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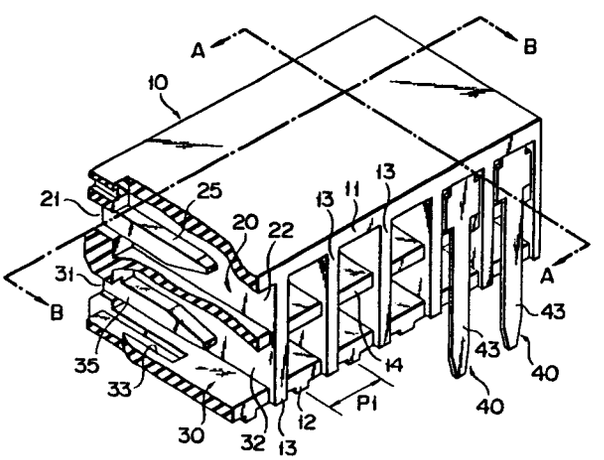
(54) Multi-contact electrical connector and method of assembling same.

(57) An electrical connector employs an insulative molded housing (10) with upper and lower cavities (20, 30) of rectangular cross-section into which are set female contacts (40, 50). The cavities (20, 30) open from front and rear faces (21, 31, 22, 32) of the housing (10) and are spaced apart by a predetermined pitch to receive with contact reception spaces (46, 56) a set of male contacts inserted from the front face (21, 31) of the housing (10). The contacts (40) in the upper cavities (20) have exterior terminal strips (43) bent down to overlie the rear face (22, 32) of the housing (10) and the lower cavites (30). These strips (43) adjoin bent-over superimposed portions (41, 44) disposed at the ceilings of the upper cavities (20) and from which spring arms (47) depend. The contacts (50) in the lower cavities (30) also have exterior terminal strips (53) which project downwardly from the lower cavities (30) but at the front face (31) of the housing (10). The terminal strips (50) adjoin contact portions (54) from which spring arms (57) are surmounted. The contacts are pre-formed as integral assemblies (61, 71) with individual contacts (40, 50) supported by a carrier (20). The contacts (50) in the lower cavities (30) are introduced into the cavities from the rear face (32) preferably with the aid of a jig and when located the terminal strips (53) are bent down. The contacts (40) in the upper cavities are likewise introduced from the rear but supported with the carrier. When set the terminal strips (43) are bent down and then severed from the carrier.



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MULTI-CONTACT ELECTRICAL CONNECTOR AND METHOD OF ASSEMBLING SAME

Field of the Invention

The present invention relates to a multi-contact electrical connector with rows of cavities containing an upper and a lower series of female contacts and to a method of assembling these components.

Background of the Invention

It is well known to construct a socket of a two-part connector as a housing with multiple female contacts contained therein with a predetermined mutual spacing. Conventional female contacts used in a multi-contact electrical connector of this type are stamped and pressed from a metallic sheet to provide regions or portions for making contact with the complementary male contact. See for example, Japanese Unexamined Utility Model Publication No. 99088/79 (especially Fig. 3). The female contacts are generally fabricated as a group in a contact assembly. This assembly then has a series of female contacts supported at a predetermined pitch along one longitudinal side of a belt-like carrier. If the contact pitch of the contact assembly coincides with that of the multi-contact electrical connector, the female contacts can be set in the connector housing while still supported by the contact carrier when the connectors are assembled. Otherwise the contacts must be cut from the contact carrier and individually set in the housing. Difficulties also arise where contacts are to be set in rows and are provided with terminal strips for providing the necessary external connection to the contacts.

Summary of the Invention

It is an object of the present invention to provide an improved multi-contact electrical connector and an improved method of assembling the contacts thereof.

A connector constructed in accordance with the invention comprises a housing defining a plurality of cavities arranged in upper and lower rows one above the other each cavity being open at opposite ends; a set of

first female contacts located within at least some of the cavities in the upper row and a set of second female contacts located within at least some of the cavities in the lower row, the contacts being of one-piece integral construction. In accordance with the invention each first contact has a contact portion, a cantilevered clamping portion spaced from the contact portion to provide therewith a reception space for a male contact insertable into the associated cavity from one end and a terminal strip connected to the contact portion and projecting outwardly from the other end of the cavity for enabling electrical connection with the contact. Each second contact has a contact portion, a cantilevered clamping portion spaced from the contact portion to provide therewith a reception space for a male contact insertable into the associated cavity from one end corresponding to said one end of each cavity containing one of the first contacts and a terminal strip connected to the contact portion and projecting outwardly from the one end of the cavity for enabling electrical connection with the contact.

