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(54) ZERO-FORCE CONNECTOR BLOCKS

(71) We, E. I. DU PONT DE NEMOURS AND COMPANY, a corporation organized and existing under the laws of the State of Delaware, United States of America, of
5 Wilmington, State of Delaware, United States of America do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—
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The present invention relates to zero-force connector blocks in which, for example, terminals carried in the blocks are withdrawn out of the path of insertion of a circuit board and are subsequently released to engage contact pads on the circuit board. In this way, the circuit board may be freely placed in position for engagement by the terminals without wear on the pads.
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In the past, a number of zero-force connector blocks have been proposed where the edge of the circuit board is inserted freely either directly into the slot or through an open side of the slot. For instance, United States Patent Number 3,555,488 discloses a zero force-type connector block in which an actuating member is moved toward the mouth of the slot to force the terminals into engagement with a circuit board previously inserted into the slot. The member is raised by a longitudinal shiftable plate member.
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United States Patent Number 3,697,929 describes an arrangement in which a rotary cam bar raises fingers which engage the free ends of the terminals in the block to force the terminals against a circuit board inserted into the block when the terminals are retracted. The use of rotary cam bars is also described in United States Patent number 3,611,259, United States Patent Number 3,638,167 and German Patent
35 40 45 Number 1,073,058.

In United States Patent Number 3,526,869 terminals are held in engagement with circuit board contact pads by spacers which are located on both sides of the rows of terminals and are forced against the terminals by longitudinal shifting of a surrounding housing.
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United States Patent Number 3,467,891 and United States Patent Number 3,596,230 disclose drive means for shifting contacts in zero-face connector blocks.
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In practice, the prior art zero force-type blocks have proved expensive to manufacture and unreliable in use, frequently because of the high operating force required to shift the cams because of the loading forces exerted upon the cams by terminals in blocks having a large number of terminals. In these blocks the terminal loading forces were reduced in order to bring the cam operating force down to an acceptable level, thus lowering the terminal contact pressure.
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According to the present invention there is provided a zero-force connector block including a support, a row of terminals supported by and extending from said support and including contacts, an elongate cam bar extending along said row of terminals, a drive mechanism for longitudinally shifting said cam bar, said cam bar and support having cooperating means arranged so that, in use, the cam bar is moved away from the support in response to longitudinal movement of the cam bar by the drive mechanism, wherein said cam bar is engageable with said terminals upon diagonal movement of the bar away from the support to flex the terminals in a direction transverse to said row and thereby move the contacts from first positions for engagement with a member to be connected to second, retracted positions for zero-force positioning of such a member.
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The cooperating means preferably com-
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prises ramps on one of said support or cam bar and projections engageable with the ramps on the other of said support or cam bar.

5 In a preferred embodiment the connector block has two rows of terminals for forming electrical connections with contact pads on both sides of the edge of a substrate such as a circuit board. The cam bar and drive mechanism simultaneously retract the terminals from both sides of a circuit board-receiving slot in the block, thus permitting free or zero force insertion of the circuit board into the slot. The cam bar is positioned between the two rows of terminals in the block and is moved diagonally with respect to the terminals to move the terminals between the retracted and contact positions. When the cam bar is raised, the terminals are retracted from the slot and the circuit board may be freely positioned within the slot. Lowering of the cam bar releases the terminals to engage pads on the board, thereby forming the desired electrical connections between the terminals and the pads. The drive mechanism exerts a longitudinally directed force on the cam bar such that the bar is shifted against rise surfaces or ramps on the support with the result that the bar is moved longitudinally while it is raised or lowered with respect to the terminals. This diagonal motion of the cam bar results in the movement of the terminals toward and away from the slot.

In one embodiment of the invention, the cam bar is shifted by means of a worm gear drive having a thread engageable with at least one tooth on the cam bar. The drive may be rotated by a tool such as a screw driver and usefully multiplies the force supplied by the operator to aid in shifting the cam bar. The cam bar is highly loaded, particularly when it is raised and simultaneously forces all of the terminals in the block away from the circuit board-receiving slot. For instance, some blocks according to the invention may contain 100 or more terminals in each of two rows, with each terminal having a contact force of 100 or more grams depending upon the particular design.

