United States Patent [19]

Henn et al.

[11] **3,858,158**

[45] **Dec. 31, 1974**

[54] **DEVICES FOR MAKING ELECTRICAL CONNECTIONS**

[75] Inventors: **Robert Walter Henn**, Dunwoody; **Christian Scholly**, Atlanta; **James Emery Voytko**, Doraville; **Thomas Leslie Williford, Jr.**, Lawrenceville; **Charles McGonigal**, Grayson; **Dean Rudisill Frey**, Dunwoody; **Donald Tolman Smith**, Norcross; **Arthur Guntis Vedejs**, Duluth, all of Ga.

[73] Assignee: **Western Electric Company, Inc.** New York, N.Y.

[22] Filed: **June 1, 1973**

[21] Appl. No.: **365,931**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 210,750, Dec. 22, 1971, Pat. No. 3,772,635.

[52] **U.S. Cl.** ..... **339/99 R**, 29/203 H, 339/108 TP, 339/113 L, 339/115 R

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

[58] **Field of Search** ..... 339/99 R, 98, 97 R, 121, 339/210 M, 156 R, 157 R, 45 M, 49 R, 176 MF, 339/184 M, 185 R, 198 GA

[56] **References Cited**

UNITED STATES PATENTS

3,611,264	10/1971	Ellis	339/99 R
3,686,617	8/1972	Uberbach	339/184 M X
3,778,750	12/1973	Caveney	339/97 R

FOREIGN PATENTS OR APPLICATIONS

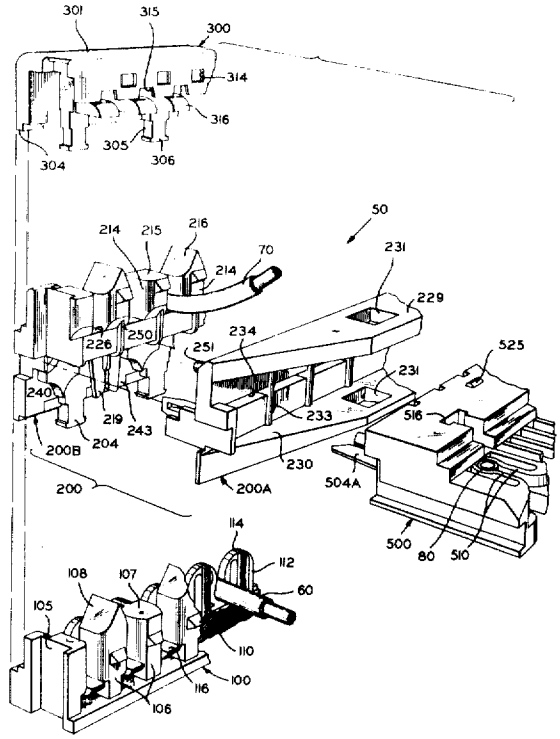
1,377,374	9/1964	France	339/99 R

Primary Examiner—Ernest R. Purser
Assistant Examiner—William F. Pate, III
Attorney, Agent, or Firm—E. W. Somers

[57] **ABSTRACT**

An index strip has alternately peaked and flat indexing teeth which are of assistance in splitting conductor pairs of a first plurality of conductors which are received in slots formed between adjacent ones of the teeth. The conductors are retained in the slots prior to assembly of a connector module with the index strip. The connector module is comprised of mating portions and includes a plurality of double-ended, contact elements. The mating portions are designed for reliable permanent assembly while securing the contact elements therein against unintended lateral and longitudinal movement. The contact elements make electrical engagement with associated ones of the conductors in the index strip when the connector module is mounted to the index strip. Depending on service requirements, a connector module having the same conductor capacity as the index strip may be used. The teeth in the index strip are arranged in groups with end ones of the groups specially designed to permit mounting of connector modules having the same length as one or more of the groups in the index strip. A bridging module may be mounted at selected locations along a connector module having the same length as one or more groups of the index strip or the bridging connector may extend along the entire length of the connector module.

20 Claims, 25 Drawing Figures



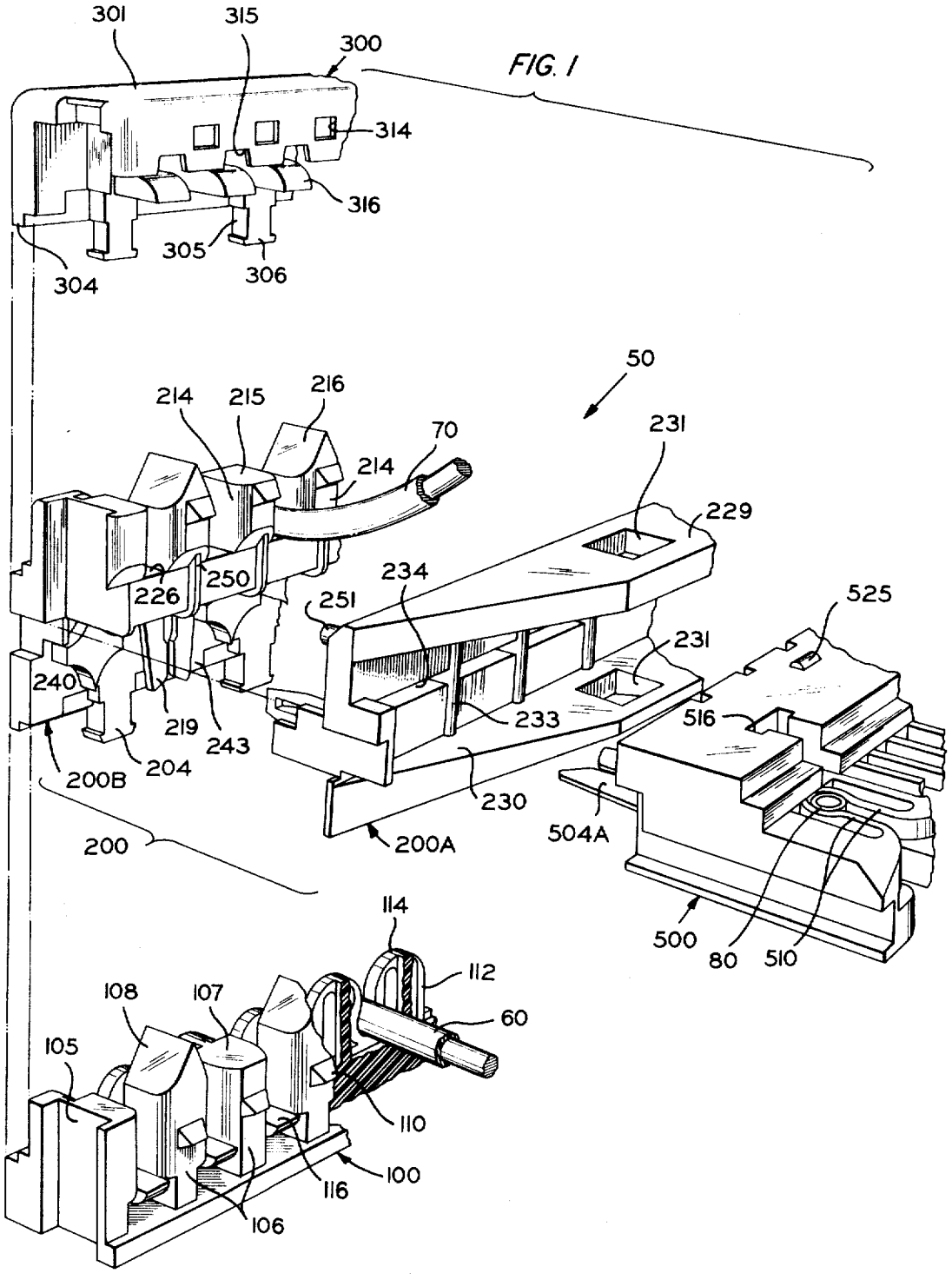

301
315
300
314
316
305
306
304
50
214
215
216
70
214
231
229
226
250
234
251
525
231
240
219
243
233
516
200B
204
230
200A
504A
200
500
80
510
114
112
108
107
60
105
110
100
116
106

FIG. 1

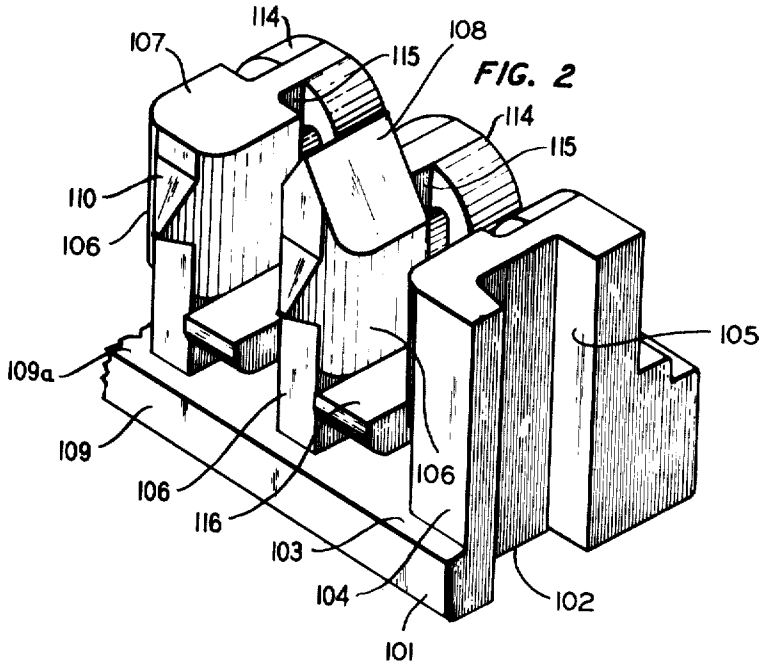
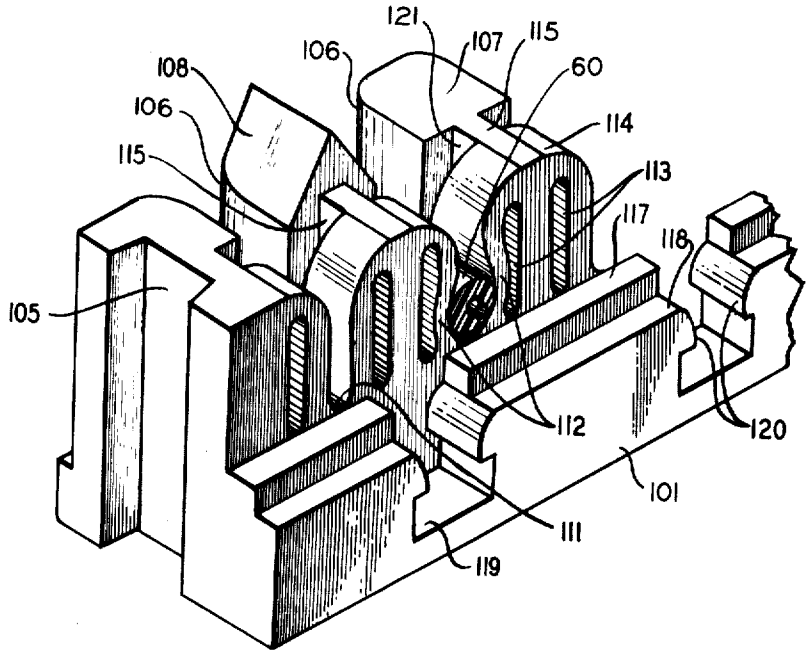