The terminal strips of the first contacts are preferably bent at right angles to the cavities alongside a rear face of the housing where the other ends of the cavities are disposed to overlap the other ends of the lower cavities. The terminal strips of the second contacts are also preferably bent at right angles to the cavities to project down from a front face of the housing where the male contacts of a plug for example would be presented.

The invention also provides a method of assembling a connector as aforesaid utilizing pre-fabricated contact assemblies composed of a series of said first contacts spaced apart by a predetermined pitch corresponding to the spacing between adjacent cavities in the upper and lower rows and supported by a carrier and a series of said second contacts spaced apart by the same predetermined

pitch and supported by a carrier; said method comprising separating the second contacts from the carrier while supporting the contacts at the predetermined pitch, inserting the said contacts into cavities in the lower row from the other ends of the cavities, bending the terminal strips of the contacts downwardly from the one end of the cavities, inserting the first contacts supported by the carrier into cavities in the upper row from the other ends of the cavities, bending the terminal strips of the contacts downwardly from the other end of the cavities to overlap the other ends of the cavities in the lower row and separating the terminal strips from the carrier.

In the contact assembly for the first contacts the terminal strips of each contact supported by the carrier conveniently merges with a base region which has the contacat portion folded underneath in face-to-face relationship and from which the leaf spring-like clamping or spring arm portion depends via a support portion perpendicular to the contact portion. In contrast in the contact assembly for the second contacts the terminal strips of each contact supported by the common carrier merges via a co-planar base region with the contact portion directly and from this is surmounted the leaf spring-like clamping or spring arm portion via a support portion perpendicular to the contact portion.

Good contact with the male contacts can be ensured by providing cooperative dimples on the facing surfaces of the contact and clamping portions of the contacts. Terminal lips on the free ends of the clamping portions which are bent away from the contact portions can assist in guiding the male contacts in the reception space between the clamping and contact portions. When assembled, the base regions of the first contacts locate with ceilings of the upper row of cavities while the base regions and contact portions of the second contacts locate with floors of the lower row of cavities. Conveniently bent-out tabs on these base regions fit in grooves in the respective ceilings and floors of the cavities to lock the

contacts in place.

The housing is conveniently a molded component with upper, lower and intermediate parallel walls sub-divided into the cavities by upstanding side walls. To assist in locating the contacts during assembly the sides of each cavity have strip-like tapered guide pieces which locate between the clamping and contact portions of the contacts.

The invention may be understood more readily, and various other features of the invention may become apparent from consideration of the following description.

An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings wherein:

Fig. 1 is a partially broken perspective view of a multi-contact electrical connector constructed in accordance with the present invention;

Fig. 2 is an enlarged sectional view of the connector of Fig. 1 taken along the line A-A thereof;

Fig. 3 is an enlarged sectional view of the connector of Fig. 1 taken along the line B-B thereof;

Fig. 4 is a perspective view of a contact assembly with contacts for use in the connector, the view being taken on the same scale as Fig. 1 and partly broken away;

Fig. 5 is a perspective view showing part of another contact assembly with contacts for use in the connector, the view being taken on the same scale as Fig. 1 and partly broken away.

The connector depicted in the drawings and forming a socket employs a housing 10 formed by injection-molding an insulating thermoplastic resin. The housing 10 defines a plurality of upper cells or cavities 20 in its upper portion and a plurality of lower cells or cavities 30 in its lower portion. the cavities 20, 30 are spaced apart by a predetermined pitch P1 and the cavities 30 are aligned with the cavities 20 as shown in Fig. 2. The cavities 20 serve to receive female contacts 40 (Fig. 4), and the cavities 30 serve to receive female contacts 50

