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Gassman

[11] **3,784,956**

[45] **Jan. 8, 1974**

[54] **PROGRAMMABLE ELECTRICAL CONNECTOR**

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[73] Assignee: **GTE Automatic Electric Laboratories, Incorporated,** Northlake, Ill.

[22] Filed: **June 5, 1972**

[21] Appl. No.: **259,617**

[52] **U.S. Cl.** ..... **339/18 R,** 339/210 M

[51] **Int. Cl.** **H01r 9/00**

[58] **Field of Search** 339/17-19, 339/24, 28, 29, 65, 66, 75, 103, 150-151, 154, 157, 176, 195, 196, 198, 206, 208, 210, 222, 242, 252, 275

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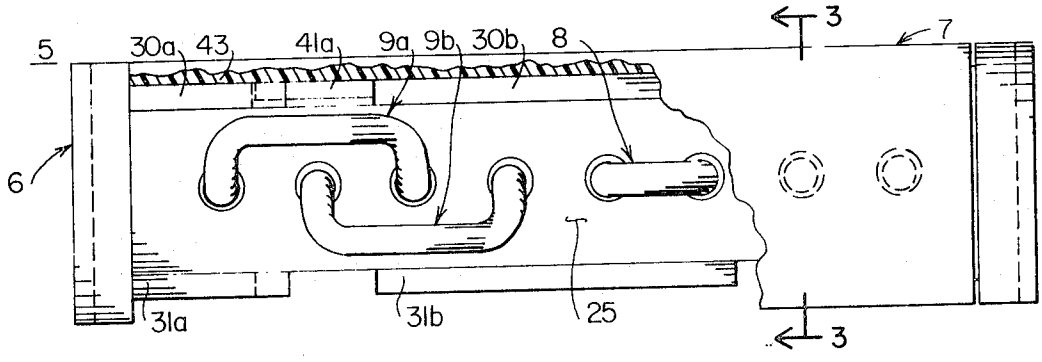
Attorney—Leonard R. Cool, Russell A. Cannon and Theodore C. Jay, Jr.

[57] **ABSTRACT**

This solderless connector comprises a rigid dielectric base having a plurality of holes therethrough with longitudinal axes that are parallel and in a common plane; a resilient channel-shaped dielectric cover; a straight strapping pin that is U-shaped; and a crossover strapping pin with parallel legs and a U-shaped head having a crossbar that is offset from adjacent ends of the legs of the second pin. A particular connector is assembled by inserting the legs of a first strapping pin into selected holes in the base through which electrical connection is desired. Connection through selected holes on either side of one leg of the first pin, without making electrical connection thereto, is provided by inserting legs of a crossover pin into the selected holes with the offset crossbar bypassing the one leg. The base and cover have complementary locking surfaces for holding the assembled connector together. In a connector for making more complex interconnections, the dielectric base and cover comprise complementary body halves that are hinged together. A plurality of complementary grooves having longitudinal axes parallel to each other and in a common plane are formed in one surface of each body half for receiving the legs of strapping pins. A pair of complementary troughs with longitudinal axes perpendicular to the axes of the grooves are formed in the one surface of each body half for receiving the offset crossbars of strapping pins. Mating locking surfaces are formed on both body halves for holding an assembled connector together.

11 Claims, 14 Drawing Figures



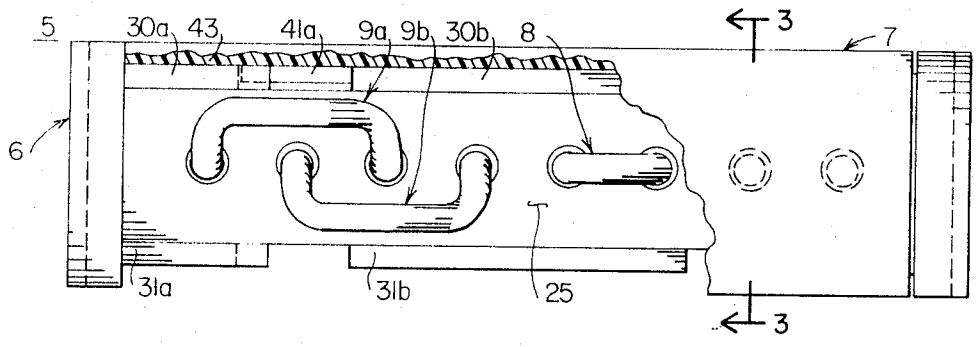


FIG. 1.