114
107
108
115
114
115
110
106
105
109a
109
106
106
116
103
104
102
101

FIG. 2

FIG. 3


121
106
107
115
108
60
106
114
115
113
117
118
105
112
120
101
111
119

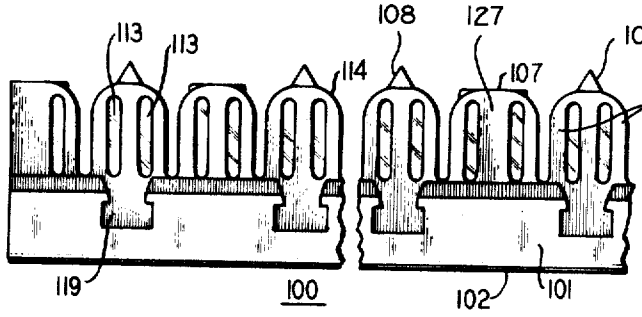


FIG. 3B

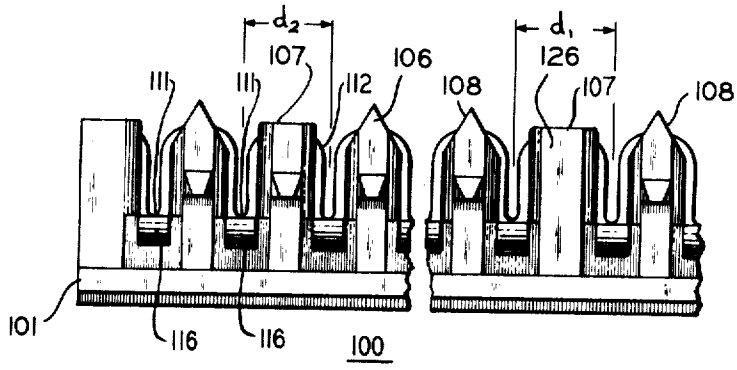


FIG. 3C

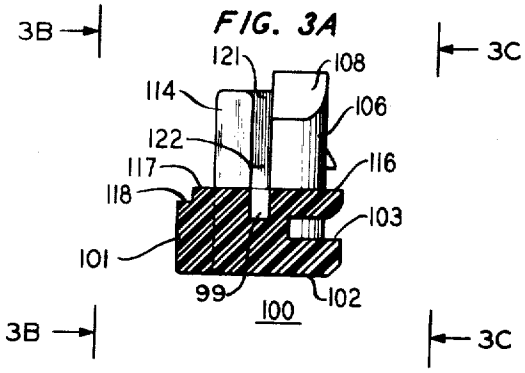


FIG. 3A

FIG. 4B

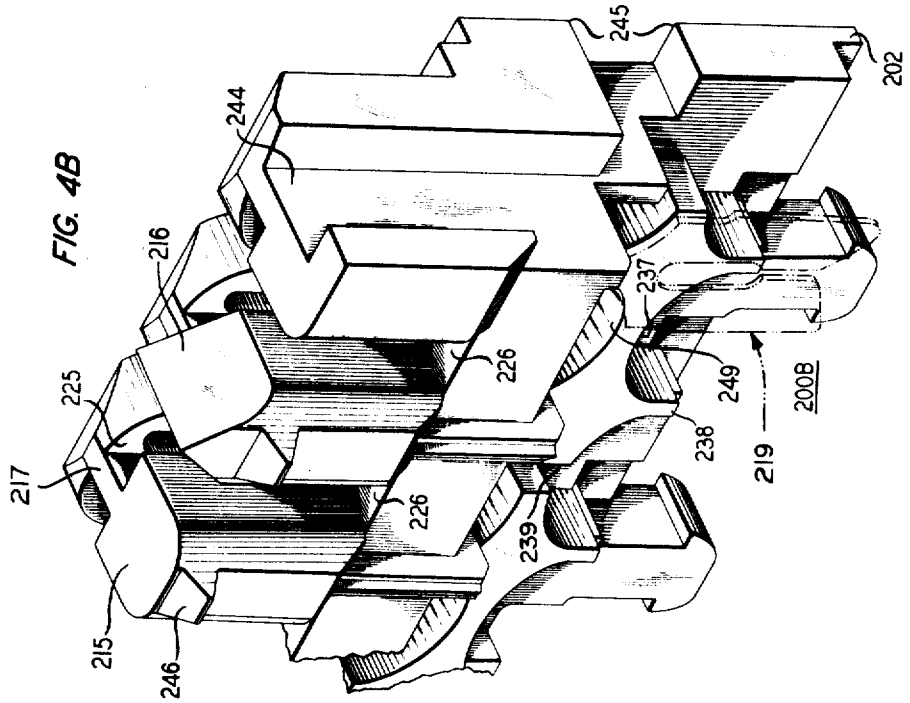

245
202
244
216
237
225
226
249
200B
217
238
219
226
239
215
246

FIG. 4A

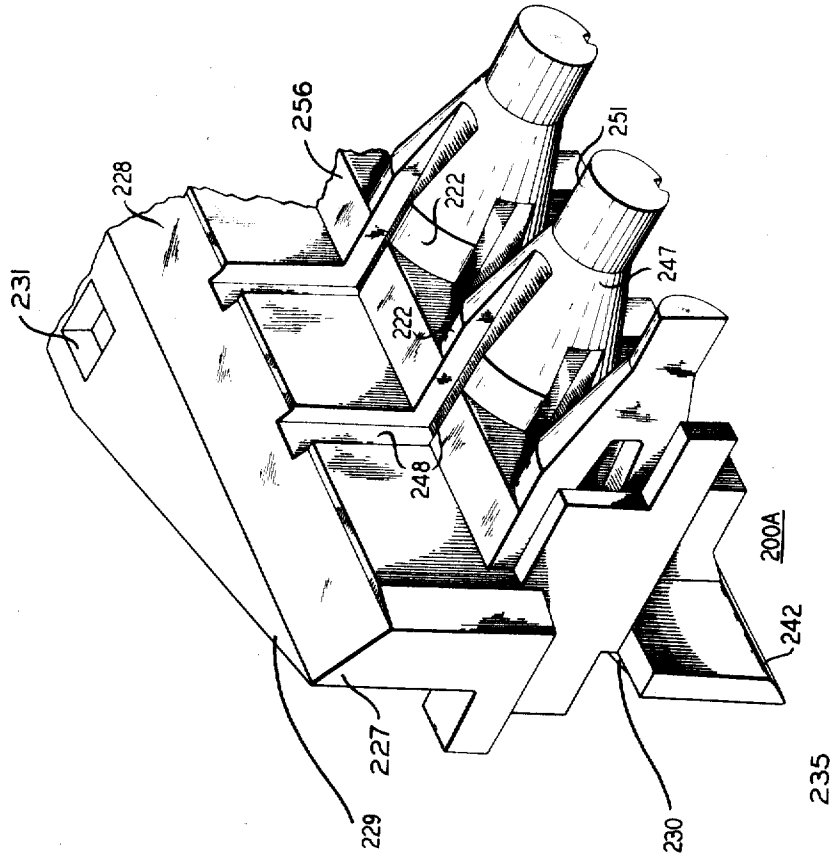

256
251
228
222
231
247
222
248
200A
242
227
235
229
230

FIG. 5

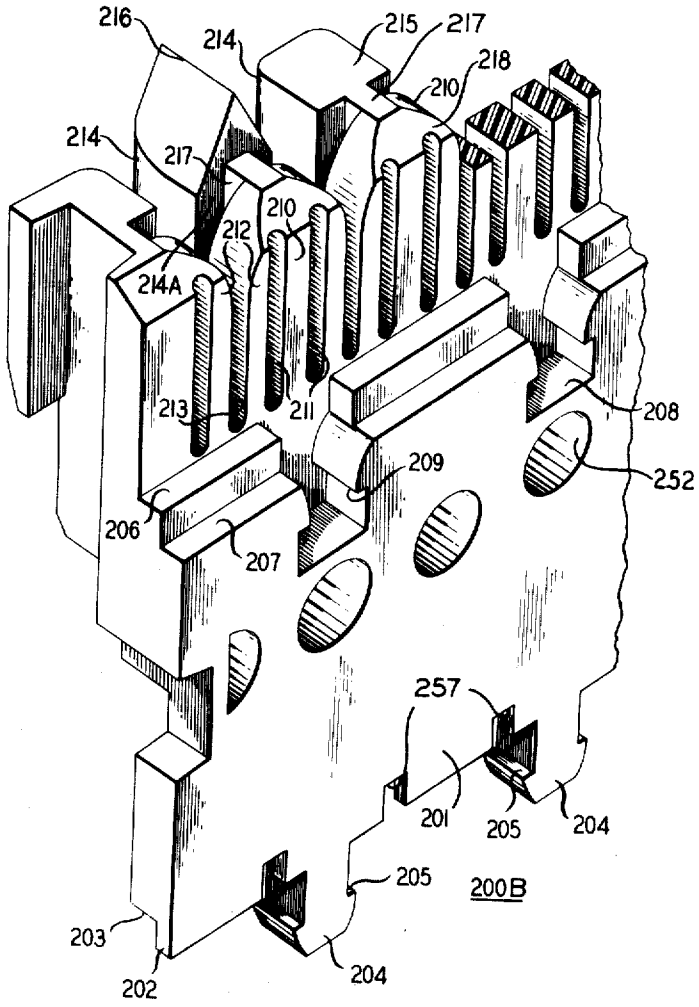

216
214
215
217
218
210
214
217
210
212
214A
213
211
208
209
252
206
207
257
201
205
204
205
200B
203
202
204

FIG. 6A

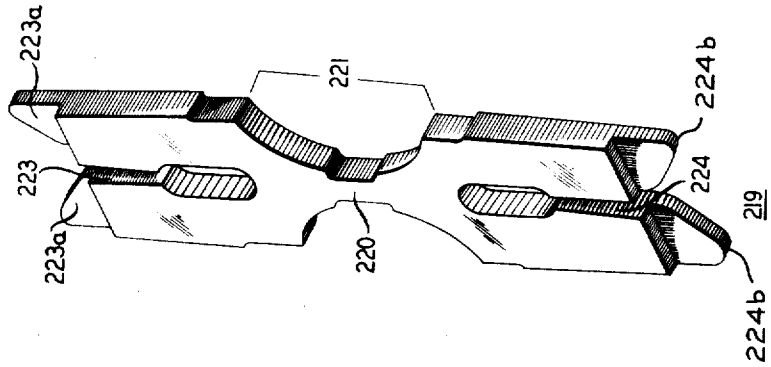
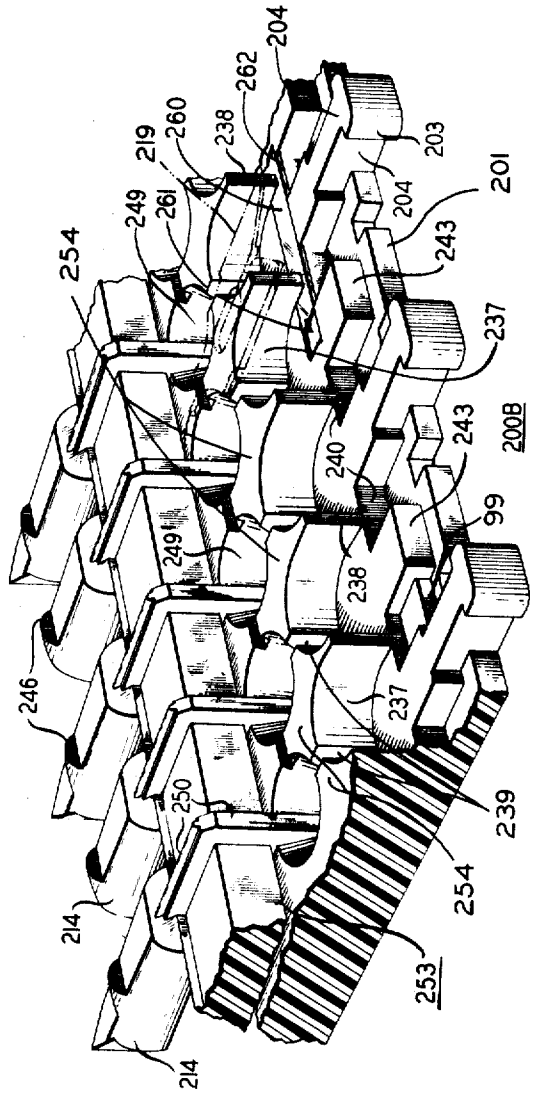