In a further embodiment of the invention, the cam bar is shifted between its two positions by means of a pin vertically mounted in the block and carrying an eccentric cam engageable with a pair of spaced fingers extending to one side of the bar. The cam bar shifts up and down along the eccentric as it moves diagonally between its two positions. This type of drive is particularly adaptable for use in a block where the edge of the circuit board is moved directly downwardly into the circuit board-receiving slot and the drive mechanism must be approached by the operator in the same direction.

anism must be approached by the operator in the same direction.

As compared with known blocks, zero force blocks described herein are relatively inexpensive to make and assemble, and through the use of the cam bar and drive mechanism the required operating forces or torque is reduced. This permits increased contact pressures between the terminals and contact pads and permits the use of less expensive contact coatings on the terminals without impairing the quality of the electrical connection. For instance, in some applications, the increased contact pressure permits gold contacts to be replaced by solder coated contacts.

Embodiments of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view, partially broken away, of a zero force connector block of the invention mounted on a circuit board;

Figure 2 is a longitudinal section of the connector block shown in Figure 1;

Figure 3 is a sectional view taken along line 3-3 of Figure 2;

Figure 4 is a view corresponding to Figure 2, but with the cam bar in the block raised to permit insertion of a circuit board;

Figure 5 is a sectional view taken along line 5-5 of Figure 4 following insertion of a circuit board;

Figure 6 is a sectional view taken along line 6-6 of Figure 4 following insertion of the board and release of the terminals to engage pads on the board;

Figure 7 is a sectional view taken along line 7-7 of Figure 2;

Figure 8 is an exploded view of a connector block using an alternative cam drive; and

Figures 9 and 10 are sectional views taken along lines 9-9 and 10-10 respectively of Figure 8.

Figures 1 to 7 show a zero force edge connector block 10 having an elongate body 12 formed of dielectric material with a mounting extension 14 located on both ends of the body. A circuit board-receiving slot 16 extends into the body from an upper surface 18 thereof and is open at body end 20 to permit loading of a circuit board 22 into the slot by movement in the direction of arrow 24 as shown in Figure 1 so that the contact edge of the board moves through the slot opening in body end 20.

An elongate terminal assembly 26 is mounted in longitudinally extending recess 28 formed in the bottom surface of body 12 and includes a support comprising a pair of like elongate plastics insulating support members 30 each supporting a row of stamp-formed metal contact terminals 32.

The plastics members 30 abut against each other at interface 34 and carry latching projections 36 on the outer surfaces thereof such that when the terminal assembly is positioned within the recess 28 in the bottom of the body 12, the projections lock behind the body latching shoulders 38 to secure the assembly 26 within the recess 28.

As illustrated in Figure 2, the body 12 has two rows of terminal pockets or recesses 44. Each terminal 32 extends from its member 30 toward slot 16 and includes a portion 39 within the upper end 40 of recess 28 and a portion 42 extending therefrom through a respective terminal pocket or recess 44 communicating recess portion 40 with circuit board-receiving slot 16. The terminals 32 are free of the side walls of pockets 44 so that they may be moved toward and away from slot 16, as described hereinafter. Terminal tail portions 46 project below block 10 to facilitate suitable connections with circuit elements. Circuit board contacts 48 are located at the free ends of terminal portions 42 for engagement with contact pads on a circuit board or like member positioned in slot 16. The contacts may be coated with a conductive material to enhance the electrical connection with the circuit board pad.

A terminal cam bar 50 is located in recess portion 40 on top of members 30 and extends longitudinally between the opposed rows of terminals in pockets 44. A number of lift projections 52 are formed on the lower surface of bar 50. The projections are spaced along the length of the bar and each include a rise surface 54 extending from the flat bottom surface of the bar at a shallow angle and facing block end 20. The rise surfaces extend from the bottom surface of the bar to stop surfaces 56 below the bottom of the bar.

When the bar 50 rests flush on the top of members 30, each projection 52 extends freely into a recess 58 formed in the portions 30. Each recess 58 includes a cam surface or ramp 60 facing the adjacent projection rise surface 54 and preferably extending parallel to such surface, and a stop recess 62 adjacent the junction of the cam surface with the top of the members 30. The upper corners 63 of the bar 50 are beveled to facilitate sliding engagement with terminal portions 38 extending into the upper end 40 of recess 28.