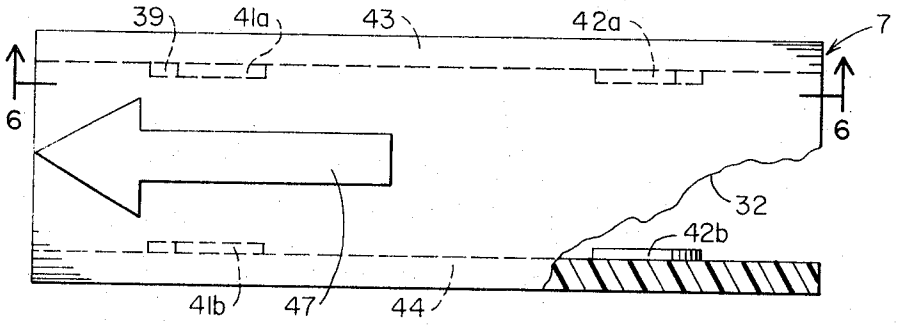


FIG. 5

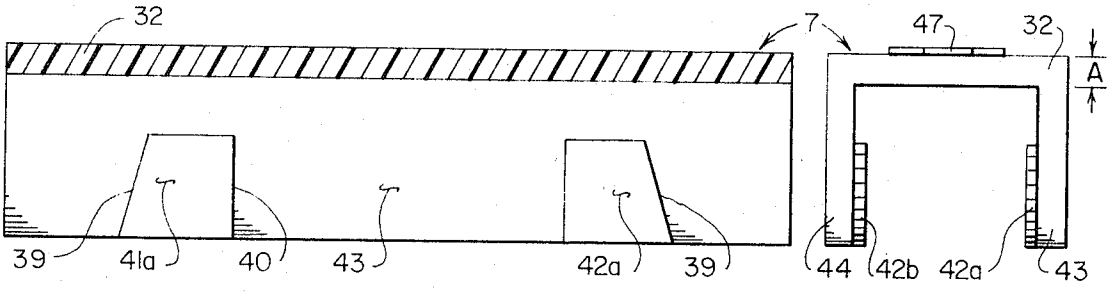


FIG. 6.

FIG. 7.

FIG. 14.

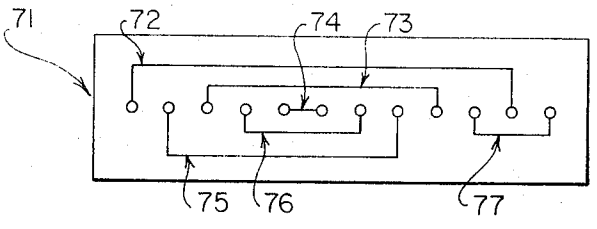
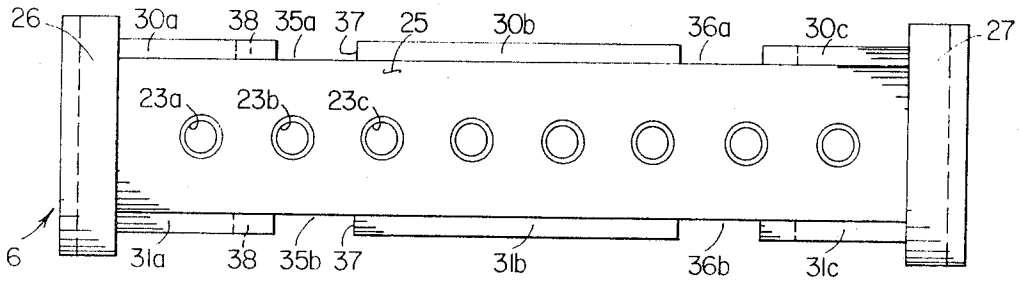


FIG. 4.