223a
221
224b
223
224
219
223a
220
224b

FIG. 6


204
262
260
238
219
203
201
249
261
204
254
243
237
243
200B
240
99
249
238
246
237
250
239
254
214
253
214

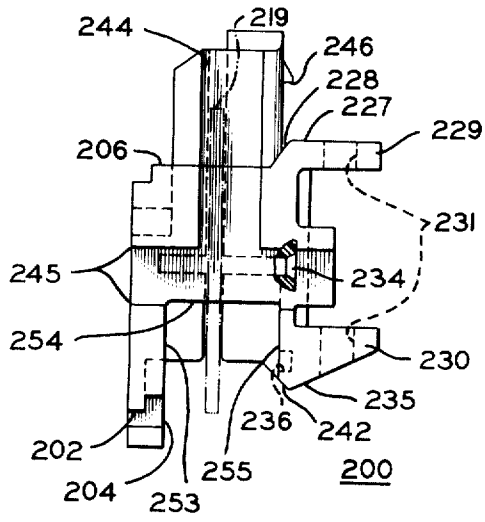


FIG. 7

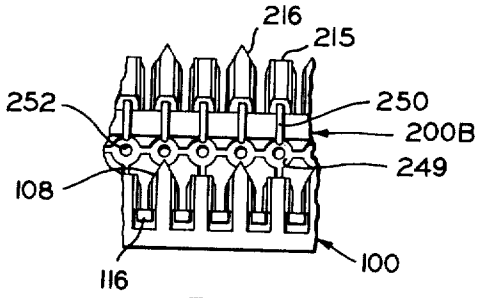


FIG. 7A

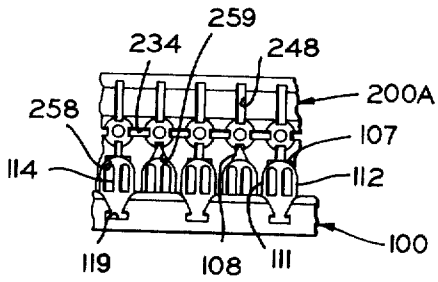


FIG. 7B

FIG. 8

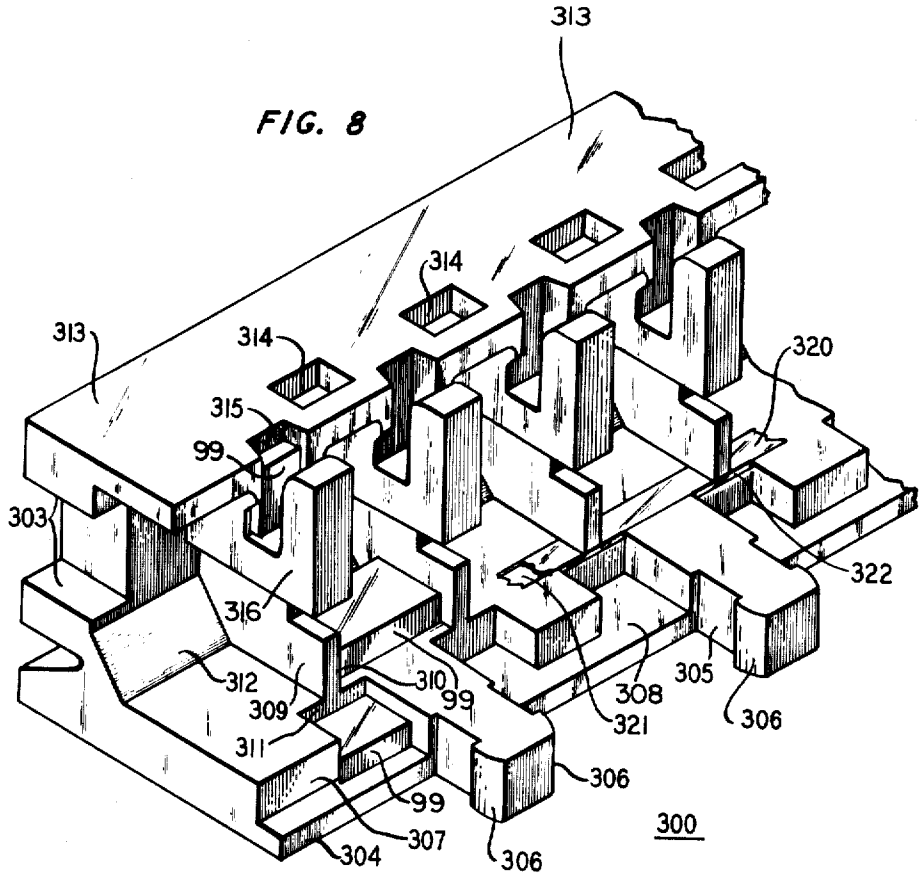

313
314
313
314
320
315
99
303
322
316
312
310
99
309
308
305
321
306
311
306
99
307
304
306
300

FIG. 9

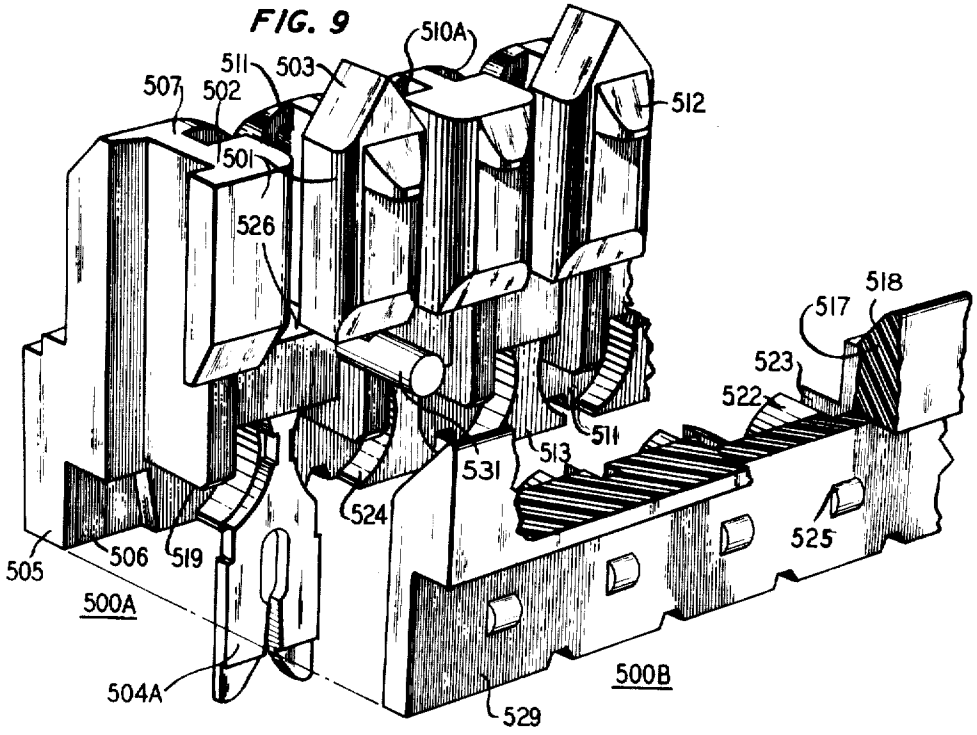
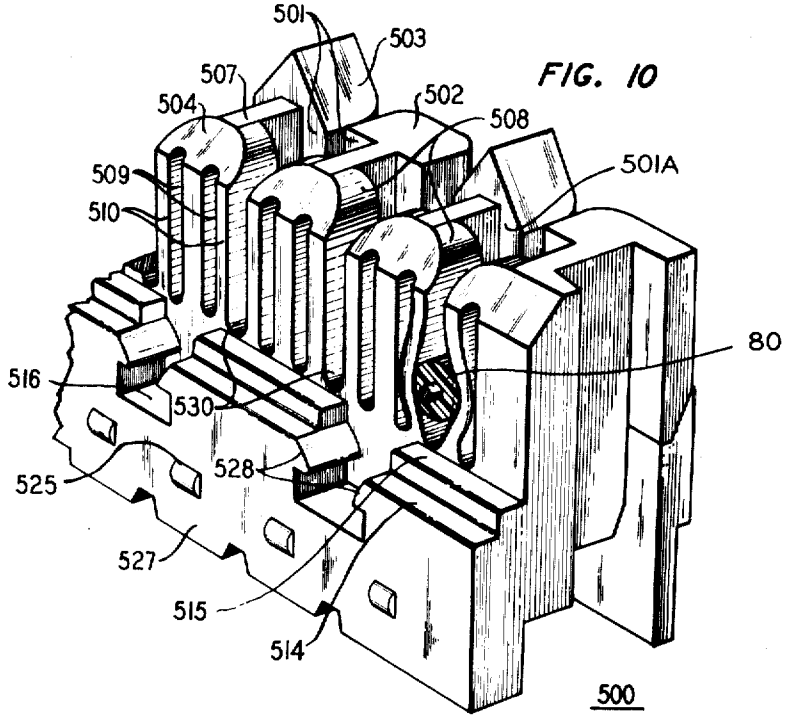