A bar shifting drive 64 is mounted in end 20 of block 10 and includes a rotatable worm gear 66 having a spiral thread 68 engagable with a tooth 70 carried by end 72 of bar 50. The worm gear 66 includes a rounded thrust end 74 which is seated in a socket formed in the ends of members 30 adjacent body end 20. The work end 76 opposite end 74 extends outwardly of body

12 through a circular opening 78 and includes slot 80 to facilitate rotation of the gear by means of a tool such as a screw driver.

The axis of cylindrical worm gear 66 is parallel to the planes of the flat cam surfaces 60 and rise surfaces 54. This orientation assures that tooth 70 and thread 68 maintain engagement during rotation of the gear and resultant movement of the cam bar 50. Other types of worm gears could be used, provided that the thread maintains engagement with the tooth on the cam bar while the lift projections are moved across the cam surfaces or ramps 60. A conical worm gear could be used where the thread moves the tooth up and down the surface of the cone. The rotational axis of such a gear could be oriented parallel to the longitudinal axis of the block so that the screw driver or tool used to rotate the worm gear would extend longitudinally from the block. Preferably, the connection between the tooth and thread is sufficiently loose to permit the engagement between lift projections and cam surfaces or ramps and stop recesses to locate the cam bar. The bar shifting drive provides the motive force for shifting the cam member but does not locate the cam bar above members 30.

The worm gear drive for the cam bar actuates a gate mechanism 82 which automatically opens and closes the opening at the end of the slot so that circuit boards may be moved into and out of the slot through the end only when the terminals have been withdrawn from the slot. The gate prevents accidental insertion of the board along the gated end of the slot when the cam bar is lowered and the terminals extend into the slot.

Mechanism 82 includes a gate member 84 rotatably mounted in a recess at block end 20 and illustrated best at Figure 7. The gate member includes a number of teeth 86 which, upon rotation of worm gear 66, mesh with teeth 88 carried by the worm gear to rotate the gate in a counter-clockwise direction as shown in Figure 7 so that gate portion 90 is moved out of slot 16 and recess 92 in the gate is positioned in alignment with the slot 16 thereby opening the slot at block end 20. Teeth 88 extend around only a small circumferential portion of the worm gear so that they engage the teeth 86 on the gate after the worm gear has been rotated nearly 270° in a clockwise direction as shown in Figure 7. This assures that the terminals are moved out of the slot 16 before the gate is opened, as will be described in further detail in the description of the operation of block 10.

Block 10 is preferably mounted on a support panel 94, which may be a circuit board, by securing means extending through

openings in extensions 14. The terminal tails 46 extend through openings in the support 94 and may, if desired, be soldered to printed circuit tracks on the lower surface of the support. Standoffs 96 space the terminal-carrying portion of block 10 above the support 94.

As illustrated in Figures 2, 3 and 7, the cam bar 50 is in the down position relative to the terminals and the terminals extend into the circuit board slot 16. The rotatable gate 84 closes the slot opening at end 20 to prevent insertion of a circuit board into the block. In order to withdraw the terminals 32 from the circuit board slot 16 and open the gate, a tool is inserted in slot 80 to rotate the worm gear in a clockwise direction as illustrated in Figure 7. Rotation of the gear brings thread 68 into engagement with tooth 70 and draws bar 50 longitudinally to the left, as shown in Figure 2, such that the rise surfaces 54 of projections 52 slide up the cam surfaces or ramps 60 of the recesses 58. The bar is raised above members 30 and is shifted to the left resulting in a diagonal movement within the block. Lateral movement of the bar is prevented by a sliding fit with the sides of the upper portion 40 of recess 28. The upward movement of the bar 50 brings the corners 63 of the bar into engagement with terminal portions 38 so that the terminals are bent outwardly of the recess 16. Continued rotation of the worm gear brings the cam bar stop surfaces onto recesses 62 formed in the terminal assembly 26. There is sufficient play between the tooth 70 and thread 68 to permit movement of the bar 50 onto the surfaces 62 despite the fact that during this last movement the bar is not raised above the terminal assembly. When the bar rests on the stop recesses 62, as shown in Figure 4, the terminals have been forced away from the slot 16 into pockets 44 to facilitate zero force loading. Collapse of the bar is prevented because the projections 52 rest on the flat recesses 62. During spreading of the terminals, the bar 50 is both lifted and shifted longitudinally toward block end 20 so that the bar corners engage and move past the terminals as the cam bar forces the terminals outwardly of slot 16.