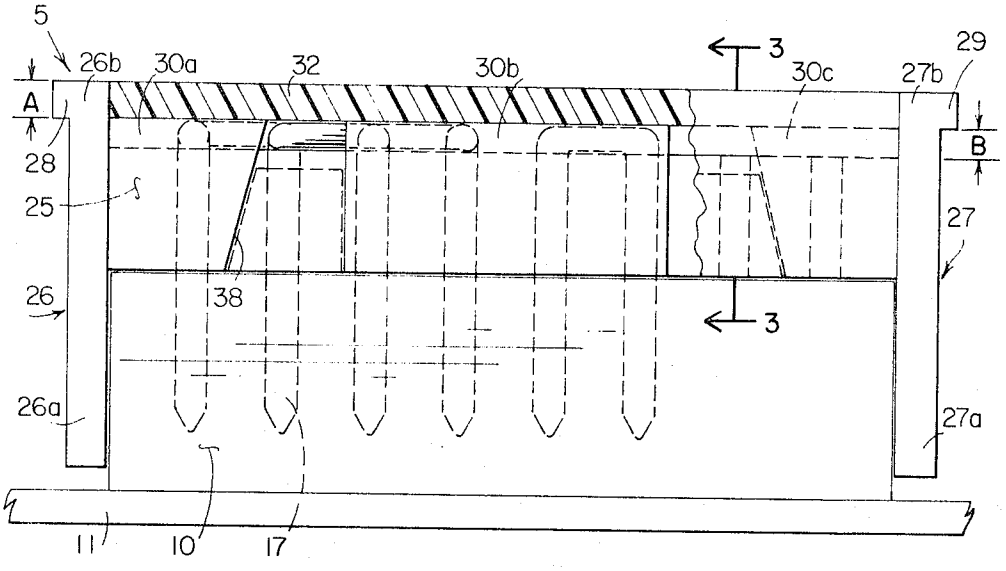


FIG. 2.

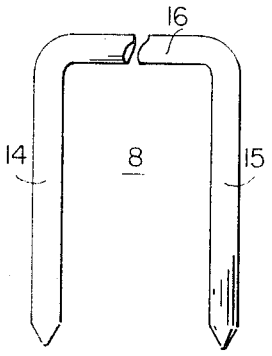


FIG. 8.

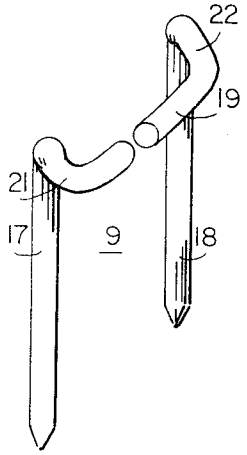


FIG. 9.

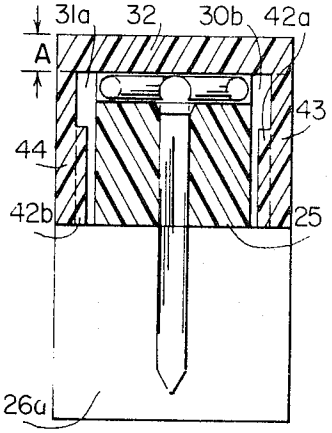
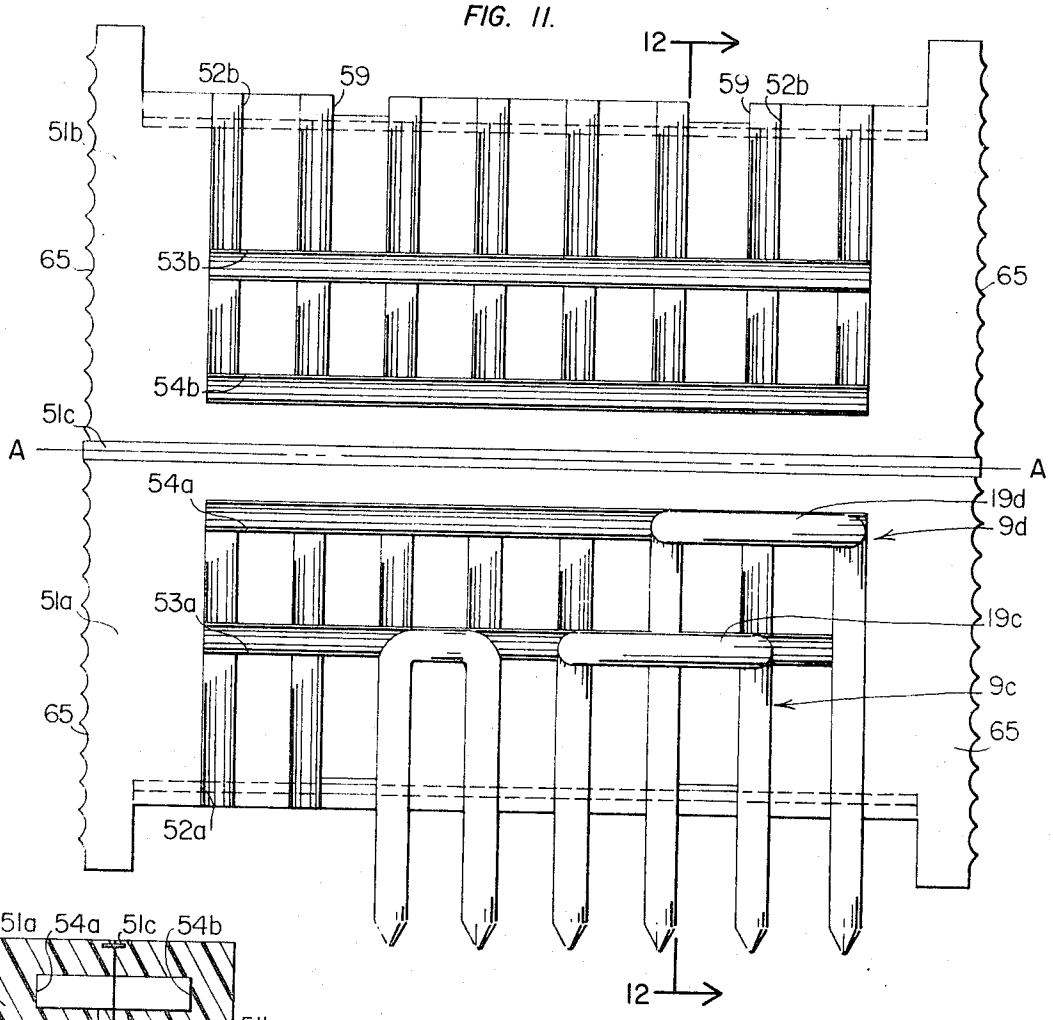