510A
511
503
507
502
512
501
526
518
517
523
522
511
513
531
524
525
505
506
519
500A
504A
500B
529

FIG. 10


501
503
507
504
502
508
501A
509
510
80
516
530
528
525
527
515
514
500

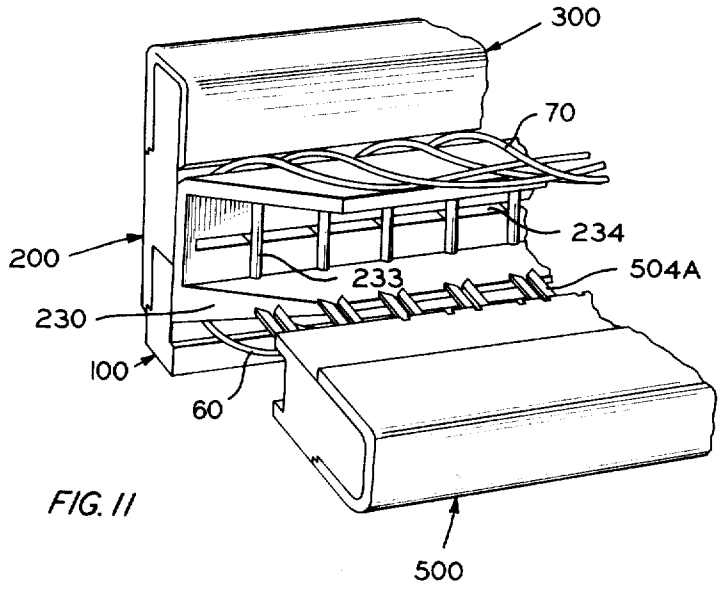


FIG. 11

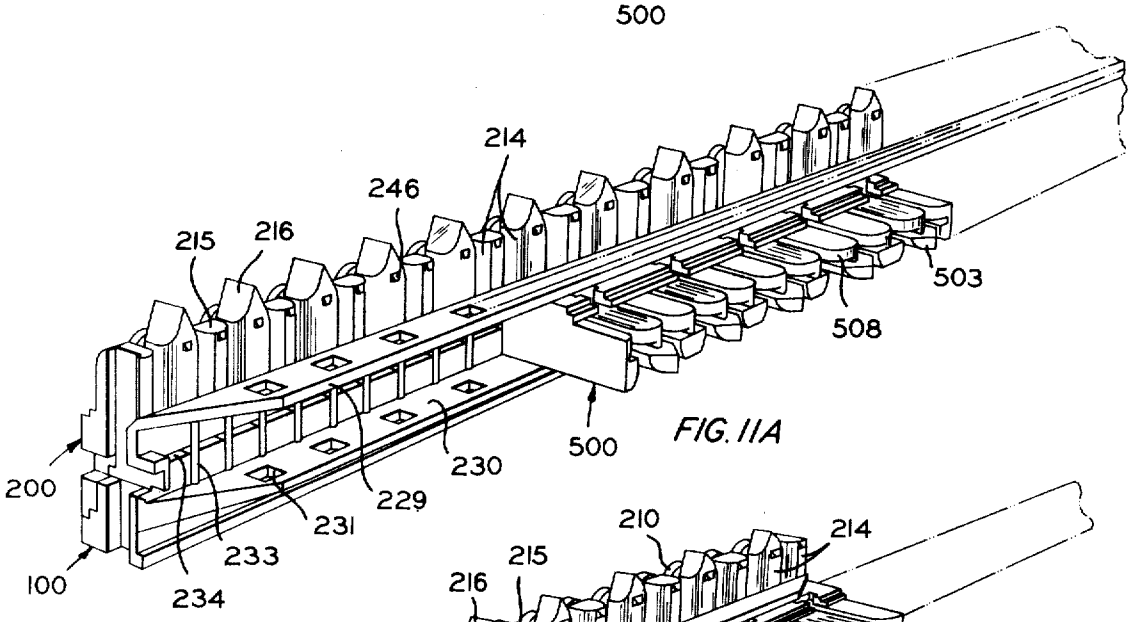


FIG. 11A

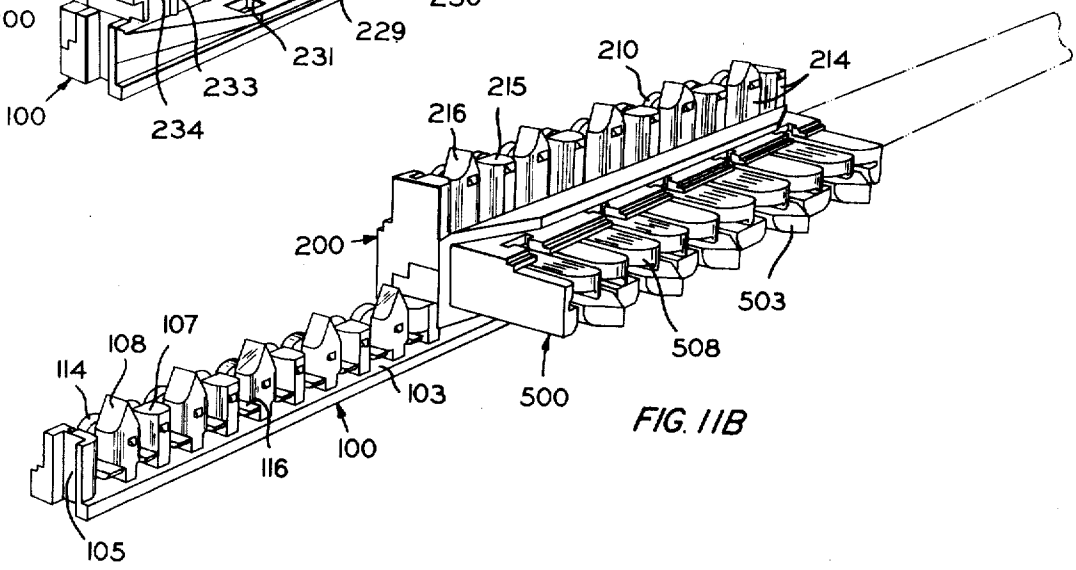


FIG. 11B

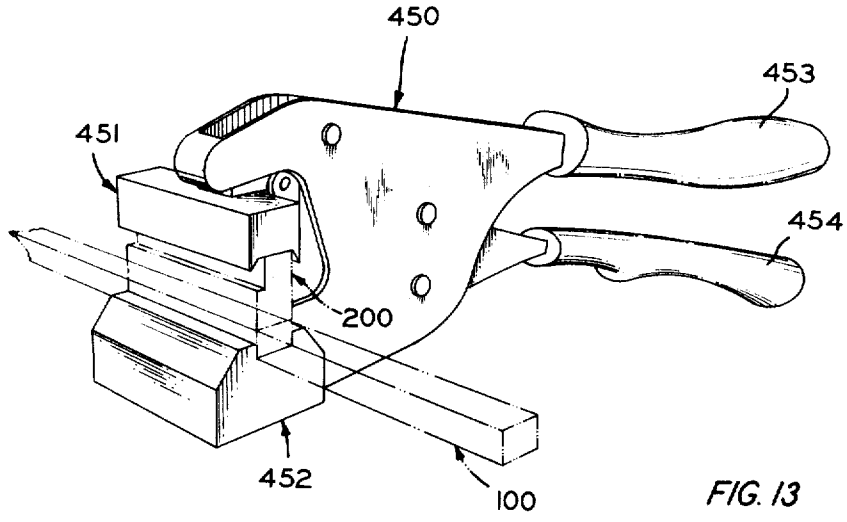


FIG. 13

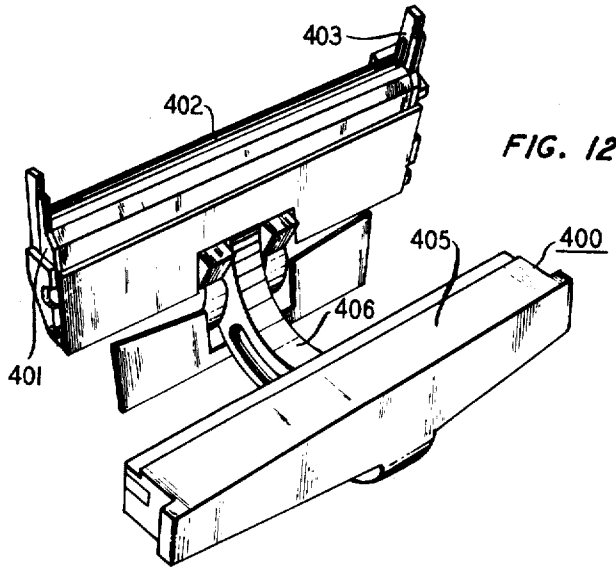


FIG. 12A

FIG. 12C

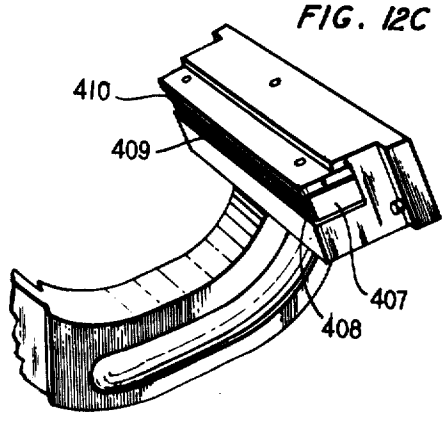
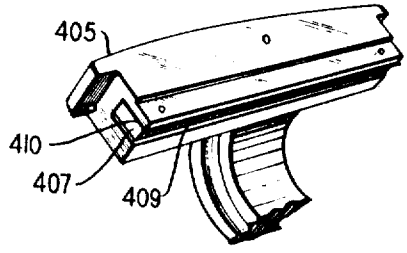


FIG. 12B



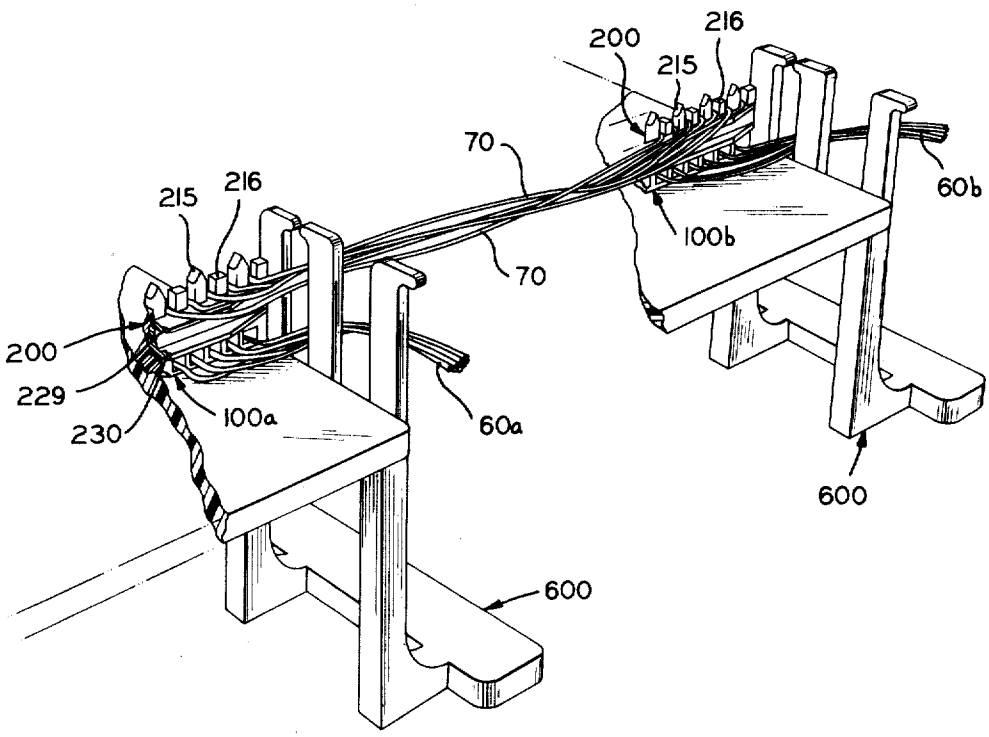


FIG. 14

DEVICES FOR MAKING ELECTRICAL CONNECTIONS

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of application Ser. No. 210,750 filed on Dec. 22, 1971 and in the names of D. R. Frey, R. W. Henn., D. T. Smith and A. G. Vedejs and now U.S. Pat. No. 3,772,635.

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to devices for making electrical connections, and more particularly, relates to devices for making cable splicing connections between two multipair communications cables with provisions for interconnecting a third multipair cable.

2. Technical Considerations and the Prior Art

A wide variety of connecting devices are presently used in the communications industry to splice together associated conductors of two cables. These connecting devices desirably should have provisions for bridging. Bridging refers to the connection of a third conductor to a two conductor splice.

There are several factors which account for the many connector designs available on the market. These include different gauges of the conductors to be spliced, the need for connectors to be used with various power tools, the need for an encapsulated splice in moisture resistant systems, modular designs to expedite conductor handling and improve housekeeping, and the thrust toward miniaturization.

It has been estimated that over one billion pair splices are made each year by the telephone industry. Considering the manpower and material costs associated therewith, there is ample incentive to better systematize splicing and bridging operations. Ideally, a basic connector to fulfill all cable splicing needs with provisions for bridging is desired.

Interconnection devices are disclosed in U.S. Pat. 3,611,264, issued on Dec. 27, 1968 in the name of B. C. Ellis, Jr. and in an application Ser. No. 218,358, filed Jan. 17, 1972 in the names of B. C. Ellis, Jr., C. McGonigal, C. Scholly and J. H. Snyder. These devices do not include facilities for bridging.

In application Ser. No. 210,750, filed Dec. 27, 1971 in the name of D. R. Frey, R. W. Henn, D. T. Smith and A. G. Vedejs, of which this application is a continuation-in-part, there is disclosed a basic splicing and bridging connector. Several additional features and modifications to that connector are desirable to provide a standard splicing and bridging connector in the industry.

SUMMARY OF THE INVENTION

A basic-splice unit includes an index strip, a connector module, and a cap. The index strip includes alternately peaked and flat-top teeth to facilitate the splitting of the conductor pairs. The index strip includes a plurality of spaced walls aligned with the teeth, deflectable longitudinally of the index strip, and defining conductor-receiving slots for holding the conductors in a spaced array prior to the mounting of the connector module on the index strip.

The connector module includes a plurality of double-ended slotted contact elements. One feature of the invention is constructing the connector module in mating

portions which are staked together subsequently. The features for mating the portions are designed to facilitate the assembly of the contact elements therewith and to secure the contact elements against unintended lateral and longitudinal movement.

The connector module is snap-mounted to the index strip. As this is done, the contact elements penetrate the insulation of conductors supported in the slots of the index strip to make electrical engagement therewith. A top portion of the module is similar in configuration to the portion of the index strip on which the connector module is to be mounted and performs the same functions. Other conductors are positioned into associated ones of the connector module teeth. The other end portion of the slotted contact elements in the connector module pierce the insulation of the associated conductors and connects electrically the conductors in the index strip and the connector module. This action also snap-mounts the module onto the index strip. Finally, the cap is snap-mounted onto the connector module.

It is desirable to have the capability of mounting to the index strip connecting modules havaing only a portion of the conductor capacity of the index strip. For example, one or more five conductor-pair modules could be selectively mounted along an index strip having a capacity for holding twenty-five conductor pairs. This is accomplished by construction of the index strip with the teeth and associated deflectable walls in groups with every n^{th} one thereof being dimensioned to permit mounting of end portions of adjacent connector modules (n being equal to 1, 2, 3 . . .).

The connector module has retentive capabilities for an optional bridging module. The bridging module provides the connector with the capability of connecting the conductors of a third cable with the conductors of a pair of cables already interconnected by the cooperation of the index strip and the connector module. Moreover, the bridging module and the connector module are constructed to have the capability of selectively bridging ones of the spliced conductor pairs in the assembled index strip and connector module.

BRIEF DESCRIPTION OF THE DRAWING

Other features of the present invention will be more readily understood in the following detailed description of specific embodiments thereof when read in conjunction with the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of an electrical connector which embodies the principles of this invention and showing an index strip, a connector module, a module cap and a bridging module;

FIG. 2 is an isometric rear view of a portion of the index strip;

FIG. 3 is an isometric front view of a portion of the index strip;

FIG. 3A is an end view, partially in section, of the index strip;

FIGS. 3B and 3C are elevational views of portions of the index strip taken along lines 3B and 3C respectfully, in FIG. 3A;

FIGS. 4A and 4B are isometric views of portions of the two mating parts which comprise the connector module, prior to the assembly thereof;

FIG. 5 is an isometric view of a portion of the one connector module part shown in FIG. 4B as viewed

from the portion thereof which will be exposed subsequent to assembly with the other part;

FIG. 6 is a perspective view of a portion of the connector module part shown in FIG. 5 and taken to accentuate the features for supporting a plurality of contact elements;

FIG. 6A is a perspective view of one of the slotted contact elements which are to be secured within an assembled connector module;

FIG. 7 is an end view of the assembled connector module;

FIG. 7A is an elevatiaonal view showing the assembled relationship of one of the mating parts of the connector module and the index strip when the connector module is mounted on the index strip;

FIG. 7B is an elevational view showing the assembled relationship of the other one of the mating parts of the connector module and the index strip when the connector module is mounted on the index strip;

FIG. 8 is a perspective view of a portion of the cap to be assembled to a top portion of the connector module;

FIG. 9 is an exploded perspective view of a portion of the bridging module and showing two molded dielectric components and contact elements prior to the assembly;

FIG. 10 is an isometric view of a portion of the bridging module in FIG. 9 as assembled;

FIG. 11 is an assembly view of portions of the index strip, connector module, and cap assembled as a two-wire splicing connector and showing a bridging module and associated cap assembled therewith and oriented for assembly with the connector module; and

FIG. 11A shows a connector module having a bridging module connected to a selected portion thereof;

FIG. 11B shows a connector module having a conductor capacity equal to only a portion of that of the index strip mounted on the index strip and having a bridging module connected thereto;

FIGS. 12A, 12B and 12C are perspective views of an assembly tool used with connecting devices embodying the principles of this invention for splicing and bridging;

FIG. 13 is a perspective view of another tool which may be used to assemble connector modules of less conductor capacity than the index strip to the index strip; and

FIG. 14 is a perspective view showing the use of ones of the index strip and the connector modules as a serving area connector.

DETAILED DESCRIPTION

OVERALL DESCRIPTION

Referring now to FIG. 1, there is shown an electrical connector, designated generally by the numeral **50.** The electrical connector **50** includes an index strip, designated generally by the numeral **100,** a connector module, designated generally by the numeral **200,** and a cap, designated generally by the numeral **300.** The connector **50** provides the capability for connecting together electrically at least one or more conductors **60—60** of a first group of conductors to one or more conductors **70—70** of a second group.

The connector module **200** includes a plurality of slotted double-ended contact elements **219—219.** One end of each of the elements is received in the index strip **100** when the connector module is mounted on the index strip to engage electrically associated ones of the conductors **60—60** held in the index strip. The other end of each of the contact elements **219—219** slices through the insulation of the conductors **70—70** when the conductors **70—70** are moved into conductor-receiving slots **213—213** in the connector module **200.**

The connector module **200** includes facilities for mounting thereon a bridging module, designated generally by the numeral **500.** The bridging module **500** has provisions for receiving a plurality of conductors **80—80** and, simultaneously with the mounting thereof to the connector module **200,** for making an electrical connection with associated ones of the conductors **60—60** and **70—70.**

The components of the connector **50** may be assembled using an apparatus **400** (see FIG. 12). Connector modules **200—200** having a reduced capacity over that of the index strip **100** may be mounted on the index strip using a tool **450** (see FIG. 13).

INDEX STRIP

As can best be seen in FIGS. **1, 2, 3** and 3A-3C, the index strip **100** includes a base **101** having a generally flat undersurface **102** and floor **103.** An end wall **104** extends vertically from each end of the base **101** and includes a guide slot **105.**

A plurality of spaced teeth **106—106** project vertically from the base **101** between the end walls **104—104.** The teeth **106—106** alternately are formed with flattened top surfaces **107—107** and wedge-shaped ends **108—108.** Each of the teeth **106—106** is recessed slightly from a side surface **109** of the index strip **100** to create a narrow ledge **109***a*. Each of the teeth **106—106** includes a latching nub **110** on one side surface thereof.

