member of the connector comprising a plug portion fitted within the socket of the receptacle frame and having a plurality of contacts; the contacts of said plug each consisting of a length of resilient metallic wire doubled upon itself in a hairpin bend at the extreme end of a blade portion consisting of a pair of side-by-side wires, the blade portion being also folded back upon itself in a return bend interconnecting the end of the blade portion with a free-standing post portion of the contact also comprising a pair of generally parallel lengths of wire extending from the aforesaid return bend to a mounting shank portion of the contact whereby the paired side-by-side wires forming the blade portion of 60

the contact are yieldable in three degrees of freedom, to conform to and engage a mating contact by flexing, twisting and spreading of the contact wires.

2. An electric connector comprising, in combination, 5
a receptacle consisting of a peripheral frame including opposed upright walls around an open socket with a plurality of parallel channels formed along the inside walls of said frame; a plurality of relatively stationary connector lead wires disposed in parallel relation and lying within said channels, with one end of each of said lead wires bent around one edge of a wall of the frame and through a notch in the edge thereof, and terminating in a hooked end portion anchored in an exterior notch; the mating member of the connector comprising a base flange and a plug portion fitted within the socket of the receptacle frame and having a plurality of grooves in generally parallel position and in registry with the aforementioned channels of the receptacle, with a contact in each of said grooves: the contacts of said plug each consisting of a length of resilient, round metallic wire doubled upon itself in a hairpin bend at the extreme end of a blade portion consisting of a pair of side-by-side wires, the blade portion being also folded back upon itself in a return bend interconnecting the end of the blade portion with a free-standing post portion of the contact also comprising a pair of generally parallel lengths of wire extending from the aforesaid return bend to a mounting shank portion of the contact fixedly mounted in the aforesaid base flange; with the blade of the contact and the free-standing post portion generally parallel with respect to each other and with the post portion loosely confined within the aforesaid groove of the plug in unsupported relation thereto whereby the paired side-by-side wires forming the blade portion of the contact are yieldable in three degrees of freedom, to conform to and engage a mating contact by flexing, twisting and spreading of the contact wires.

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