FIG. 3.

FIG. 11.



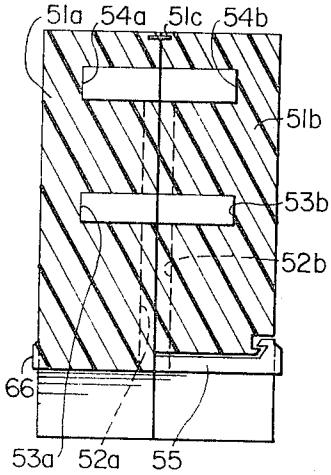


FIG. 12.

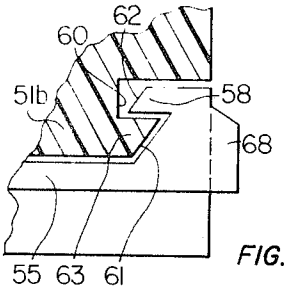


FIG. 13.

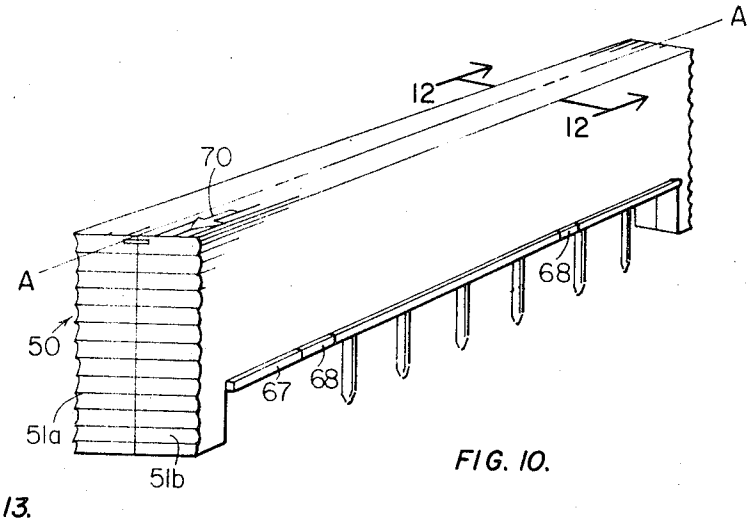


FIG. 10.

PROGRAMMABLE ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

This invention relates to apparatus for making electrical connections, and more particular to a programmable plug for selectively strapping electrical circuitry in any one of several possible predetermined configurations.

In telephone communications data transmission systems there are requirements for individual or separate repeaters operating with: through-power and a unidirectional signal path; through-power and a bidirectional signal path; loop power and a unidirectional signal path; or loop power and a bidirectional signal path. Through-power indicates the condition when power from a central power supply is connected through one repeater to another repeater in a repeater chain. Loop power indicates the condition when power to the last repeater of the chain is looped back in the direction of the central power supply. A unidirectional signal path is one in which a transmitted signal travels in only one direction, e.g., from East to West. A bidirectional signal path is one in which a transmitted signal travels in both directions, e.g., from East to West and from West to East. In this example, four different units must be produced if separate pieces of equipment are used to satisfy each of the aforementioned circuit options. This is expensive! In many instances, it is more economical to design, manufacture, and stock a single universal unit that can later be modified to operate in any one of the four modes than to design, manufacture, and stock four different units. Strapping is a method of electrically connecting selected terminals on a universal unit to make it operate in a specified one of several possible operating modes in order to satisfy a particular option.