The index strip **100** is provided with facilities for receiving ones of the conductors **60—60.** Conductor-receiving slots **111—111** (see FIG. 3) are formed between adjacent ones of a plurality of upright arms **112—112** along the side of the index strip **100** opposite to that along which the teeth **106—106** are formed. Moreover, each of the conductor-receiving slots **111—111** is aligned with an associated one of the spaces between adjacent ones of the teeth **106—106.**

The arms **112—112** are formed by two spaced slots **113—113** molded in a riser **114** aligned with each of the teeth **106—106** and connected thereto by a web **115.** Absent one of the conductors **60—60** in one of the slots **111—111,** the arms **112—112** defining the slot are vertical and substantially separated by a constant distance. When one of the conductors **60—60** is introduced into the slot **111,** the associated arms **112—112** deflect horizontally away from each other in the vicinity of the conductor in a direction longitudinally of the index strip **100.** Because of their mode of suspension, the arms **112—112** bend toward each other in the region above the conductor (see FIG. 3). This reverse bend in each of the arms **112—112** serves to further snub and secure the conductors **60—60** within the index strip **100.**

A platen surface **117** having an edge notch **118** is formed along the entire surface of the index strip **100** adjacent the risers **114—114** (see FIG. 3). The surface **117** serves as a conductor-cutting anvil to facilitate severing the conductors **60—60** in a plane congruent with

the outwardly facing surface of the risers **114—114.** The platen surface **117** is interrupted periodically by openings **119—119** which have rounded, snap-in entrance wings **120—120.** Each of the openings **119—119** advantageously is aligned laterally of the index strip **100** with the teeth **106—106** having the wedge shaped ends **108—108,** and thus between adjacent pairs of the conductor -receiving slots **111—111** (see FIG. 3B).

The index strip **100** includes facilities which yield in a direction normal to the conductors **60—60** and normal to the longitudinal axis of the strip to further facilitate the retention of the conductors. A cantilever beam **116** (see FIGS. **1, 2,** 3A and 3C) is molded spaced above the floor **103** and between each of the teeth **106—106.** Each of the cantilever beams **116—116** is aligned with an associated one of the slots **111—111** and preferably at approximately the same level as the invert of the slot. The beam **116** is not attached to the walls of the adjacent ones of the teeth **106,** and has sufficient flexibility to deflect toward engagement with the floor **103.** As can be seen in FIG. 3A, each of the beams **116—116** extends beyond associated ones of the teeth **106—106.**

The index strip **100** also has provisions for receiving one end of each of the contact elements **219—219** of a connector module **200** mounted on the index strip. A slot **121** is defined between each two adjacent ones of the webs **115—115** and the inwardly facing surfaces of the adjacent ones of the risers **114—114** and the inwardly facing surfaces of adjacent associated ones of the associated teeth **106—106** (see FIGS. **3** and 3A). The slot **121** as is seen in FIG. 3A extends below the invert of the conductor-receiving slots **111—111** to form a well **122.**

The slots **121—121** are designed to receive one end of each of the double-ended slotted metallic contact elements **219—219** when the connector module **200** is assembled to the index strip **100.** First ends of the contact elements **219—219** slice through the insulation of the conductors **60—60** held in the conductor-receiving slots **111—111** between the upright arms **112** and in engagement with the cantilever beams **116—116** and then extend into the associated well **122.** The well **122** may contain an encapsulant compound, such as a polyethylene -polybutene compound or a like nonconductive, nonflowing, normally highly viscous material that protects exposed conductor ends against the deleterious effects of water and corrosion.

One of the advantages of the connector **50** embodying the principles of this invention is the modularity thereof. While the index strip **100** is generally made to accommodate fifty conductors, the connector module **200** may advantageously be made, for example, in five pair modules, ten pair or twenty-five pair modules (see FIG. 11B). Similarly, it may be desirable to bridge-connect into at least part of one or more or all of the connector modules **200—200,** or into complete ones thereof which are mounted on the index strip **100.** It is this ability to selectively position connector modules **200—200** and bridging modules **500—500** that makes the connector **50** adaptable to many uses in the interconnection industry.

This capability presents manufacturing problems, the resolution of which are manifested in new design features. It is not feasible to mold the index strip **100** with the smallest possible dimensions, have uniform structure throughout, and accommodate the periodic mounting of connector modules which are in contiguous relation to each other. In order to over come this problem, the index strip **100** is constructed with every n^{th} flat-topped tooth **126** thereof (n=1,2 2. .) having a larger dimension (0.108 inch) longitudinally of the index strip than the other teeth (0.086 inch) (see FIG. 3C). Every associated n^{th} one of the risers **114—114** is constructed with a thicker central web portion **127** to increase the width of the riser aligned with each one of the wider teeth **126—126** (see FIG. 3B).

Thus, the index strip **100** is constructed with a plurality of conductor-receiving slots **111—111** formed in groups with ones of the wider teeth **126—126** separating the groups (see FIG. 3C). The spacing d_1 (0.298 inch) between adjacent slots **111—111** of adjacent groups is different from the spacing d_2 (0.276 inch) between adjacent slots in the same group. Generally, every fifth one of the flat-topped teeth **106—106** is enlarged.

The capability of mounting two, three or five conductor pair connector modules, for example, on the index strip is advantageous from the standpoint of installation. A rather large apparatus (see Flg. **12**) is required to mount a twenty-five pair connector module on the index strip. This may reduce the frequency with which this connecting system is used in preference to the use of single conductor pair connectors known in the art. The economies realized with being able to use a smaller tool **450** (see FIG. **13**) plus the reduced initial investment of connector modules are further advantage of the modularity design approach in the connector **50.**

The construction of the index strip **100** with every n^{th} tooth being enlarged provides an additional benefit. An installer may use the enlarged ones of the teeth **106—106** as an aid in aligning the connector module **200** with the index strip **100** in preparation for the mounting of the connector module to the index strip.

Of course, the index strip **100** could be constructed such that every one of the teeth **106—106** (n=1) has the same dimension. Then it would be possible to mount a one conductor capacity connector module anywhere along the index strip. This arrangement would significantly increase the length of the index strip.

CONNECTOR MODULE

The connector module **200** cooperates with the index strip **100** to provide the capability of connecting together electrically a plurality of the conductors **60—60** secured within the index strip **100** to associated ones of the conductors **70—70.** The connector module **200** is configured so as to be mountable on the index strip **100.** Moreover, the connector modules **200—200** may be manufactured in any length which is a multiple of d, d being the distance between successive ones of the wider teeth **126—126** of the index strip **100.** In this way, connector modules **200—200** may be mounted selectively on the index strip **100** in accordance with customer demands rather than an initial excessive investment. Of course, if all the teeth **106—106** were uniformly as wide as the teeth **126—126,** a one conductor connector module **200** could be used.

The connector module **200** is comprised of a contact element securing part **200A** (see Flg. **4A**) and a conductor and contact-receiving part **200B** (see FIGS. **4B**

and 5). The parts 200A and 200B are constructed to facilitate the mating thereof and the securing therewithin of the contact elements 219—219 against unintended lateral and longitudinal movement. Provisions are also made for reliably securing together the parts 200A and 200B.

As can be seen in FIG. 5, the part 200B is constructed with a wall 201 terminating along a lower edge surface 202 having a notch 203 and downwardly extending legs 204—204. Each of the legs 204—204 is formed with two gripping portions 205—205. The legs 204—204 are adapted to lock into associated ones of the slots 119—119 of the index strip 100.

An upper portion of the face 201 of the part 200B terminates along an edge of a ledge 207 spaced below a platen 206 (see FIG. 5). The platten 206 serves as a conductor -cutting anvil. A plurality of latching openings 208—208 are formed in the part 200B and open to the side wall 201. The latching slots 208—208 are formed with entrance wings 209—209 which snap-mount latching facilities of the cap 300.

The part 200B of the connector module 200 is molded, or otherwise formed, to include a plurality of risers 210—210 (see FIG. 5), substantially identical to the risers 114—114 of index strip 100. The risers 210—210 extend upwardly from the platten 206 and are each molded with two slots 211—211 to form upright arms 212—212. Adjacent ones of the arms 212—212 of adjacent ones of the risers 210—210 define conductor -receiving slots 213—213 for holding ones of the conductors 70—70. The molding of the risers 210—210 with the arms 212—212 provides for yielding thereof in a longitudinal direction in the same manner in which the arms 112—112 of the index strip 100 behave when conductors 60—60 are introduced therebetween. Each of the risers 210—210 has an upper chamfered surface 218 (see FIG. 5) to facilitate mounting of the cap 300.

The part 200B is also formed with a plurality of teeth 214—214 (see FIGS. 4B and 5). Alternate ones of the teeth 214—214 have a flattened top surface 215 while the others have a wedge-shaped end 216. Each of the teeth 214—214 is attached to an associated one of the risers 210—210 by a narrow web 217. As can best be seen in FIG. 4B, a snubbing surface 226 is formed between each adjacent pair of the teeth 214—214.

As with the teeth 106—106 of the index strip 100, every n^{th} one of the teeth 214—214 having a flattened top surface 215 is constructed to have a greater dimension longitudinally of the connector module 200 than the intervening teeth. This aligns the teeth 214—214 of the connector module 200 with the teeth 106—106 of the index strip and compensates for the non-uniformity of the index strip. It follows that every associated n^{th} one of the risers 210—210 be constructed with a thicker central web portion to increase the width of the riser to maintain the alignment of the risers with the teeth.

It must be appreciated that the capacity of the connector module 200 may be only a portion of that of the index strip 100. A connector module 200 may only extend between every n^{th} tooth of the index strip 100. In that event, end teeth of the connector module 200 are as shown in FIG. 5. The widened n^{th} tooth of the index strip 100 permits adjacent mounting of ones of the connector module 200—200. Other connector modules 200—200 may be added as customer service demand increases.

Further, the connector module 200 has provisions for securing thereto the cap 300. Each of the teeth 214—214 is provided with a latching nub 246.

Advantageously, one or both sides of each of the wedge-shaped ends 108—108 and 216—216 of the index strip 100 and the connector module 200, respectively, may be identically color-coded. Color-coding of the wedge-shaped ends 108—108 and 216—216 facilitates the correct splitting of each of differently color-coded pairs of the conductors 60—60 and 70—70.

The construction of the inner recesses is important to the mounting of the contact elements 219—219. Each of the contact elements 219—219 is constructed from a conductive material and is elongated having opposed end portions (see FIG. 6A). Each of the end portions of the contact element 219 is bifurcated to form a slightly tapered conductor-receiving slot 223 and 224 which open to flared entrances 223*a* and 224*b*, respectively. The widest portion of the slot 223 is adjacent the flared entrance 223*a*. As can best be seen in FIG. 6A, the thickness of the contact element 219 is substantially reduced at each of the end portions.

It should be noted that the width of the conductor-receiving slot 223 or 224 at their widest points is slightly less than the gage of the conductive portion of the smallest conductors 60 or 70 to be spliced or bridged with the connector 50. In this way, when one of the conductors 60—60 or the conductors 70—70 is moved into the slot 223 or 224, the insulation is pierced and electrical engagement established between the conductor and the contact element 219.

As can be seen in FIG. 6A, the conductor-receiving slots 223 and 224 of the contact element 219 are enlarged at the inner ends thereof. This reduces the amount of material between the slots 223 and 224 and a narrow waist section 220 and permits greater yielding of the bifurcated portions when a conductor is introduced therebetween. Without this enlargement feature, the bifurcated portions could exhibit enough resistance to moving in response to a conductor being received in the slots 223 or 224 that conductors made of a soft metal could be unduly deformed.

The contact element 219 is shaped to cooperate with molded portions of the connector module 200 to secure the contact element therein. The contact element 219 has semicircular opposed recesses 221—221 midway between the bifurcated end portions to form the narrow waist section 220.

The molded inner recesses of the part 200B of the connector module 200 can best be explained by referring to FIGS. 4B and 6. A plurality of openings 249—249 are molded such that plateaus 254—254 are formed between adjacent ones of the openings. Each of the plateaus 254—254 is aligned with an associated one of the conductor-receiving slots 213—213. Each of the contact elements 219—219 is supported on the associated plateau surfaces 254—254 as seen in FIGS. 1 and 6, prior to and subsequent to the assembly of the parts 200A and 200B.

As can be seen in FIG. 4B, the contact elements 219—219 are mounted on the surfaces 254—254 such that the slots 223 and 224 thereof intersect with associated ones of the slots 213—213 and the bifurcated end portions are received in associated ones of a plurality of wells 225—225. Each of the wells 225—225 is

formed between adjacent ones of the webs 217—217, inwardly facing surfaces of adjacent ones of the upright arms 212—212, and the inwardly facing surfaces of adjacent ones of the teeth 214—214. The portion of each contact element 219 between the bifurcation and the central waist portion 220 extends through a slot 253 which may be seen in FIG. 6.

When the connector module 200 is mounted on the index strip 100, the other bifurcated end portion 224 of each of the contact elements 219—219 is aligned with the associated one of the conductor-receiving slots 111—111 in the index strip 100 and is introduced into the associated well 122.