The gate mechanism 82 remains closed during raising of the cam bar 50 to spread the terminals. As the cam bar is raised to its uppermost position, teeth 88 on the form gear are rotated clockwise sufficiently, as illustrated in Figure 7, to mesh with teeth 86 so that the continued final rotation of the worm rotates the gate 84 in a counter-clockwise direction sufficiently to position the recess 92 in alignment with the slot while the cam bar stop surfaces slide longitudinally on recess surfaces 62. Thus, it is

not possible to move a circuit board through the slot at block end 20 until the terminals have been removed from the slot.

With the terminals held away from slot 16 by the cam bar 50 and the gate mechanism is open, a circuit board may be moved through the slot at the end 20 so that it is positioned within the slot with a contact pad 100 thereon on each side of the board located opposite each terminal contact 48. The circuit board 22 is fully inserted when the lead edge thereof bottoms against the slot end 102 at end 104 of the body. When in this position, the trailing edge of the board has been moved past the gate.

The terminals in the block are brought into electrical engagement with contact pads 100 on the inserted board 22 by rotating the worm gear in a counter-clockwise direction as illustrated in Figure 7. Initial rotation of the worm gear rotates the gate 84 in a clockwise direction to return it to the position of Figure 7 where it closes the slot 16. Continued rotation of the worm moves the cam bar 50 to the right as illustrated in Figure 4 along the stop recesses 62 and then to the right and down in a diagonal direction as the projections 52 fall down ramps 60 and the bar returns to the position of Figure 2 where the terminals, being free of corners 63, move towards slot 16 and establish electrical contact with the aligned contact pads 100 on board 22.

Figures 8, 9, and 10 illustrate a second embodiment of the invention. Zero force edge connector block 110 is similar to block 10 illustrated in the previous figures with the exception that an alternative bar shift drive 112 is used in place of the worm gear bar shifting drive 64. The block 110 includes a body 118 having a circuit board-receiving slot 114 closed at both ends to receive circuit boards with contacts on both sides where the edge of the board is moved into the slot in the direction of arrow 116 as illustrated in Figure 9. A pair of plastic members 120 each carrying a row of terminals 122 extending along one side of the slot 114, are mounted in body 118 as described in connection with block 10 and a cam bar 124 rests on the upper surfaces of the members 120. The cam bar carries lift projections 126 which cooperate with cam surfaces or ramps 128 and stop surfaces 131 to raise the cam bar diagonally as it is shifted longitudinally along the block and raised above the members 120 by the bar shifting drive 112. This drive includes a cam pin 130 mounted in body 118 with end 132 fitted in bore 134 and slotted pin head 136 located in an opening 138 in a stepped surface 140. The cam pin includes a cylindrical eccentric 142 which

rotates within a cavity 144 in the body 118. Cavity 144 communicates with the outside of the body through window 146.

A pair of fingers 148 extend to one side of the cam bar 124 at the end adjacent the pin 130. The eccentric 142 is fitted between the fingers 148 which are spaced apart to make a close fit with the cylindrical eccentric. Semi-cylindrical recess 150 at the bottom of the space between the fingers 148 conforms to the shape of the eccentric. As illustrated in Figures 9 and 10, the eccentric has a height greater than the height of the fingers to permit up and down movement of the cam bar with respect to the cam pin.

Figure 10 illustrates the cam bar 124 in the down position with the eccentric facing to the right and fitted in the bottom of recess 150. The cam bar is moved from the lower to the upper position to spread the terminals outwardly of slot 114 by inserting a tool into the slot in cam pin head 136 and rotating the pin in a clockwise direction so that the lobe of the eccentric rotates past window 146, 180° from the position of Figure 10. This motion moves the cam bar to the left so that the lift projections 126 ride up the cam surfaces or ramps 128 and rest upon the stop surfaces 131. When the cam bar 13 fully raised, the bar has been shifted to the left as illustrated in Figure 10, twice the throw of the eccentric and the eccentric is again seated against the bottom of recess 150. As the cam bar is constrained against lateral movement, seating of the eccentric against the bottom surface 150, whether the cam bar is in the lower or raised positions, limits rotation of the cam pin.