One prior-art strapping method is to provide standard solder terminals conveniently arranged on a printed circuit board. Wires are soldered to selected terminal pins to make desired interconnections. This method has the obvious disadvantage of requiring alteration of the physical wiring of stored universal equipment after fabrication thereof has been completed by a manufacturing unit. This method has the further disadvantage of requiring that a skilled operator make the connection since schematic drawings must be read and interpreted to identify connections to be made and great care must be used in making the connections so as not to damage the universal equipment. This method is therefore expensive and time consuming and includes the high probability that an error may in making these connections. Although wire-wrap connections may be used in place of solder connections, a skilled operator is also required to make these connections.

Another prior-art strapping method is to fabricate a special printed circuit strapping board with the required strapping pattern on it, insert terminal pins on a printed circuit board of a universal unit into plated-through holes on the strapping board, and solder the pins and holes together. This technique is also relatively expensive and time-consuming since solder joints must be made in order to complete the connection.

Where it is desired to selectively connect common pins on a plurality of individual connectors that are arranged side-by-side, bus strips are employed to accomplish this strapping. Common pins of the connectors are interconnected by conductive clips that are slid onto a conductive bus bar. The clips have holes therein

that go over the common pins for making electrical connection thereto. Heat shrinkable dielectric tubing covers the portion of the bus bar between the clips for insulating the common pins and bar from other bypassed pins of the connectors. Although this technique is useful for interconnecting large numbers of pins, it is complex and expensive and also requires a skilled operator to read and interpret schematic diagrams for making the proper assembly.

An object of this invention is the provision of a strapping connector that is inexpensive and is simple to assemble.

Another object is the provision of a solderless strapping connector.

A further object is the provision of a programmable strapping connector.

An additional object is the provision of a plug-in strapping connector.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be more fully understood from the following detailed description thereof, together with the drawings in which:

FIG. 1 is a top view of a connector 5 embodying the principles of this invention, with a cover 7 partially broken away;

FIG. 2 is a side elevation view of connector 5;

FIG. 3 is a section view of connector 5 taken along line 3—3 in FIGS. 1 and 2;

FIG. 4 is a top view of the base 6 of connector 5 ;

FIG. 5 is a top view of the cover 7;

FIG. 6 is a section view of cover 7 taken along line 6—6 in FIG. 5;

FIG. 7 is an end view of cover 7 looking in the direction of the arrow 47 in FIG. 5;

FIG. 8 is a front view of a strapping pin 8 having a straight crossbar 16;

FIG. 9 is a perspective view of a crossover strapping pin 9 having an offset crossbar 19;

FIG. 10 is a perspective view of an assembled programmable connector 50 embodying an alternate form of this invention;

FIG. 11 is an enlarged front view of the body 51 of connector 50 prior to folding the two body halves 51*a* and 51*b* along line A—A;

FIG. 12 is a section view of the folded connector body 51 taken along line 12—12 in FIGS. 10 and 11, with the connector pins removed therefrom for the sake of clarity of illustration;

FIG. 13 is an enlarged fragmentary view of a portion of FIG. 12 illustrating the snap-lock which holds the two body halves 51*a* and 51*b* together; and

FIG. 14 is a schematic representation of a top view of a connector 71 embodying this invention in which the pins thereof are connected in a more complex strapping configuration.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings, reference characters with the same numerals designate the same or similar elements in the several figures. A preferred form of a connector embodying the principles of this invention is the connector 5 in FIGS. 1–3 which comprises a dielectric base 6 (see FIG. 4), a channel-shaped dielectric cover 7 (see FIGS. 5–7), and strapping pins 8 and 9 (see FIGS. 8 and 9). The base 6 and cover 7 may both be plastic parts that are formed by injection molding a

plastic such as ABS (acrylonitrile-butadiene-styrene). The connector **5** is plugged into a receptacle **10**, for example, on a printed circuit board **11**, see FIG. **2**.

The straight-connect strapping pin **8** is U-shaped (see FIG. **8**), and comprises a pair of cylindrical legs **14** and **15** that are parallel to each other, and a straight crossbar **16** that is orthogonal to the legs and is connected to adjacent ends thereof. Thus, the legs **14** and **15** and crossbar **16** of pin **8** are in the same plane. The crossover strapping pin **9**, however, (see FIG. **9**) comprises a pair of cylindrical legs **17** and **18** that are parallel to each other in one plane, and a U-shaped head in a second plane that is orthogonal to the one plane. The crossbar **19** of pin **9** is spaced from the legs thereof and is connected to adjacent ends of the latter by shanks **21** and **22**. The lengths of the crossbars of pins **8** and **9** may be varied depending on the number of holes **23** in the connector base **6** that are to be spanned by a particular pin **9**. It can readily be seen that a large number of different strapping configurations can be accomplished with a family of pins **8** and **9** having different length crossbars.

The connector base **6** comprises an elongated body **25** having walls **26** and **27** formed on the ends thereof. The end walls have lower portions **26***a*, **27***a* and upper portions **26***b*, **27***b* extending below and above, respectively, the body **25**. The inner surfaces of the lower wall portions **26***a* and **27***a* aid in aligning connector **5** when it is assembled onto the receptacle **10**. Flanges **28** and **29** which protrude out from the upper wall portions **26***b* and **27***b*, respectively, provide gripping surfaces for removing connector **5** from the receptacle **10**. The upper wall portions **26***b* and **27***b* extend a distance A above the longitudinal ridges **30** and **31** which project above the top surface of base **25** at the sides thereof. The distance A is equal to the thickness of the top **32** of cover **7** as is shown in FIGS. **6** and **7**. The height B of the ridges **30** and **31** is slightly greater than the thickness of the crossbars of pins **8** and **9**.

A plurality of holes **23** extend through the connector base **25**. These holes **23** are preferably centered and evenly spaced apart in the body **25** with their axes parallel to each other and in a common plane. The holes **23** are sized to receive the legs of pins **8** and **9**.

A pair of slots **35** and **36** are formed in each side of base **25**. One wall **37** defining each slot is orthogonal to the common plane through holes **23**. The other wall **38** of each slot is tapered to make with wall **37** an actuate angle having its vertex above the top surface of the connector body **25**. The wall **38** essentially defines a locking surface which mates with a complementary surface **39** of a tab **41** on cover **7** as if described more fully hereinafter. The slots **35** and **36** are identical except that each tapered wall **38** of the slots is proximate the adjacent end wall of tbe connector body **25**.

Referring now to FIGS. **5–7**, cover **7** is a channel-shaped member having a top **32** and side walls **43** and **44**. The cover **7** is dimensioned to fit snugly over the connector body **25** and between the end walls **26** and **27** thereof. A pair of tabs **41** and **42** are formed on the inner surface of each side wall of the cover. The shapes of the tabs **41** and **42** are complementary to those shapes of associated slots **35** and **36** so that the tabs will snap into the associated slots to hold the connector together when cover **7** is pressed onto the body **25**. The tapered wall **39** of each tab is adjacent an end of the cover **7** so that the latter can be snapped onto the connector base **6** when it is oriented in either of the two possible directions. An arrow **47** indicating a reference direction is formed on the outer surface of the top **32** of the cover. The cover **7** is made of a resilient dielectric material so that the sides **43** and **44** thereof will snap tightly against the sides of the connector body **25** after these parts have been pressed together.

The connector **5** is assembled by inserting pins **8**, **9***a* and **9***b* into selected holes **23** in a prescribed pattern such as is illustrated in FIG. **1**. By using the crossover pin **9***a*, for example, it is possible to conveniently make electrical connection between holes **23***a* and **23***c* located on either side of the hole **23***b* having a leg **17** therein, without making electrical connection to the latter. Since the body **25** is symmetrical, it is immaterial which of the walls **26** and **27** is used as a reference from which to orient the pins **8** and **9**. Assembly of the connector is completed by pressing the cover **7** over the body **6** to snap the tabs **41**, **42** into associated slots **35**, **36** with the arrow **47** pointing toward the end wall that is used as a reference from which to orient the pins.

In practice, the cost of stamping out the pins **8** and **9** and injection molding the connector base **6** and cover **7** is very low. It is possible therefore to produce a quantity of each of these parts and a number of different size pins **9**. A connector with any one of several different strapping configurations can then be programmed by merely selecting and assembling the necessary parts. If a connector is assembled incorrectly, it can be discarded rather than repaired since the component parts are inexpensive.

An alternate embodiment of this invention that is useful in producing connectors with more complex strapping configurations is illustrated in FIGS. **10–13**. The dielectric body **51** of connector **50** is shown in the open position in FIG. **11** with strapping pins **8** and **9** loaded therein as is described more fully hereinafter. The connector body **51** is shown in FIG. **10**, **12**, and **13** in the closed position. The strapping pins are omitted from FIG. **12** (which is a section view of the closed connector body **51** that is taken along the line **12—12** in FIGS. **10** and **11**) for the sake of clarity in illustrating the cross section of the connector body. FIG. **13** is an enlarged view of a portion of the closed connector body in FIG. **12** for illustrating the snap-lock that holds the connector body together.

The dielectric body **51** of connector **50** comprises a pair of complementary half portions **51***a* and **51***b* which are connected together by a hinge **51***c*. A plurality of complementary semicircular grooves **52** are formed in the adjacent inner surfaces of each body half for receiving the legs of strapping pins **8** and **9**. A pair of complementary troughs **53** and **54** are also formed in each surface of each body half for receiving the U-shaped heads of crossover pins **9***c* and **9***d*, respectively. The lengths of both the legs and crossbars of strapping pins in the connector **50** may be varied. As shown in FIG. **11**, the legs of each strapping pin are shown in a groove **52** of the body half **51***a*. The crossbar **19***d* of pin **9***d* is positioned for being located in trough **54***b* when the connector body is closed. Alternatively, a pin **8** with its crossbar in the junction of troughs **54***a* and **54***b* may be used in place of the pin **9***d*. The crossbar **19***c* of pin **9***c* is positioned in FIG. **11** to be in the trough **53***b* when the connector body is closed in order to bypass the leg of connector **9***d*. The crossbar of the other strapping pin is shown in the junction of the troughs **53***a* and **53***b*.

A pair of arms 55 extend from the bottom of the body half 51*a*. Each of the arms 55 has a hook on the free end thereof with a lip 58 projecting inwardly toward the body half 51*a*. The other body half 51*b* has a pair of troughs 59 (see FIG. 11) in the bottom thereof for receiving associated arms 55. The body half 51*b* also has slots 60 in its outer surface adjacent the bottom thereof for receiving associated ones of the lips 58 to secure the two body halves together (see FIG. 13). The connector body 51 is preferably made of a resilient dielectric material with the edges 61 and 62 on the body half 51b and lip 58 tapered to provide sliding surfaces whereby a lip 58 slides over an associated flange 63 to snap into an associated slot 60 when pressure is applied to an arm 55. In this manner, the two body halves 51*a* and 51*b* are secured together.

The ends 65 of the connector body are knurled for facilitating removal of connector 50 from a receptacle (not shown). Ridges 66 and 67 on the outer surfaces of each body half (see FIGS. 12 and 10, respectively also facilitate removal of the connector from a receptacle. Tabs 68 on the free ends of the arms 55 have the same cross sections and dimensions as the ridge 67 to make it difficult to disassemble a connector 50 without destroying the snap locks thereof. This intentionally makes it difficult to rework an assembled connector 50 to program it to provide a different strapping configuration. Since the connector parts can be manufactured for a very low price, if a connector 50 is assembled incorrectly it can be discarded rather than repaired.

A reference arrow 70 is formed on the top of body half 51*b*, for example. This means that strapping pins 8 and 9 must always be loaded ino the connector body 51 from a prescribed direction.

It is readily seen that a wide variety of strapping configurations can be accomplished with the connector 50. A schematic representation of a connector 71 with a relatively complex strapping configuration obtained with a connector body similar to that shown in FIG. 12 and having grooves 52 defining 12 different holes for receiving legs of strapping pins is illustrated in FIG. 14. One of the several possible ways of producing this strapping configuration with such a connector body is to locate the crossbars of crossover pins 72 and 73 in the lower and upper left troughs 53*a* and 54*a*, respectively; with the strapping pin 74 in the junction of either the lower troughs 53 or the upper troughs 54. The crossover pins 75 and 76 can then be located in the lower and upper right troughs 53*b* and 54*b*, respectively; with the other crossover pin 77 in either the upper or lower right trough.

Although this invention has been shown and described in relation to preferred embodiments thereof, variations and modifications will be apparent to those skilled in the art. For example, it is not necessary for the troughs 53 and 54 in adjacent body halves in FIG. 12 to be paired. It is possible for the troughs 53*a* and 53*b* to be offset from each other, for more or less than two troughs 53 and 54 to be formed in one body half, or for all of the troughs to be formed in the same one side of a body half.

What is claimed is:

1. A programmable plug-in connector for selectively interconnecting sockets of a receptacle, comprising

a connector body formed of an electrically insulating material and comprising a pair of mating body halves, each of said body halves having a plurality of grooves in one wall thereof with parallel longitudinal axes that are in a common plane and having a first trough with a longitudinal axis perpendicular to the axes of said grooves, said grooves forming a plurality of openings in said body that extend through the bottom thereof when the one walls of said body halves are mated together,

a first electrically conductive strapping pin having a first leg in one of said openings that has other openings on either side thereof, said first leg having one end protruding through the bottom of said body and having an other end,

a second electrically conductive strapping pin having second and third legs in associated openings on differnt sides of the one opening so that the longitudinal axes of said first, second, and third legs are in the common plane, said second and third legs also having one ends projecting through the bottom of said body and having other ends, said second pin having an electrically conductive arm in a trough in one of said body halves and interconnecting the other ends of said second and third legs through a path that bypasses first leg, and

means securing said body halves together for holding said pins in place when the one ends thereof are forced into the sockets of a receptacle.