The part 200B of the connector module 200, as shown in FIG. 6, includes arches 237—237 which are formed by downwardly extending conductor-stuffers 238—238. The contact elements 219—219 are mounted in the part 200B such that the slot 224 of each is aligned with an associated one of the stuffers 238—238 with the associated bifurcated end portions thereof extending into the spaces formed by the arches and below the ends of the stuffers.

When the connector module 200 is mounted on an index strip 100 the contact elements 219—219 engage the conductors 60—60 such that the conductors are moved into associated ones of the slots 224—224. The mounting of the connector module 200 on the index strip 100 seats the conductors 60—60 in engagement with the invert of the slots 111—111 and the cantilever beams 116—116. The wire stuffers 238—238 generally engage the conductors just as they are being seated. The conductor-stuffer 238 bears down upon each insulated conductor 60 lodged in the slots 111—111 to ensure that each conductor is secured within the slot.

Every one of the arches 237—237 is provided with a slot 239 (see FIG. 6) communicating with an associated one of the openings 249—249. Each of the slots 239—239 accommodates a key (not shown) axially located under mating portions of the part 200A. The key (not shown) blocks the space between the associated mating surface and the associated tooth surface 107 on the index strip 100 to maintain the dielectric strength between adjacent ones of the contact elements 219—219.

Aligned with each of the conductor-stuffers 238—238 is a clearance recess 240 for one of the snubbed conductors 60—60. The recesses 240—240 are separated by walls 243—243 molded between adjacent ones of the legs 204—204. An encapsulant is advantageously preplaced in each of the recesses 240—240. This permits each conductor end to be disclosed and surrounded by encapsulant to maintain the dielectric strength between adjacent ones of the conductors 60—60.

The part 200B of the connector module 200 may include a guide groove 244 (see FIG. 4B) at each end thereof which enables the module to be mounted in the bed of the hand or power-operated splicing tool 400 (see FIG. 12A). A recess 245 is also formed in the sides of the part 200B of the connector module 200 to facilitate mounting in the tool bed so that the portion of the part 200A adapted to receive the bridging module 500 is oriented upwardly.

Referring now to FIG. 4A, it is seen that the part 200A is formed with a snubbing brace 227 having a downwardly tapered surface 228. When the parts 200A and 200B are mated, the snubbing brace 227 engages the snubbing surface 226 (see FIGS. 1 and 7). This gives the conductors 70—70 an upward turn and forces the conductors into engagement with facilities formed in the cap 300.

Referring now to FIG. 4A, it is seen that the part 200A has upper and lower rails 229 and 230 extending laterally therefrom. The rails 229 and 230 are adapted to receive a bridging connector 500 therebetween. The rails 229 and 230 are provided with a row of spaced latching holes 231—231. As can be seen in FIG. 1, a vertical surface 232 is formed between the rails 229 and 230 includes a series of upright ridges 233—233 which affords improved dielectric breakdown between the contact elements 219—219 of the bridging module 500.

The connector module 200 is designed to facilitate selective bridging of the contact elements 219—219 therein. Midway between each pair of the adjacent ridges 233—233, and aligned with the waist section 220 of each of the contact elements 219—219, there are provided bridging slots 234—234 having tapered entrances (see FIG. 7). The bridging slots 234—234 provide additional electrical access from without the assembly to each of the contact elements 219—219.

The connector 50 may be assembled using only the index strip 100 and the connecting module 200 to provide electrical connection between electrical conductors 60—60 and conductors 70—70 held in the index strip and in the connector module, respectively. In that event, the slots 234—234 may provide access for testing purposes.

Of course, when the briding module 500 is connected to the connector module 200, conductive elements in the bridging module may be used for test purposes. But if the bridging module 500 is used to bridge connect ones of the conductors 80—80, testing may be accomplished by providing additional access openings (not shown) on the opposite side of the connector module 200.

As can be seen in FIG. 7, the part 200A is molded with a bottom snubbing brace 235 adjacent the lower rail 230. The bottom front snubbing brace 235 is formed with an inwardly facing beveled surface 242 and functions as a snubbing bar. Along the length of the bottom snubbing brace 235, latching holes 236—236 are spaced so that when the module 200 is mounted over the teeth 106—106 of index strip 100, the latching nubs 110—110 of the teeth 106 lock into engagement with the associated ones of the latching holes 236—236.

As has been indicated hereinbefore and as seen in FIG. 3A, the cantilever beams 116—116 of the index strip 100 extend beyond the forward edges of the teeth 106—106. When the connector module 200 is assembled to the index strip 100, the bottom front snubbing brace 235 effects bending contact with the insulated conductors 60—60 supported on the beams 116—116. The beams 116—116 and the conductors 60—60 are deflected downwardly until the latching nubs 110—110 of the strip 100 snap into and lock in the associated ones of the latching holes 236—236. At this point, the conductors 60—60 are firmly snubbed by the brace 235.

The part 200A is formed to secure the contact elements 219—219 and to facilitate the mating thereof with the part 200B. The part 200A is formed with a plurality of cylindrical extensions 222—222 adjacent a

ledge 256. A truncated cone or frustum 247 having an L-shaped groove 248 is molded integrally with each extension 222 and facilitates assembly of the two parts 200A and 200B. The L-shaped groove 248 extends through the cylindrical extension 222. It should be understood that the frustum 247 may be a truncated pyramid as well as a cone.

The truncated cones 247—247 are inserted into the similarly configured holes 249—249, and tongues 250—250 formed on the part 200B (see FIG. 6) are received in the grooves 248—248. The truncated cones 247—247 have plug ends 251 which protrude through assembly holes 252—252 (see FIG. 5) communicating with the holes 249—249. The plug ends 251—251 are deformed adjacent the rear face 201 of the module 200 in a staking operation to secure together the parts 200A and 200B.

The uniquely constructed cones 247—247, sections 222—222 and plug ends 251—251 not only facilitate the assembly of the two mating parts 200A and 200B, but also secure within that assembly the contact elements 219—219. Since the contact elements 219—219 are mounted on the plateaus 254—254 defining the openings 249—249, the reception of the cones 247—247 in the openings 249—249 causes the curved surfaces of the sections 222—222 to engage the waist sections 220—220 of the contact elements (see FIG. 1). The engagement of opposing portions of adjacent sections 222—222 with opposite waist-defining contact surfaces of the section 220 secures the contact element 219 within the module 200.

A portion of the L-shaped groove also contributes to an improvement in the dielectric strength of the module 200. It should be observed that the grooves 248—248 fall between adjacent ones of the contact elements 219—219. The grooves 248—248 and tongues 250—250 received therein increase the path between the adjacent contact elements and hence increases the dielectric strength. An encapsulant compound may also be used at the joint between the grooves 248—248 and the tongues 250—250 to further increase the dielectric strength.

The mating part 200A is constructed to seat in engagement with the teeth 106—106 of the index strip 100 when the connector module 200 is mounted thereto. As can best be seen in FIG. 7B, the part 200A is constructed with alternately flat and peak-topped recesses 258 and 259 respectively to receive the flat-topped and wedge-shaped teeth 106—106 of the index strip.

In what is presently believed to be the most general use of the connector 50, conductors 60—60 are moved into the conductor-receiving slots 111—111 of the index strip 100 and the ends thereof severed to be flush with the front surfaces of the risers 114—114 (see FIG. 3). Then ones of the connector modules 200—200 are mounted to the index strip 100 and ones of the conductors 70—70 dressed thereinto.

The connector 50 is constructed so that it may also be used to connect into a position intermediate the ends of a group of the conductors 60—60. In that usage, the conductors 60—60 are positioned in the conductor-receiving slots 111—111 and extend therethrough without being severed or dressed off at the platen surface 117.

This gives the connector 50 a new dimension of adaptability. For example, the connector 50 may be connected into an intermediate point along a group of the conductors 60—60 which are connected at one end thereof to equipment which is to be replaced. Then a connector module 200 is mounted to the index strip 100 and conductors 70—70 are dressed into the connector module. Then the other ends of the conductors 70—70 are connected to the replacement equipment and simultaneously the old equipment removed to effect cutover without down time.

In order to impart this function to the connector 50, the connector module 200 must be modified slightly. When the connector module 200 is mounted to the index strip 100, the top surfaces of the cantilever beams 116—116 are slightly below the bottom rail 230 to snub the conductors 60—60 therebetween. However, since the risers 114—114 are received in the openings formed by the arches 237—237 of the connector module (see FIG. 7A), the ends of the conductors 60—60 abut the inwardly facing surface of the side wall 201. In order to provide the connector 50 with the capability of having conductors 60—60 extend therethrough, the side wall 201 is constructed with notches 257—257. Each of the notches 257—257 is aligned with one of the conductor-receiving openings 111—111 when the connector module 200 is mounted to the index strip 100 such that a conductor 60 may extend through the associated notch (see FIG. 5).

CAP STRUCTURE

The cap 300 (see FIG. 1) includes an exterior surface 301 having a longitudinal groove 302 to accommodate a tool-cutting or compression blade. A vertical guide groove 303 is formed in each end and is adapted to be received in a tool-mounting fixture when the cap 300 is to be assembled to the connector module 200.

A lower rear edge surface 304 (see FIG. 8) of the cap 300 is continuous except for latching legs 305—305 extending therefrom and each of which includes a pair of grips 306—306. In the assembly of the cap 300 with the connector module 200, the notched indentation 207 of the connector module 200 is engaged by the edge 304 while the offset regions 307 engage the surface 206. The latching legs 305—305 mate with the latching slots 208—208 of the connector module 200 to secure the cap 300 to the connector module.

On either side of each leg 305, the offset regions 307 are extended into a conductor recess 308. Each of the recesses 308—308 is aligned with an associated one of the conductor-receiving slots 213—213 of the module 200 when the cap 300 is assembled to the module 200. A conductor stuffer 309 is formed above each of the conductor recesses 308—308 and has a downwardly depending rib the bottom surface 310 of which is planar with a top roof 311 of the associated one of the recesses 308—308.

When the cap 300 is mounted on the connector module 200, the risers 210—210 are accommodated in the chambers of cap 300 that are defined between each of the conductor stuffers 309—309 and slanted roof portions 312—312. The slanted roof portions 312—312 engage the chamfered surfaces 218—218 of the risers 210—210.

A plurality of spaced latching holes 314—314 are formed along a side wall 313 of the cap 300 (see FIG. 8). These are similar in purpose and function to the latching holes 236—236 of the connector module 200.

The bottom edge of the side wall **313** includes spaced wells **315—315**. The spaced wells **315—315** are adapted to receive beams **316—316** constructed integrally with the cap **300** that deflect when brought into engagement with associated ones of the conductors **70—70** present on the snubbing surface **226** of the connector module **200**. The deflecting beams **316—316** are similar in basic structure and function as the beams **116—116** of the index strip **100**.

Encapsulating sealant may be preplaced in the interior cavities of the cap **300**, including the recess **308**, the wells **315**, and in the regions below the beams **316—316**. This facilitates the use of the connector **50** in a moisture resistant communications system without detracting from the integrity thereof.

The index strip **100**, the connector module **200**, and cap **300** may be manufactured by plastic molding techniques known to the art. They may be constructed of materials such as polycarbonate, polyamide, or related polymer such as ABS resin. All of these provide adequate mechanical strength and rigidity as well as adequate electrical insulation.

USE OF THE INDEX STRIP, THE CONNECTOR MODULE AND THE CAP

The two conductor splicing assembly that is shown in FIG. **11** is pieced together with the aid of an apparatus designated generally by the numeral **400** and depicted in FIGS. **12A**, **12B**, and **12C**. The apparatus **400** includes a base or platen **401** with a longitudinal slot **402** that is just wide enough to snugly receive the index strip **100**. Spaced ribs **403** project from the slot **402** and are received in the guide slots **105—105** of the index strip **100**, in the guide grooves **244—244** of the connector module **200**, and finally in the guide grooves **303—303** of the cap **300**. To assure a tight fit, the ribs **403—403** may be spring-loaded (not shown).

A head **405** is pivotally connected to the base **401** by a pivotally mounted arm **406**. The head **406** includes a boss bar **407** with plural bosses **409** extending therefrom. A blade **410** is mounted adjacent the boss bar **407** and is advantageously extensible beyond, or retractable from, the bosses **409—409**.

In using the apparatus **400**, an index strip **100** is placed as described in the base **401** with the teeth **106** of the index strip facing upwardly. Then, a predetermined number of insulated conductors **60—60** are placed loosely in the conductor-receiving slots **111—111** between the upright arms **112—112** and extending between associated ones of the spaced teeth **106—106**.

With all of the conductors **60—60** in place, the head **405** is moved pivotally into position above the index strip **100**. The boss bar **407** is forced downwardly and the spaced bosses **409—409** engage and urge associated ones of the insulated conductors **60—60** fully down in associated ones of the slots **111—111** thereby causing the associated arms **112—112** to yield horizontally. The extent of boss penetration is limited by engagement of the bottom edge **408** of the boss bar **407** with the flattened top surfaces **107** of the index strip **10**. Near the end of the downward stroke, the blade **410** severs the conductors with the surface **117** (see FIG. **3**) serving as a cutting anvil.

The head **405** is then moved pivotally, and one of the connector modules **200—200** is placed on the guide ribs **403—403** and brought into contact with the index strip **100**. The head **405** is again moved pivotally into engagement with the flattened top surfaces **215—215** of the teeth **214—214** of the connector module **200**.