With the cam bar in the raised position, the terminals 122 are moved outwardly of the slot 114 into their respective pockets in body 118 and a circuit board may be positioned within slot 114 free of the terminals. When the board is moved into the slot, the cam pin 130 may be rotated in the counter-clockwise direction to lower the cam bar and permit terminals 122 to move toward the slot for engagement with contact pads on both sides of the circuit board seated in the slot. As illustrated in Figure 8, suitable indicia may be provided on surface 140 to indicate the direction of rotation of the cam pin for moving the cam bar between the open and closed positions.

WHAT WE CLAIM IS:—

1. A zero-force connector block including a support, a row of terminals supported by and extending from said support and including contacts, an elongate cam bar extending along said row of terminals, a drive mechanism for longitudinally shifting said cam bar, said cam bar and support having co-operating means arranged so that, in use,

the cam bar is moved away from the support in response to longitudinal movement of the cam bar by the drive mechanism, wherein said cam bar is engageable with said terminals upon diagonal movement of the bar away from the support to flex the terminals in a direction transverse to said row and thereby move the contacts from first positions for engagement with a member to be connected to second, retracted positions for zero-force positioning of such a member.

2. A connector block as claimed in claim 1, wherein said cooperating means comprises ramps on one of said support or cam bar and projections engageable with said ramps on the other of said support or cam bar whereby longitudinal movement of the cam bar moves the projections along the ramps.

3. A connector block as claimed in claim 2, wherein said ramps are provided on said support and said projections are provided on said cam bar, and wherein stop surfaces are provided on said support at the end of each ramp, each stop surface being engageable by a corresponding projection when the projection has moved along the respective ramp upon longitudinal movement of the cam bar.

4. A connector block as claimed in any preceding claim, wherein said drive mechanism comprises a worm gear rotatably mounted on said support and having a thread with a work surface movable upon rotation of the gear in a direction parallel to the direction of diagonal movement of said cam bar, and wherein said cam bar includes at least one tooth engageable with the work surface on said worm gear thread.

5. A connector block as claimed in any preceding claim further comprising a shiftable gate located in the path of movement of a member towards said block, said gate being connected to said drive mechanism by a lost motion connection whereby the gate is closed by movement of the drive mechanism corresponding to initial movement of the contacts away from the retracted positions, and opened by movement of the drive mechanism corresponding to final movement of the contacts toward the first positions.

6. A connector block as claimed in claim 5 when appended to claim 4, wherein said gate comprises a member rotatably mounted in said support, and teeth on said member are engageable with teeth on said worm gear during a portion of the rotation of the worm gear only, said member including a portion movable into and out of the path of movement of the member to be connected.

7. A connector block as claimed in any of claims 1 to 3, wherein said drive com-



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rotates within a cavity 144 in the body 118: Cavity 144 communicates with the outside of the body through window 146.

A pair of fingers 148 extend to one side of the cam bar 124 at the end adjacent the pin 130. The eccentric 142 is fitted between the fingers 148 which are spaced apart to make a close fit with the cylindrical eccentric. Semi-cylindrical recess 150 at the bottom of the space between the fingers 148 conforms to the shape of the eccentric. As illustrated in Figures 9 and 10, the eccentric has a height greater than the height of the fingers to permit up and down movement of the cam bar with respect to the cam pin.

Figure 10 illustrates the cam bar 124 in the down position with the eccentric facing to the right and fitted in the bottom of recess 150. The cam bar is moved from the lower to the upper position to spread the terminals outwardly of slot 114 by inserting a tool into the slot in cam pin head 136 and rotating the pin in a clockwise direction so that the lobe of the eccentric rotates past window 146, 180° from the position of Figure 10. This motion moves the cam bar to the left so that the lift projections 126 ride up the cam surfaces or ramps 128 and rest upon the stop surfaces 131. When the cam bar 13 is fully raised, the bar has been shifted to the left as illustrated in Figure 10, twice the throw of the eccentric and the eccentric is again seated against the bottom of recess 150. As the cam bar is constrained against lateral movement, seating of the eccentric against the bottom surface 150, whether the cam bar is in the lower or raised positions, limits rotation of the cam pin.