2. The connector according to claim 1 including a second trough in one of said body halves, said second trough having a longitudinal axis perpendicular to the longitudinal axes of said grooves and parallel to the longitudinal axes of said first troughs and a depth sufficient to receive said arm therein.

3. The connector according to claim 2 wherein each of said body halves has a second trough therein with a longitudinal axis perpendicular to the axes of said grooves and a depth sufficient for receiving said arm therein, the longitudinal axes of said second troughs being in the same plane.

4. The connector according to claim 3 wherein said mating halves are hinged together.

5. A programmable plug-in connector for selectively interconnecting sockets of a receptacle, comprising

a first elongated body section formed of an electrically insulating material and having a plurality of first grooves in one side thereof with longitudinal axes that are parallel to each other and in a common plane, and having a first trough in the same one side thereof with a longitudinal axis that is perpendicular to the axes of said first grooves,

a second elongated body section formed of an electrically insulating material and having in one side thereof a pattern of second grooves and a second trough that is complementary to the pattern on said first body section,

said first and second grooves forming openings extending through the bottom surfaces of said body sections when the one sides of the latter body sections are mated together,

a first electrically conductive strapping pin having a first leg in one of said openings that has other openings on either side thereof, said first leg having one end protruding through the bottom surfaces of said body sections and having an other end,

a second electrically conductive strapping pin having second and third legs in associated openings on different sides of the one opening so that the longitudinal axes of said first, second, and third legs are in

the common plane, said second and third legs also having one ends projecting through the bottom surfaces of said body sections and having other ends, said second pin having an electrically conductive arm interconnecting the other ends of said second and third legs through a path that bypasses said first leg, said arm being located in one of said first and second troughs, and

means for securing said first and second body sections together.

6. The connector according to claim **5** including a plurality of said first troughs spaced apart in said first body section, each of said first troughs having a depth sufficient to receive said arm therein.

7. The connector according to claim **5** wherein said arm is in a plane that is substantially perpendicular to the common plane and has a substantially channel-shaped cross section with a crossbar bypassing openings in said body sections that are between the legs of said second pin and including a plurality of first and second complementary troughs spaced apart in said first and second body sections, respectively, and having parallel longitudinal axes, each of said first and second troughs having a depth sufficient to receive said crossbar therein.

8. The connector according to claim **7** wherein said body sections are hinged together.

9. The connector according to claim **8** wherein said last-named securing means comprises a support member having one end connected to said first body section and extending toward the second body section, the other end of said member and a surface of the second body section having a complementary hook thereon and slot therein, respectively, whereby said body sections are snap-locked together by rotating said body sections about said hinge.

10. A programmable plug-in connector for selectively interconnecting sockets of a receptacle, comprising

a first electrically conductive strapping pin having a first leg with one and other ends thereof;

a second electrically conductive stapping pin having second and third legs that are parallel to each other in a common plane, each of said second and third legs having one and other ends thereof, said second pin having an electrically conductive arm interconnecting the other ends of said second and third legs and being in a second plane that is orthogonal to the common plane containing said second and third legs, the thickness of said arms being no greater than a prescribed value;

an electrically nonconductive elongated connector body having a plurality of holes therethrough having parallel longitudinal axes in a common plane and defining openings in opposing bottom and top walls thereof, at least one other wall of said body extending above said top wall to form a closed ridge around the connector body and having a height equal to the prescribed value; said first leg being selectively inserted into one of said holes that has other holes on either side thereof, one and other ends of said first leg protruding through the bottom and top walls, respectively, of said body; said second and third legs being selectively inserted into associated holes on different sides of the one hole so that the longitudinal axes of said first, second, and third legs are in the same common plane; said second and third legs having one and other ends projecting through the bottom and top walls, respectively, of said body; said arm being located in the ridge opening on said body, and being spaced in the second plane from and bypassing the other end of said first leg;

an electrically nonconductive cover, and

means for connecting said cover to said body over the other ends of said legs for holding said pins in place when the one ends thereof are forced into the sockets of the receptacle.

11. The connector according to claim **10** wherein said arm is substantially channel shaped and has a crossbar spaced from the other end of said first leg in the second plane, said arm being located in the body opening formed by said ridge; and wherein said cover is an open-ended elongated channel-shaped flexible structure; the cross sections of a portion of said cover and body being complementary, a side surface portion of one of said cover and body having a tab thereon, an adjacent side surface portion of the other of said cover and body having a mating slot therein for interlocking with said tab when said cover is pressed onto said body.

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