The head **405** first causes the lower insulation-piercing slot **224** of each contact element **219** to engage the associated conductor **60** by slicing through the outer insulation and effecting firm complaint electrical and mechanical connection to the conductive portion. As this connection is made and near the end of the downward stroke of the head **405**, the legs **204—204** snap into the associated slots **119—119** of the index strip **100**. Similarly, the latching nubs **110—110** engage with the latching holes **236—236** of the connector module **200**, thus securing the module **200** to the index strip **100**. As the connector module **200** is mounted to the index strip **100**, the risers **214—214** of the connector module seat into engagement with the curved surfaces of associated ones of the arches **237—237** (see FIG. **7A**).

During this procedure, sealing compound preplaced in connector module **200** cavities formed by surfaces **253,254, 255** in the slot **121** of the index strip **100**, is displaced to encapulate the electrical connection between the conductors **60—60** and the contact elements **219—219**.

It is important that the conductors **241—241** be held securely during the mounting of the connector module **200** on the index strip **100**. If not so held, the conductors could be drawn out of the slots **113—113** instead of being moved into the conductor-receiving slots **223** of the contact elements **219—219**. The cantilever beam **116** acts at one point of each associated conductor **60**, and the longitudinally deflecting upright arms **112—112** act at a close second point of each conductor to provide rigid support of the conductor in the vicinity of the associated contact element **219**. This prevents motion of the conductor in the area to be contacted.

The head **405** is again raised and moved pivotally out of engagement with the assembly. Then pairs of conductors **70—70** to be selectively connected to those conductors **60—60** now mounted on the index strip **100** are assembled onto the module **200** in exactly the manner described for the assembly of conductors onto the index strip. An operator uses the wedge-shaped ends **216—216** of the module **200** to split the conductor pairs, just as the wedge-shaped ends **108—108** of the index strip **100** were used when positioning the conductors **60—60** in the index strip. The boss bar **407** is used to snub down the conductors **70—70** on the snubbing surfaces **226**, thus effecting an electrical connection between these conductors and the upper insulation-piercing slots **223—223** of the contact elements **219—219**. The blade **410** severs the conductor ends with the surface **206** functioning as a cutting anvil.

The head **405** is again disengaged from the assembly, and a cap **300** is placed on the ribs **403**. The final downward stroking of the head **405** brings the vertically deflectable beams **316—316** into engagement with associated ones of the conductors **70—70**. The beams **316—316** cause a snubbing bend in each of the conductors **70—70** by causing it to be engaged with snubbing surfaces **226**, brace **227** and the upper rail **229**. Finally, the legs **305—305** of the cap **300** snap into associated ones of the slots **208—208** of the connector module **200**, and the latching nubs **246—246** engage with associated ones of the latching holes **314—314**.

An alternative assembly would be to position the connector module **200** on the guides over the index strip **100**. Then the conductors **70—70** are dressed into the top of the connector module **200**. The connector module **200** is pressed onto the index strip **100** thereby seating and cutting the conductors prepositioned in the index strip.

It will be recalled that the upright arms **212—212** in the connector module **200** and the upright arms **112** in the index strip **100** are each rigidly supported at a top and a bottom end. The conductor-receiving slots which they define are configured so that the presence therebetween of an insulated conductor **60** or **70** of greater diameter than the nominal arm separation causes the arms to yield at the contact zone. Elsewhere, the arms **112** and **212** grippingly close over the conductor **60** and **70**, respectively, as in the reverse bend configuration shown in FIG. **1**.

The lower snubbing brace **235** and the cnatilever beams **116—116** of the index strip **100** grippingly accommodate different conductor gauges with varying degrees of deflection of the beams **116—116**. This is due in part to the cantilever beam being suspended from an interior position outwardly between adjacent teeth at a nominal at-rest position above the interior floor **103**. Depending on the guage of the conductors **60—60** when the connector module **200** has been snap-mounted into place, the cantilever beams **116—116** may actually be in contact with the side floor **103** of the index strip **100** and the insulation of the conductors **60—60** may actually be deformed. The deformation characteristics of the cantilever beams **316—316** of the cap **300** interacting with the snubbing surface **226** of the connector module **200** are similar to those of the beams **116—116**.

When using connector modules **200—200** having less than a twenty-five pair conductor capacity, the hand tool **450** (see FIG. **13**) may be used to mount the connector module to the index strip. The tool **450** is portable and designed for ease of operation by an installer.

As can be seen in FIG. **13**, the tool **450** includes upper and lower jaws **451** and **452**, respectively. The lower jaw **452** is designed to engage with a portion of the index strip **100** while the upper jaw **451** is designed to hold one of the connector modules **200—200**, generally of a five conductor pair capacity. After having dressed the conductors **60—60** into the index strip **100** as hereinbefore described, the operator manipulates the tool **450** to engage the lower jaw **452** with a selected portion of the index strip **100**. The selected portion of the index strip **100** includes one or more five pair groups of conductor-receiving openings **111—111**. Then the operator inserts one of the connector modules **200—200** into the upper jaw **450** and operates hand grips **453** and **454** to mount the connector module to the selected portion of the index strip **100**. Next, the operator dresses ones of the conductors **70—70** into the connector module **200**.

A further inventive embodiment may be illustrated by referring to FIGS. **6** and **8**. A blade **260** which performs the function of the tool blade **410** is added directly into the connector module. As seen in FIG. **6**, the blade **260** is received in a slot **261** in the part **200B** of the connector module **200** so that the outer surface of the blade is substantially flush with the interior surface of the legs **204**. An edge **262** of the blade **260** is also flush with the same surface, and extends about 40 mils below the conductor-stuffers **238—238**.

Similarly, in FIG. **8**, a blade **320** is mounted in a recess **321** formed in the cap **300** with the outer surface of the blade flush with the interior surface of the legs **306**. The blade edge **322** extends about **40** mils below the bottom surface **310** of the conductor-stuffer **309**.

The blades **260** and **320** advantageously may be made of a ceramic material, or equivalent, that is hard enough to slice relatively ductile metal, is sufficiently nonbrittle, and has good insulative and dielectric properties. The blades **260** and **320** may be mounted in the slot **261** and recess **321**, respectively, by a suitable adhesive.

BRIDGING CONNECTOR

As is seen in FIGS. **9** and **10**, a bridging module **500** may be used to bridge-connect ones of a third plurality of conductors **80—80** into electrical engagement with associated ones of the spliced conductor **60** and secured within the indexing strip **100** and the connector module **200**. The provisions in the connector module **200** for receiving the conductive elements of the bridging module **500** may also be used to provide testing access to selected ones of the contact elements **219—219**.

The bridging connector **500** is comprised of two mated parts **500A** and **500B**. The part **500A** is constructed with a plurality of teeth **501—501** alternately having flattened top surfaces **502—502** and wedge-shaped ends **503—503** (see FIG. **9**). A latching nub **512** is formed on the outwardly facing surface of each of the teeth **501—501**.

The part **500A** is also formed with a plurality of risers **508—508** which are best seen in FIG. **10**. Each of the risers **508—508** is joined to the corresponding tooth **501** by a web **507**.

Each of the risers **508—508** is formed with two vertical slots **509—509** to form longitudinally yielding flexible arms **510—510** which yield to conductors **80—80** in the manner described with respect, for example, to the arms **212—212** of the connector module **200**. A plurality of slots **530—530** for receiving ones of the conductors **80—80** are formed between adjacent ones of the risers **508—508**. The conductor-receiving slots **530—530** are substantially at the same level as a floor **526** which is adjacent to each of the teeth **501—501**. The slots **530—530** open onto a platen **515** extending between end walls **505—505** of the part **500A** and having a notch **514** terminating in a side surface **527**. The side surface is also provided with openings **516—516** having snap-in entrance wings **528—528**.

A snubbing brace **517** having an inwardly facing beveled surface **518** is formed adjacent to the floor **526** between each two adjacent ones of the teeth **501**. The beveled portion **518** extends upwardly from floor **526**.

Each of a plurality of wells **511—511** (see FIG. **9**) is formed by adjacent ones of the webs **507—507**, inwardly facing portions **510A—510A** of adjacent upright arms **510**, and inwardly facing surfaces **501A** of adjacent ones of the teeth **501**. The wells **511—511** are similar to the wells **225—225** shown in FIG. **4B**, and house double-ended slotted metallic contact elements **504—504** which may, for example, be similar to the element **219** shown in FIGS. **1** and **6A**. The elements **504—504** are mounted on adjacent half-circle mount-

ing surfaces **513—513** (see FIG. **9**). Bifurcated end portions **504A—504A** of contact elements **504—504** extend downwardly and out beyond an edge **506**, as seen in FIGS. **9** and **11**.

The two parts **500A** and **500B** are advantageously molded separately, and then joined by insertion of pins **531—531** ending from ribs **519—519** into openings (not shown) formed in the part **500B**. The ribs **519—519** are received in associated ones of a plurality of mounting grooves **523—523** formed in the part **500B**. Half-circular portions **522—522** in the part **500B** are received in circular openings **524—524** formed between adjacent ones of the downwardly extending ribs **519—519**.

A plurality of latching nubs **525—525** are formed on the side surface **527** (see FIG. **10**) of the part **500A** and on a side surface **529** (see FIG. **3**) of the part **500B**.

Pursuant to another aspect of the invention, a cap identical to the cap **300** snap-mounts onto the bridging connector **500**. The legs **305—305** thereof are received in the openings **516** of the bridging connector **500** and the nubs **512—512** received by latching holes **314**. The action of the deflecting beam **316** on an associated conductor in one of the slots **530—530** is identical to that already described in earlier mention of beam **316**. Likewise, with the cap **300** snap-mounted on the bridging connector **500**, the brace **517** snubs the conductors **80—80** and the conductor-stuffers **309** of the cap **300** stuffs each of the conductors into the associated one of the slots **530—530**.

The mounting of the bridging module **500** on the connector module **200** is accomplished by latching of nubs **525—525** into associated ones of the latching holes **231—231**. The ends **504A—504A** of the contact elements **504—504** extend through the bridging slots **234—234** and into electrical engagement with the associated narrow waist sections **220—220** of the associated ones of the connector module contact elements **219—219**.

It should be appreciated that the bridging module **500** may be of the same length as the connector module **200** or may accommodate, for example, only five conductor pairs. The connecting arrangement just described permits the selective engagement of a bridging module **510** with the one or each one of the connecting modules **200—200**. This arrangement also facilitates the selective testing of the assembled index strip **100** and connector module **200**.

USE AS SERVING AREA CONNECTOR

While the discussion hereinbefore has been concerned with the use of the connector **50** including the bridging module **50**, it is another aspect of this invention to use only the index strip **100** and the connector module **200** to connect together pairs of conductors. This permits the connector **50** less the bridging module to be used as a serving area connector (see FIG. **14**) in the environment described in the hereinbefore referred to U.S. Pat No. 3,611,264 and application Ser. No. 218,358.

As is shown in FIG. **14**, index strips **100—100** are mounted on wiring blocks, designated generally by the numeral **600**. Conductors **60*a*—60*a*** running to a central office (not shown) are dressed into the index strip **100*a*** and conductors **60*b*—60*b*** running to subscribers' homes are dressed into the index strip **100*b***. Then connector modules **200—200** are mounted to the index strip **100*a*** and **100*b*** and conductors **70—70** run therebetween to effect appropriate electrical connections between subscribers and the central office. Additional connector modules **200—200** and index strip **100—100** may be added as service demand increases.

It is to be understood that the above-described arrangements are simply illustrative of the invention. Other arrangements may be devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. An electrical connector, which includes:

a first dielectric block having a plurality of spaced conductor-holding openings formed in groups with the spacing between adjacent openings of adjacent groups being different from that between adjacent openings within a group;

a second dielectric block adapted to be mounted to the first dielectric block and having a plurality of elongated contact elements spaced along and secured therein, each of the contact elements having conductor-receiving slots at opposite ends thereof, the second dielectric block having conductor-receiving openings into which protrude one end of the contact elements to engage electrically conductors received in the conductor-receiving openings, the other ends of the contact elements insertable into associated ones of the conductor-holding openings in the first dielectric block when the second block is mounted thereto to cause the conductors held therein to be moved into the conductor-receiving slots in the contact elements to make electrical engagement withthe walls thereof, and be connected electrically to the conductors in the second dielectric block, the second dielectric block also having a plurality of access openings aligned with associated ones of the contact elements; and

a third dielectric block having conductive elements secured therein capable of being connected electrically to conductors held in spaced openings formed in the third dielectric block, the third dielectric block adapted to be connected to the second dielectric block to extend ends of the conductive elements thereof into the access openings to engage electrically associated ones of the contact elements;

the second dielectric block capable of being constructed in a length corresponding to one or more of the groups of conductor-holding openings in the first dielectric block to permit selective mounting of ones of the second dielectric blocks along the first dielectric block;

the third dielectric block capable of being constructed in a length corresponding to the length of the second dielectric block or a portion thereof to which the third dielectric block is to be connected.

2. The electrical connector of claim **1**, which also includes a plurality of openings in the second dielectric block for testing access subsequent to connection of the third dielectric block to the second dielectric block.