With the cam bar in the raised position, the terminals 122 are moved outwardly of the slot 114 into their respective pockets in body 118 and a circuit board may be positioned within slot 114 free of the terminals. When the board is moved into the slot, the cam pin 130 may be rotated in the counter-clockwise direction to lower the cam bar and permit terminals 122 to move toward the slot for engagement with contact pads on both sides of the circuit board seated in the slot. As illustrated in Figure 8, suitable indicia may be provided on surface 140 to indicate the direction of rotation of the cam pin for moving the cam bar between the open and closed positions.

WHAT WE CLAIM IS:—

1. A zero-force connector block including a support, a row of terminals supported by and extending from said support and including contacts, an elongate cam bar extending along said row of terminals, a drive mechanism for longitudinally shifting said cam bar, said cam bar and support having co-operating means arranged so that, in use,

the cam bar is moved away from the support in response to longitudinal movement of the cam bar by the drive mechanism, wherein said cam bar is engageable with said terminals upon diagonal movement of the bar away from the support to flex the terminals in a direction transverse to said row and thereby move the contacts from first positions for engagement with a member to be connected to second, retracted positions for zero-force positioning of such a member.

2. A connector block as claimed in claim 1, wherein said cooperating means comprises ramps on one of said support or cam bar and projections engageable with said ramps on the other of said support or cam bar whereby longitudinal movement of the cam bar moves the projections along the ramps.

3. A connector block as claimed in claim 2, wherein said ramps are provided on said support and said projections are provided on said cam bar, and wherein stop surfaces are provided on said support at the end of each ramp, each stop surface being engageable by a corresponding projection when the projection has moved along the respective ramp upon longitudinal movement of the cam bar.

4. A connector block as claimed in any preceding claim, wherein said drive mechanism comprises a worm gear rotatably mounted on said support and having a thread with a work surface movable upon rotation of the gear in a direction parallel to the direction of diagonal movement of said cam bar, and wherein said cam bar includes at least one tooth engageable with the work surface on said worm gear thread.

5. A connector block as claimed in any preceding claim further comprising a shiftable gate located in the path of movement of a member towards said block, said gate being connected to said drive mechanism by a lost motion connection whereby the gate is closed by movement of the drive mechanism corresponding to initial movement of the contacts away from the retracted positions, and opened by movement of the drive mechanism corresponding to final movement of the contacts toward the first positions.

6. A connector block as claimed in claim 5 when appended to claim 4, wherein said gate comprises a member rotatably mounted in said support, and teeth on said member are engageable with teeth on said worm gear during a portion of the rotation of the worm gear only, said member including a portion movable into and out of the path of movement of the member to be connected.

7. A connector block as claimed in any of claims 1 to 3, wherein said drive com-

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prises a rotatable cam pin including an eccentric, said cam bar including a pair of fingers positioned one to each side of said eccentric, the height of the eccentric being greater than the height of the fingers for movement of the cam bar along the axis of said cam pin.

8. A connector block as claimed in any preceding claim, further comprising a body having a longitudinally extending slot in one side thereof and a longitudinally extending recess extending along the opposite side thereof parallel to the slot, two rows of terminal-receiving pockets extending within said body and communicating said slot and recess, two rows of terminals extending from said support, each row of terminals extending through the pockets in a corresponding one of the row of pockets with the contacts of each row of terminals normally positioned in said slot, wherein said cam bar extends in the recess between said support and said slot and between the two rows of terminals.

9. A connector block as claimed in claim 8, wherein said support is formed from a pair of like insulating support members arranged in abutting relationship and a row of terminals extends from each support member.

10. A connector block as claimed in claim 9, wherein a latch is carried by each support member and engages said body.

11. A zero-force connector block substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 7 of the accompanying drawings.

12. A zero-force connector block substantially as hereinbefore described with reference to and as illustrated in Figures 8 to 10 of the accompanying drawings.

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