(Fig. 5). The housing 10 has a top wall 11, a bottom wall 12 spaced apart from and substantially parallel to the top wall 11 and, a plurality of side walls 13 substantially perpendicular to the walls 11 and 12 and partitioning the space between the walls 11 and 12 by the pitch P1. An intermediate wall 14 substantially parallel to the walls 11 and 12 intersects the walls 13 and partitions the space between the walls 11 and 12 and each two adjacent side walls 13 into half. The cavities 20 are thus defined by the top wall 11, adjacent side walls 13 and the wall 14. Each cavity 20 has a front opening 21 for receiving a male contact (not shown) during operation which mates with the female contact 40 therein. A rear opening 22 of each cavity 20 receives the female contact 40 during assembly. The cavities 30 are defined by the bottom wall 12, adjacent side walls 13 and the wall 14. Each cavity 30 has a front opening 31 for receiving a male contact (not shown) during operation which mates with the female contact 50 therein. A rear opening 32 in each cavity 30 receives the female contact 50 during assembly. The male contacts are usually assembled as a plug. The walls 11, 12 are provided with grooves 23, 33 in the central regions of the ceiling and floors of the cavities 20, 30. Guide pieces 25, 35 are provided on the side walls 13 of the cavities 20, 30.

The contacts 40 are made from a rectangular plate which is cut out and pressed to provide a contact assembly 60 as shown in Fig. 4. The assembly 60 is composed of a belt-like contact carrier 61 and a series of contacts 40 connected to one longitudinal side of the carrier 61 and arranged side by side at predetermined pitch P2. The individual contacts 40 are separated from the carrier 61 after assembly.

Each contact 40 has an intermediate base region 41 a contact piece 42 joining the head of the base region 41, and a terminal strip 43 serving as a tail of the base region 41. The contact piece 42 has a contact portion 44 extending alongside the head of the base region 41 a

support portion 45 extending downward from the inner end of the portion 44, and a cantilevered clamping portion 47 extending from one end of the portion 45 and inclined progressively towards the portion 44 except for a terminating lip which is bent more sharply away from the portion 44. A male contact reception space 46 is defined between the portions 44, 47 of the contact piece 42. The distance between the contact portions 44 and 47, i.e. the width of the reception space is smallest in the vicinity of the bent end lip of the portion 47. Semi-spherical dimples or projections 48A and 48B are provided on the portions 44 and 47 in a mutually confronting relation, where the distance between the portions 44 and 47 is minimal. The base region 41 is punched partially opposite substantially the centre of the portion 44 to provide an upwardly bent tab or click piece 49.

The contacts 50 are similarly made from a rectangular plate which is cut out and pressed to form a contact assembly 70 as shown in Fig. 5. The assembly 70 is composed of a belt-like contact carrier 71 and a series of contacts 50 connected to one longitudinal side of the carrier 71 and arranged side by side at predetermined pitch P2. The individual contacts 50 are separated from the carrier 71 during assembly.

Each contact 50 has an intermediate base region 51, a contact piece 52 adjoining the region 51 and a terminal strip 53 serving as a tail of the base region 51. The contact piece 52 has a contact portion 54 serving as the head of the base region 51, a support portion 55 extending upward from one end of the contact portion 54, and a cantilevered clamping portion 57 extending from one end of the portion 55. The portion 57 is progressively inclined towards the portion 54 except for a terminating lip which is bent more sharply away from the portion 54. A male contact reception space 56 is defined between the portions 57,54. The distance between the contact portions 54 and 57, i.e. the width of the reception space is smallest in

the vicinity of the bent end lip of the portion 57. Semi-spherical dimples or projections 58A and 58B are provided on the portions 54, 57 in a mutually confronting relation, where the distance between the portions 54 and 57 is minimal. Longitudinal margins at the edges of the portion 54 are bent upward over a width of about the thickness of the portion 54. The portion 54 is partially punched at its centre to provide a tab or click piece 59, which extends downward.

The pitch P2 of the contacts 40 and 50 of the assemblies 60 and 70 is best made equal to the pitch P1 of the cavities 20 and 30 in the housing 10.

The grooves 23, 33 in the ceiling of the cavities 20 and the floor of the cavities 30 respectively each extends from substantially the centre of the cavity 20 to the front of the housing 10 and each groove 23, 33 has a width slightly larger than that of the tabs 41, 59 of the contacts 40, 50 respectively so that the distal end of the tabs 49, 59 can be received in one of the grooves 23, 33 when the contact 40, 50 is being set in the corresponding cavity 20, 30. The end of each groove 23, 33 near the opening 22, 32 has a step 24 slightly closer to the opening 22, 32 than the distal end of the tab 49, 59 of the contact 40, 50 set in the corresponding cavity 20, 30. The guide pieces 25 in each cavity 20 project toward each other and extend parallel to the ceiling and floor of the cavity 20. When each contact 40 is set in a corresponding cavity 20 the guide pieces 25 locate between the portions 44 and 47 of the contact 40. The end portion of each guide piece 25 near the opening 22 is tapered on its lower surface, and slightly tapered on its upper surface. The thickness T1 of each guide piece 25 is smaller than the maximum distance between the portions 44 and 47 but larger than the minimum distance therebetween except for the gap between the projections 48A and 48B.

The guide pieces 25 project toward each other and extend parallel to the ceiling and floor of each cavity 30. When each contact 50 is set in a corresponding cavity

30, the guide pieces 35 locate between the portions 54 and 57. The end portion of each guide piece 35 near the opening 32 is tapered on its upper surface and slightly tapered on its lower surface. The thickness T2 of each guide piece 35 is the same as the thickness T1 but is smaller than a maximum distance between the portions 54 and 57 but larger than a minimum distance therebetween except for the gap between the projections 58A and 58B thereof.

The contacts 50 are set in the cavities 30 of the housing 10 in the following manner. The contacts 50 supported by the carrier 71 at the pitch P2 (equal to P1) are cut therefrom, after they are held by a jig (not shown) or the like. The individual contacts 50 held by the jig at the pitch P2 are then inserted into corresponding openings 32 of the cavities 30 by introducing the terminal portions 53 of the contacts 50 first with the base portions 51 facing downward. Both longitudinal edges of the portion 54 of each contact 50 passes through channels defined by the guide pieces 35 in the cavity 30 and the floor of the cavity 30. The longitudinal edges of the portion 57 pass through channels formed by the ceiling of the cavity 30 and the guide pieces 35. The longitudinal edges of the portion 57 slide along the upper surface of the guide pieces 35 which urge the portion 57 upwardly. The portions 54 and 57 are thus separated such that the minimum distance therebetween, excluding the distance between projections 58A and 58B, is equal to the thickness T2 of the guide pieces 35. When the contact 50 is guided to its predetermined fixed position in the cavity 30, the tab 59 enters the groove 33. The terminal portion 53 of the contact 50 extends outside the housing 10 through the front opening 31 and is thereafter bent downward at a right angle as shown in Fig. 2.

The contacts 40 are then set in the cavities 20 of the housing 10 but in this case the contacts 40 supported

by the carrier 61 at pitch P2 (equal to P1) are inserted into the cavities 20 of housing 10 through the rear openings 22 without being separated from the carrier 61. In this case, the contact portions 42 are inserted first with the base portions 41 facing upwardly. The longitudinal edges of the base 41 of each contact 40 and the portion 44 pass through channels formed by the ceiling of the corresponding cavity 20 and the guide pieces 25 therein. Both longitudinal edges of each portion 47 pass through channels formed by the guide pieces 25 and the floor of the cavity 20. Since the longitudinal edges of the portion 47 slide along the lower surface of the guide pieces 25 as it is guided inside the cavity 20 the portion 47 is biased downwardly. The portions 44 and 47 are thus separated such that the minimum distance therebetween, excluding the distance between the projections 48A and 48B, is equal to the thickness T1 of the guide pieces 25. When the contact 40 is guided to its predetermined fixed position in the corresponding cavity 20, the tab 49 enters the groove 23. The terminal portions 43 of the contacts 40 extend outside the housing 10 and are bent downwards at a right angle. The contact carrier 61 is finally cut from the contacts 40 set in the cavities 20.

With the contacts 40, 50 set in the cavities 20, the minimum distance between the portions 44, 47, and 54, 57 excluding the distance between projections 48A, 48B, 58A, 58B is increased to T1, T2 and as a result, the biasing forces on the cantilever portions 47, 57 is somewhat larger. This together with the cooperating projections 48A, 48B, 58A, 58B ensures good electrical contact between these portions 47, 57 and male contacts (not shown) inserted into the spaces 46, 56 of the contacts 40, 50 through the openings 21 and 31, respectively. The minimum distance between the portions 44, 47 is kept at T1, and the minimum distance between the portions 54 and 57 is kept at T2. The lips at the distal ends of the portions 47, 57 which are bent away from the portions 44, 54, respectively ensure the male contacts can

be properly recovered without damaging or bending the ends of the portions 47, 57.

The longitudinal edges of the portions 54 of the contacts 50 are bent upward to increase the thickness of these bent portions and improve the mechanical strength. Even if the distance between the guide pieces 35 and the floor of each cavity 30 cannot be decreased to the thickness of the central portion of the portion 54 due to technical problems in resin molding, the portion 54 can still be reliably held between the guides 35 and the floor of the cavity 30. When the male contacts are inserted and force acts on the rear side of the housing 10 the tabs 49, 59 of the contacts 40, 50 engage with the steps 24, 34 of the grooves 23, 33, so that the contacts 40, 50 will not be inadvertently detached from the housing 10.

Not all the cavities 20, 30 need accommodate contacts 40, 50 but conversely if desired, contacts can be set in all the cavitites 20, 30.

CLAIMS

1. A multi-contact electrical connector comprising a housing (10) defining a plurality of cavities (20,30) arranged in upper and lower rows one above the other, each cavity (20,30) being open at opposite ends; a set of first female contacts (40) located within at least some of the cavities (20) in the upper row; a set of second female contacts (50) located within at least some of the cavities (30) in the lower row, the contacts (40,50) being of one-piece integral construction; characterised in that each first contact (40) has a contact portion (44), a cantilevered clamping portion (47) spaced from the contact portion (44) to provide therewith a reception space (46) for a male contact insertable into the associated cavity (20) from one end (21) and a terminal strip (43) connected to the contact portion (44) and projecting outwardly from the other end (22) of the cavity (20) for enabling electrical connection with the contact (40) and each second contact (50) has a contact portion (54), a cantilevered clamping portion (57) spaced from the contact portion (54) to provide therewith a reception space (56) for a male contact insertable into the associated cavity (30) from one end (31) corresponding to said one end (21) of each cavity (20) containing one of the first contacts (40) and a terminal strip (53) connected to the contact portion (54) and projecting outwardly from the one end (31) of the cavity (30) for enabling electrical connection with the contact (50).

2. A connector according to claim 1, wherein the terminal strips (42,53) extend substantially perpendicular to the contact portions (44,54) of the contacts (40,50) and generally alongside and from outer faces of the housing (10).

3. A connector according to claim 1 or 2, wherein the contact portion (44) of each first contact (40) lies alongside a base region (41) which adjoins the contact portion (44) via a sharp bend and the terminal strip (43) is connected directly to the base region (41).

4. A connector according to claim 3, wherein the base region (41) locates with an upper ceiling wall of the associated cavity (40).

5. A connector according to any one of claims 1 to 4, wherein the contact portion (54) of each second contact (50) is connected directly to the terminal strip (53) thereof.

6. A connector according to claim 5, wherein the contact portion (54) of each second contact (50) adjoins the terminal strip (53) via a base region (51) and the base region and contact portions (51,54) locate with a lower floor wall of the associated cavity (50).

7. A connector according to any one of claims 1 to 6, wherein the contact and clamping portions (44,47,54,57) of each contact (40,50) are interconnected by a support portion (45,55) extending substantially perpendicular to the contact portion (44,54).

8. A connector according to any one of claims 1 to 7, wherein the clamping portions (47,57) of the contacts (40,50) have terminal lips bent away from the associated contact portion (44,54) and the clamping and contact portions (44,54,47,57) have corresponding projections (48A,,48B,58A,58B) which define the minimal distance between these portions.

9. A connector according to any one of claims 1 to 8, wherein the housing (10) is composed of upper and lower walls (11,12), side walls (13) extending between the upper and lower walls (11,12) and an intermediate wall (14) extending between the side wall (13) the upper row of cavities (40) being bounded by the upper, intermediate and side walls and the lower row of cavities (50) being bounded by the lower, intermediate and side walls and wherein the upper and lower walls have slots (23) in each cavity (20,30) which locate with a tab (49,59) of a contact therein.

10. A connector according to claim 9 wherein the side walls are provided with shaped guide pieces (25,35)

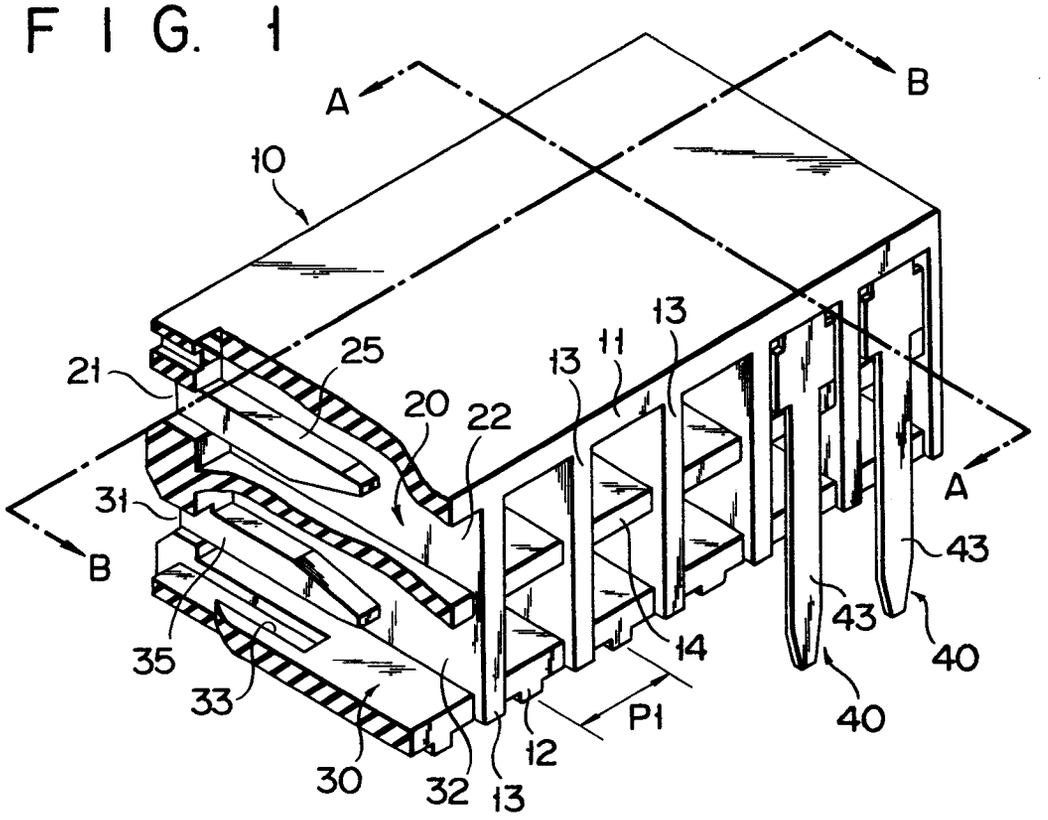
disposed in each cavity (20,30) the guide pieces (25,35) serve to locate between the contact and clamping portions (44,54,47,57) of the contacts (40,50) during assembly to guide the contacts (40,50) into the cavities (20,30).

11. A connector according to claim 10, wherein the guide pieces (25,35) are tapered to decrease in cross-section towards the other ends (22,33) of the cavities (20,30) into which the contacts (40,50) are introduced during assembly.

12. A connector according to any one of claims 1 to 11, wherein longitudinal edges of the contact portions (34) of each of the second contacts (50) are bent towards the clamping portion (57) thereof.

13. A method of assembling an electrical connector constructed in accordance with any one of the preceding claims; and utilizing pre-fabricated contact assemblies composed of a series of said first contacts (40) spaced apart by a predetermined pitch corresponding to the spacing between adjacent cavities (20,30) in the upper and lower rows and supported by a carrier (61) and a series of said second contacts (50) spaced apart by the same predetermined pitch and supported by a carrier (71); said method comprising separating the second contacts (50) from the carrier (71) while supporting the contacts (50) at the predetermined pitch, inserting the second contacts (50) into cavities (30) in the lower row from the other ends of the cavities (30), bending the terminal strips (53) of the contacts (50) downwardly from the one end of the cavities (30), inserting the first contacts (40) supported by the carrier (61) into cavities (40) in the upper row from the other ends of the cavities (40) bending the terminal strips (43) of the contacts (40) downwardly from the other end of the cavities (40) to overlap the other ends of the cavities (50) in the lower row and separating the terminal strips (43) from the carrier (61).

FIG. 1


A
B
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A
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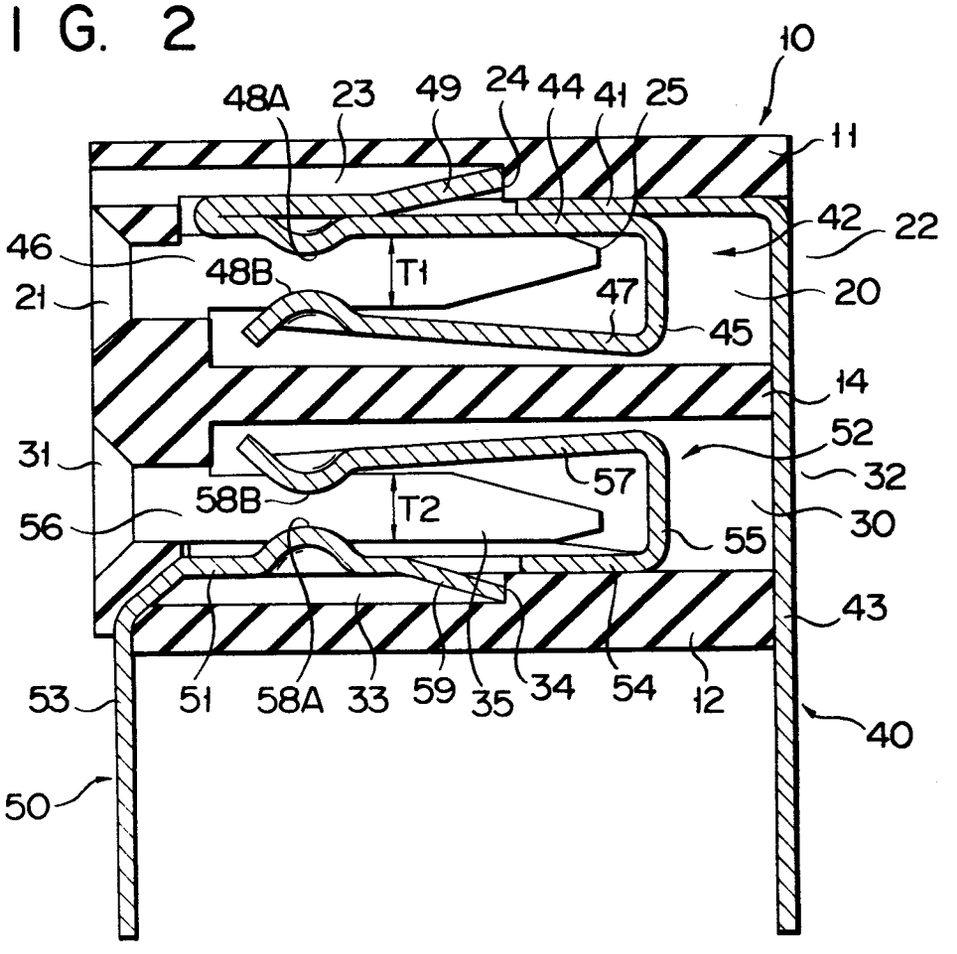
P1
12
30
32
13

FIG. 2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48B
T1
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57
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FIG. 3

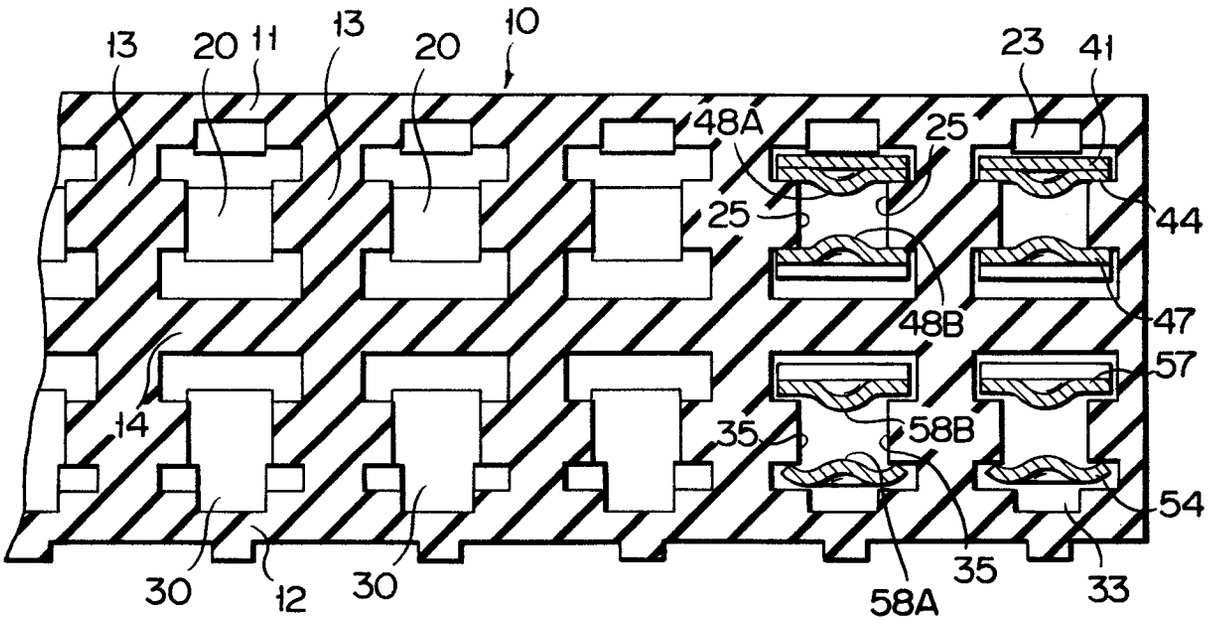

FIG. 4

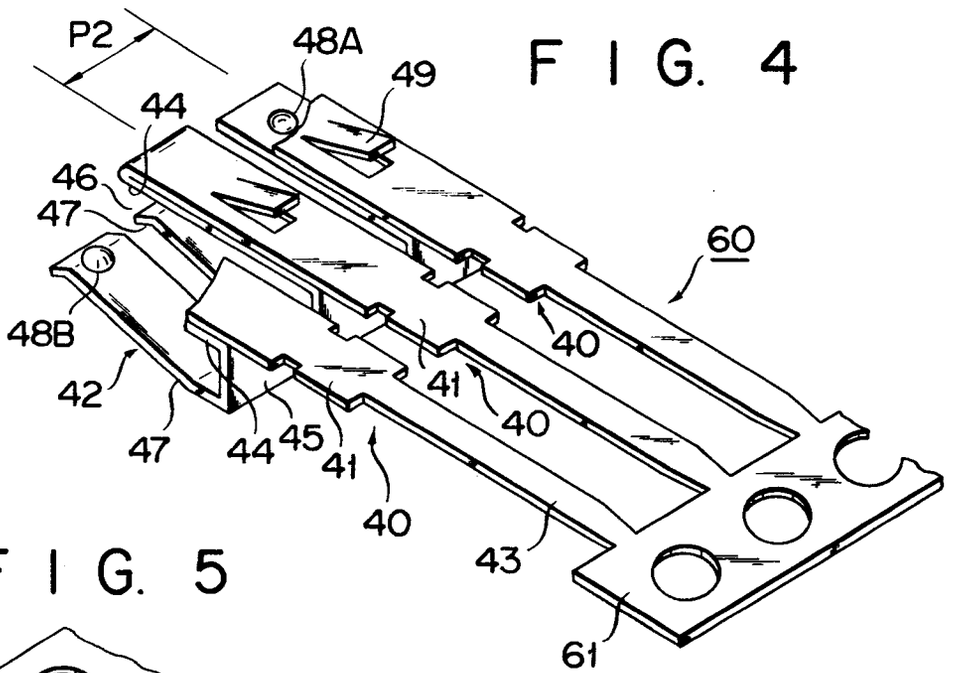

FIG. 5