3. An electrical connector, which includes:

an index strip constructed from a dielectric material and having a plurality of spaced openings for hold-

ing insulated conductors and formed in groups such that the spacing between adjacent openings of adjacent groups is different from that between adjacent openings within a group;

a connector module adapted to be mounted on the index strip, and comprised of mating portions constructed from a dielectric material and a plurality of elongated contact elements spaced along and between the mating portions, each of the elements having a conductor-receiving slot formed at opposite ends thereof, the contact element having a waist section, the one end of each contact element being insertable into an associated one of the openings in the index strip to cause the conductors held therein to be received in the conductor-receiving slot at that end of the contact element to make electrical engagement therewith, one of the mated portions of the connector module having conductor-receiving openings into which protrude the other ends of the contact elements to engage electrically conductors received in the conductor-receiving openings of the connector module and thence be connected electrically to the conductors in the index strip when the connector module is mounted on the index strip, the connector module also having a plurality of access openings aligned with associated ones of the waist sections of the contact elements;

one of the mating portions having facilities aligning the parts for mating for reliably securing together the portions and for engaging the waist sections of the contact elements upon mating of the portions to secure the contact elements against unintended lateral and longitudinal movement; and

a bridging module constructed of a dielectric material and having contact elements therein capable of being connected electrically to conductors held within in a spaced array in the bridging module, the bridging module adapted to be mounted to the connector module such that the contact elements thereof extend into the access openings in the connector module to engage the waist sections of associated contact elements in the connector module;

the connector module capable of being constructed in a length corresponding to one or more of the groups of openings in the index strip to permit mounting of connector modules at selected groupings along the index strip;

the bridging module capable of being constructed in a length corresponding to the length of the connector module or a portion thereof to which the bridging module is to be connected.

4. The electrical connector of claim **3**, wherein the mating portions of the connector module include:

a first mating portion which includes the conductor-receiving openings and also having

an interior floor;

spaced teeth projecting above the floor with the space between adjacent ones of the teeth aligned with an associated conductor-receiving opening;

a side wall downwardly depending from the interior floor and having a plurality of openings formed therethrough and spaced therealong such that each of the openings is aligned with an associated one of the teeth; and a second mating portion having

a longitudinally extending web generally parallel to the side wall of the first mating portion when the portions are mated;

upper and lower side rails extending laterally from the web and defining therebetween a channeled opening adapted to receive the bridging module;

a plurality of pins extending laterally from the web on a side thereof opposite to that from which the rails extend, each of the pins including a portion of constant cross section integral with the web and having a frustum extending coaxially therewith;

the free end section of each pin adapted to protrude through associated ones of the openings in the side wall of the first mating portion to subsequently be deformed to secure together the parts;

the web having a plurality of slots formed therethrough communicating with the channeled opening between the rails and extending into opposing portions of each adjacent pair of frusta, the slots providing electrical access to each of the contact elements from without the connector when the portions are mated, the slots spaced along the web so as to be aligned with the contact elements of ones of the bridging modules received between the rails.

5. The electrical connector of claim **4**, wherein:

the index strip includes a plurality of spaced teeth, adjacent ones of the teeth defining the conductor-holding openings;

each of the elements includes bifurcated end sections spaced apart by a central narrow waist section, the end sections defining an entrance to the slot between the bifurcations, with the end slot extending a substantial distance toward the waist section;

the contact elements are mounted in the connector module such that one end thereof extends into associated ones of the conductor-receiving openings formed therein and the second end extending downwardly such that the slot thereof communicates with a cavity into which extend associated ones of the teeth of the index strip when the connector module is mounted on the index strip such that the slots of the contact elements are aligned with associated ones of the conductor-receiving openings in the index strip;

the first mating portion of the connector module being constructed such that the portion of the module defining the openings into which the frusta extend support the contact elements with the narrow waist section of each contact element spanning between upper and lower dielectric mounting surfaces which are configured to support the contact element adjacent the waist section;

the narrow waist section of each contact element being aligned with associated ones of the conductor-receiving openings in the first mating portion of the connector module and with associated ones of the slots in the longitudinally extending web of the second mating portion of the connector module;

the side surfaces of the portion of the pins having the constant cross-sectional area engaging the edge surfaces defining the narrow waist section of adja-

cent contact elements when the portions are mated, and the portions of the slots extending into opposing portions of the frusta contiguous each waist section providing access to the channelized opening between the rails;

the engagement of the frusta with the contact elements being such as to permit a slight amount of movement of the contact elements for alignment purposes when mating the connector module with the index strip and the bridging module.

6. The electrical connector of claim **5**, wherein:

the sections of the pin of constant cross sections are cylindrical such that the surfaces engaging the waist section of the contact elements on the connector module are semi-circular.

7. The electrical connector of claim **5**, wherein:

the mounting of the bridging module between the rails of the second mating portion of the connector module causes the contact elements of the bridging module to be extended through the access openings in the web of the second mating portion and into the associated opposing slots in the associated frusta such that one bifurcated end portion of the contact element in the bridging module is moved into engagement with the narrow waist section of the contact element in the second mating portion, the unsupported span of the waist section of the contact elements in the connector module insuring that the one bifurcated end portion of the contact element in the bridging module makes electrical engagement with the contact element in the connector module.

8. The electrical connector of claim **5**, wherein:

the first mating portion of the connector module is formed with L-shaped ridges extending first from each one of the teeth and then normally thereto into associated ones of the openings into which the frusta extend;

the frusta of the second mating portion of the connector block each being formed with an L-shaped groove, one leg of each groove formed in the face of the web which faces the first mating dielectric portion when the portions are mated, the other portion of each groove extending along the associated one of the frusta, the portion in the web adapted to receive the leg of an associated one of the ridges extending to the tooth to facilitate mating of the two portions, the portion of the groove in the frusta adapted to receive the portion of the associated ridge extending into the openings which receive the frusta, the latter portions of the ridges and grooves serving to increase the dielectric path between adjacent ones of the contact elements of the connector module to improve the dielectric strength thereof.

9. The electrical connector of claim **5**, wherein:

the slot extending inwardly from each of the entrance portions of each of the contact elements being enlarged adjacent the waist section to increase the flexibility of the bifurcated portions.

10. The electrical connector of claim **5**, wherein:

the teeth in the index strip and in the connector module are constructed such that end teeth of each group of openings have a greater dimension longitudinally of the index strip than the teeth therebetween;

the enlargement of the end teeth facilitating the alignment of the connector module with the index strip prior to the mounting of the connector module to the index strip.

11. An electrical connector, which includes:

a first dielectric block having a plurality of spaced conductor-holding openings formed in groups with the spacing between adjacent openings of adjacent groups being different from that between adjacent openings within a group; and

a second dielectric block adapted to be mounted to the first dielectric block and having a plurality of elongatead contact elements spaced along and secured therein, each of the contact elements having conductor-receiving slots at opposite ends thereof, the second dielectric block having conductor-receiving openings into which protrude one end of the contact elements to engage electrically conductors received in the conductor-receiving openings, the other ends of the contact elements insertable into associated ones of the conductor-holding openings in the first dielectric block when the second block is mounted thereto to cause the conductors held therein to be moved into the conductor-receiving slots in the contact elements to make electrical engagement with the walls thereof, and be connected electrically to the conductors in the second dielectric block; and

the second dielectric block capable of being constructed in a length corresponding to one or more of the groups of conductor-holding openings in the first dielectric block to permit selective mounting of ones of the second dielectric blocks along the first dielectric block.

12. The electrical connector of claim **11**, which also includes a plurality of openings in the second dielectric block for testing access.

13. An electrical connector, which includes:

an index strip constructed from a dielectric material and having a plurality of spaced openings for holding insulated conductors and formed in groups such that the spacing between adjacent openings of adjacent groups is different from that between different openings within a group; and

a connector module adapted to be mounted on the index strip, and comprised of mating portions constructed from a dielectric material and a plurality of elongated contact elements spaced along and between the mating portions, each of the elements having a conductor-receiving slot formed at opposite ends thereof, the contact element having a waist section, the one end of each contact element being insertable into an associated one of the openings in the index strip to cause the conductors held therein to be received in the conductor-receiving slot at that end of the contact element to make electrical engagement therewith, one of the mated portions of the connector module having conductor-receiving openings into which protrude the other ends of the contact elements to engage electrically conductors received in the conductor-receiving openings of the connector module and thence be connected electrically to the conductors in the index strip when the connector module is mounted on the index strip;

one of the mating portions having facilities aligning the parts for mating, for reliably securing together

the portions, and for engaging the waist sections of the contact elements upon mating of the portions to secure the contact elements against unintended lateral and longitudinal movement;

the connector module capable of being constructed in a length corresponding to one or more of the groups of openings in the index strip to permit mounting of connector modules at selected groupings along the index strip.

14. The electrical connector of claim **13** wherein the mating portions of the connector module include:

a first mating portion which includes the conductor-receiving openings and also having

an interior floor;

spaced teeth projecting above the floor with the space between adjacent ones of the teeth aligned with an associated conductor-receiving opening;

a side wall downwardly depending from the interior floor and having a plurality of openings formed therethrough and spaced therealong such that each of the openings is aligned with an associated one of the teeth; and a second mating portion having

a longitudinally extending web generally parallel to the side wall of the first mating portion when the portions are mated;

a plurality of pins extending laterally from the web on an inwardly facing side thereof, each of the pins including a portion of constant cross section integral with the web and having a frustum extending coaxially therewith;

the free end section of each pin adapted to protrude through associated ones of the openings in the side wall of the first mating portion to subsequently be deformed to secure together the mating portions.

15. The electrical connector of claim **14** wherein:

the index strip includes a plurality of spaced teeth, adjacent ones of the teeth defining the conductor-receiving openings;

each of the contact elements includes bifurcated end sections spaced apart by a central narrow waist section, the end sections defining an entrance to the slot between the bifurcations, with the end slot extending a substantial distance toward the waist section;

the contact elements are mounted in the connector block such that one end thereof extends into associated ones of the conductor-receiving openings formed in the connector module and the second end extending downwardly such that the slot thereof communicates with a cavity into which extend associated ones of the teeth of the index strip when the connector module is mounted on the index strip such that the slots of the contact elements are aligned with associated ones of the conductor-holding openings in the index strip;

the first mating portion of the connector module being constructed such that the portion of the module defining the openings into which the frusta extend support the contact element on dielectric mounting surfaces which are configured to support the contact element adjacent the waist section;

the narrow waist section of each contact element being aligned with associated ones of the conductor-receiving openings in the first mating portion of the connector module;

the side surfaces of the portion of the pins having the constant cross-sectional area engaging the edge surfaces defining the narrow waist section of adjacent contact elements when the portions are mated;

the engagement of the frusta with the contact elements being such as to permit a slight amount of movement of the contact elements for alignment purposes when mounting the connector module with the index strip to assemble the electrical connector.

16. The electrical connector of claim **15** wherein:

the sections of the pin of constant cross sections are cylindrical such that the surfaces engaging the waist section of the contact elements on the connector module are semi-circular.

17. The electrical connector of claim **15** wherein:

the first mating portion of the connector module is formed with L-shaped ridges extending first from each one of the teeth and then normally thereto into associated ones of the openings into which the frusta extend;

the frusta of the second mating portion of the connector block each being formed with an L-shaped groove, one leg of each groove formed in the face of the web which faces the first mating dielectric portion when the portions are mated, the other portion of each groove extending along the associated one of the frusta, the portion in the web adapted to receive the leg of an associated one of the ridges extending to the tooth to facilitate mating of the two portions, the portion of the groove in the frusta adapted to receive the portion of the associated ridge extending into the openings which receive the frusta, the latter portions of the ridges and grooves serving to increase the dielectric path between adjacent ones of the contact elements of the connector module to improve the dielectric strength thereof.

18. The electrical connector of claim **15**, wherein:

the slot extending inwardly from each of the entrance portions of each of the contact elements being enlarged adjacent the waist section to increase the flexibility of the bifurcated portions.

19. The electrical connector of claim **15**, werein:

the teeth in the index strip and in the connector module are constructed such that end teeth of each group of openings have a greater dimension longitudinally of the index strip than the teeth therebetween;

the enlargement of the end teeth facilitating the alignment of the connector module with the index strip prior to the mounting of the connector module to the index strip.

20. The electrical connector of claim **15**, wherein:

the web of the second mating portion is formed with a plurality of slots therethrough communicating with an outwardly facing surface thereof and extending into opposing portions of each adjacent pair of frusta to provide access to each of the contact elements from without the connector module when the portions are mated;

the contact elements being supported with the narrow waist section of each contact element spanning between the dielectric mounting surfaces;

the narrow waist section of each contact element being aligned with associated ones of the slots in the web of the second mating portion of the connector module.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,858,158

DATED : December 31, 1974

INVENTOR(S) : ROBERT W. HENN, et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the specification, front page, items [75] and [73] should appear as follows:

--[75] ROBERT WALTER HENN, Dunwoody; CHRISTIAN SCHOLLY, Atlanta, JAMES EMERY VOYTKO, Doraville; THOMAS LESLIE WILLIFORD, JR., Lawrenceville; and CHARLES MCGONIGAL, Grayson; all of Georgia.--

--[73] Assignee: Bell Telephone Laboratories, Inc.
Murray Hill, New Jersey
Western Electric Company, Inc.
New York, N. Y.--

Signed and Sealed this

eleventh Day of *November 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks