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Derr et al.

[11] **3,829,821**

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[54] **LATCHING SYSTEM FOR AN ELECTRICAL CONNECTOR ASSEMBLY AND A TOOL FOR ACTUATING SAID SYSTEM**

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[52] **U.S. Cl.** ..... **339/91 R,** 339/18 R, 339/176 M

[51] **Int. Cl.** **H01r 13/64**

[58] **Field of Search** 339/31, 47–49, 339/74, 75, 91, 123, 125, 126, 128, 184, 186, 217, 205, 208, 176, 192, 196, 198, 211, 218, 65, 66, 113, 18

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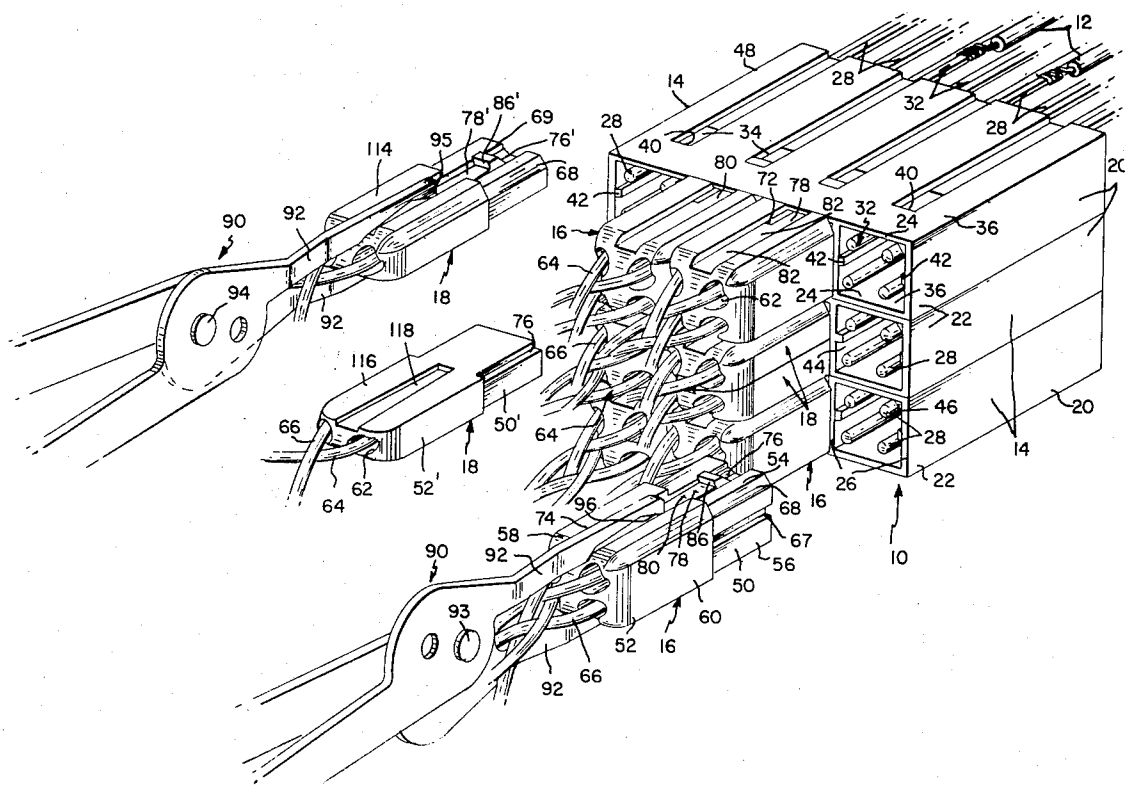
[57] **ABSTRACT**

A changeable interconnecting means comprising a plurality of receptacles arranged in a tightly packed stack with their sides against each other. The receptacles contain contact pins arranged in cells. The pins are connected to external conductors by wires extending from the rearward ends of the pins. Interconnections are made by plug members containing sockets which are dimensioned to fit snugly into the cells. The plug members are individually removable by virtue of latching means recessed in their sides which engage complementary latching means in the receptacles.

11 Claims, 7 Drawing Figures



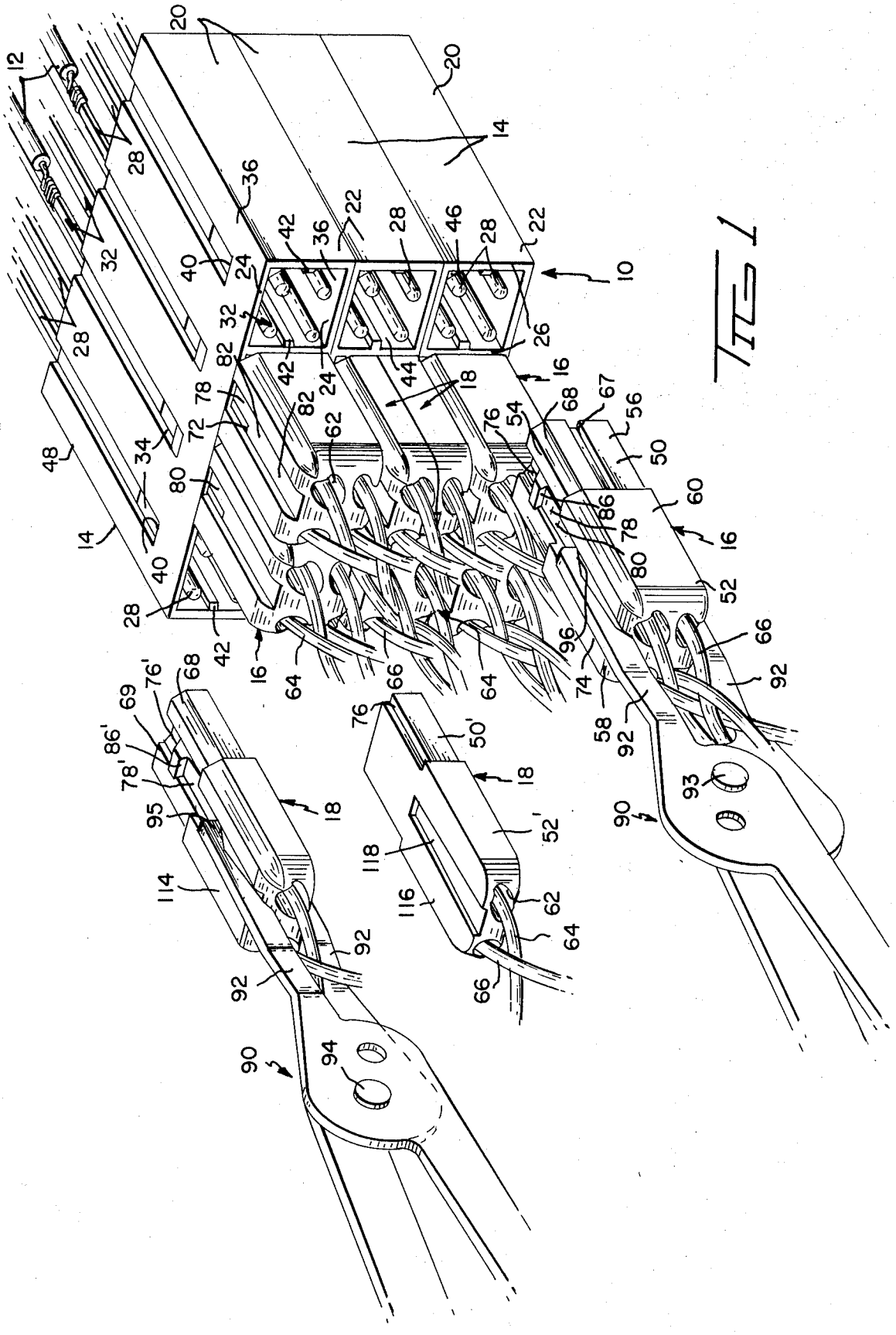
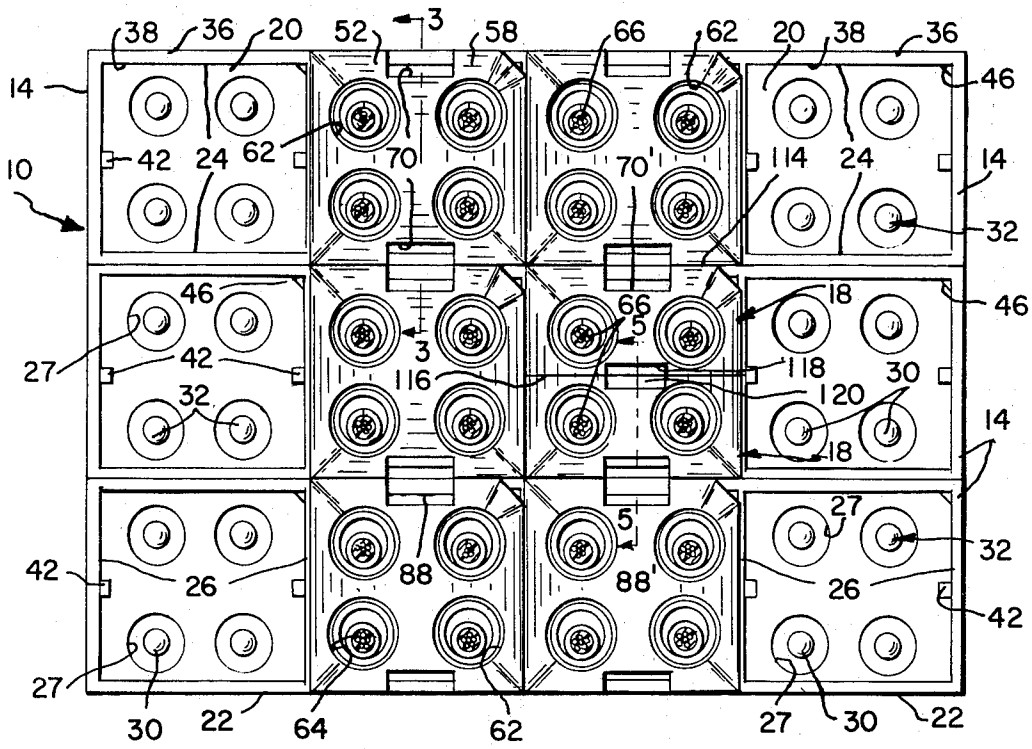


FIG. 1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64
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30
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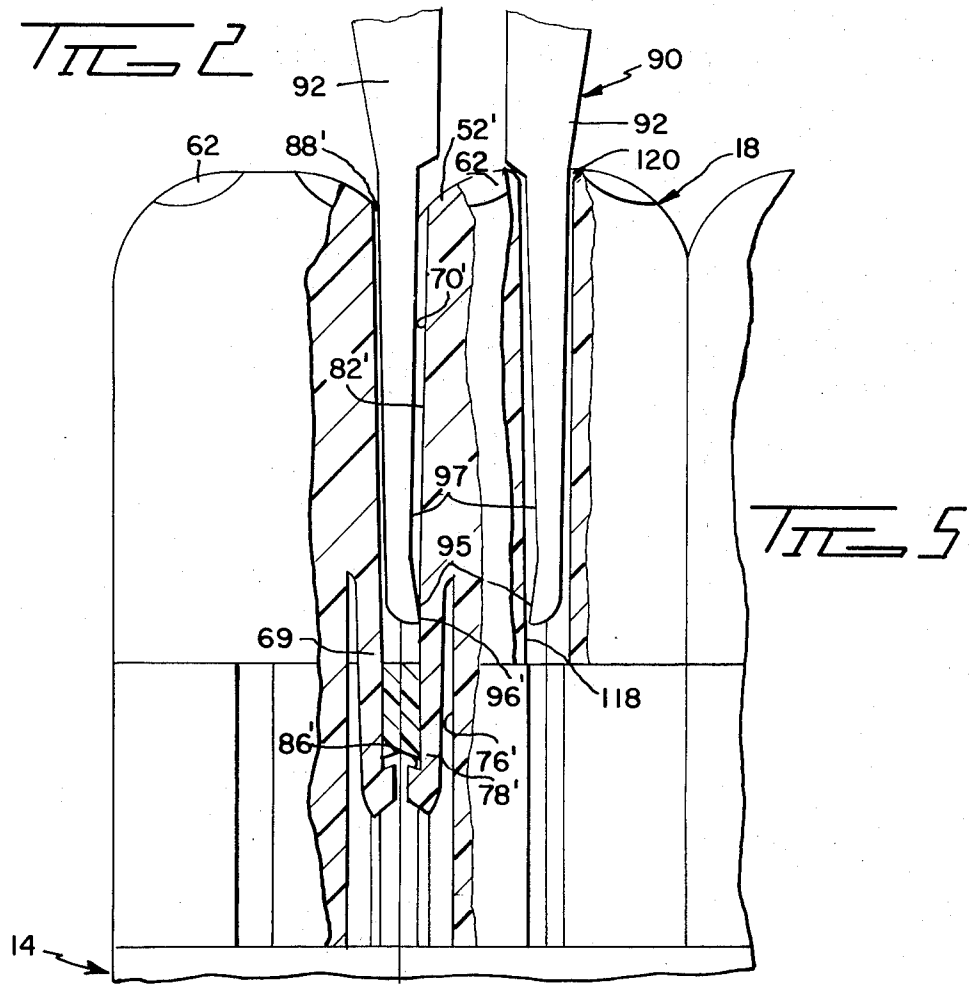
FIG 2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92
52'
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FIG 5

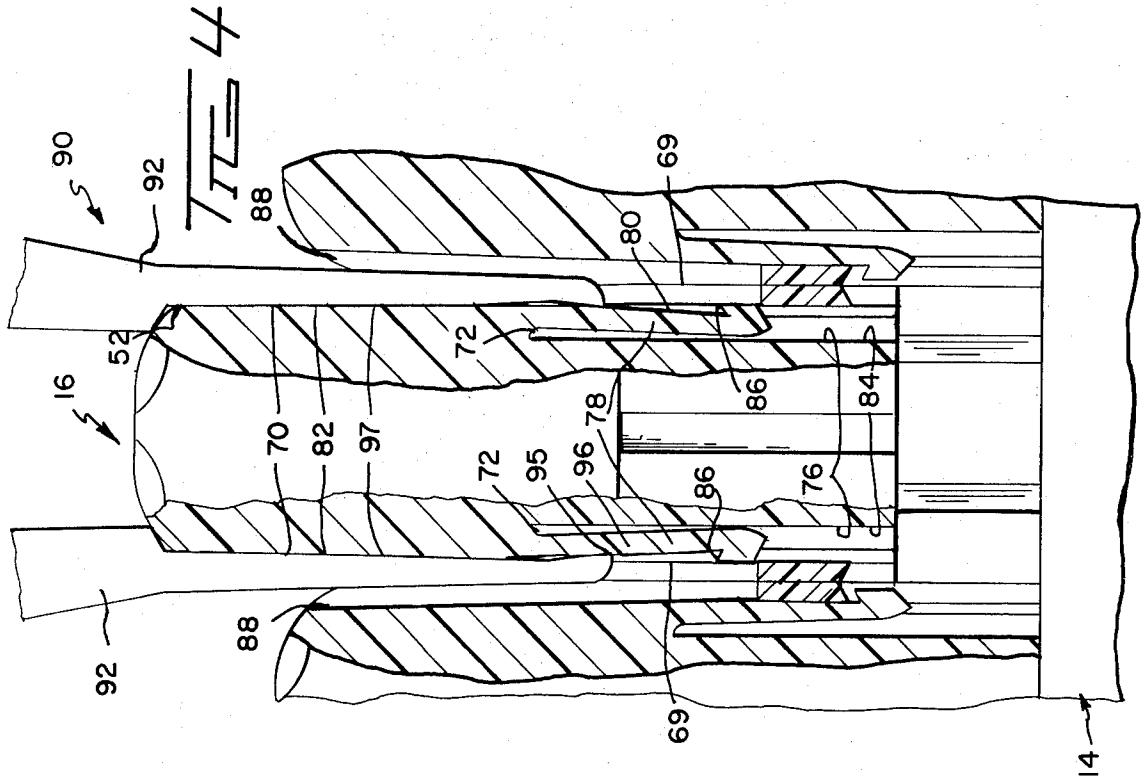
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FIG. 4

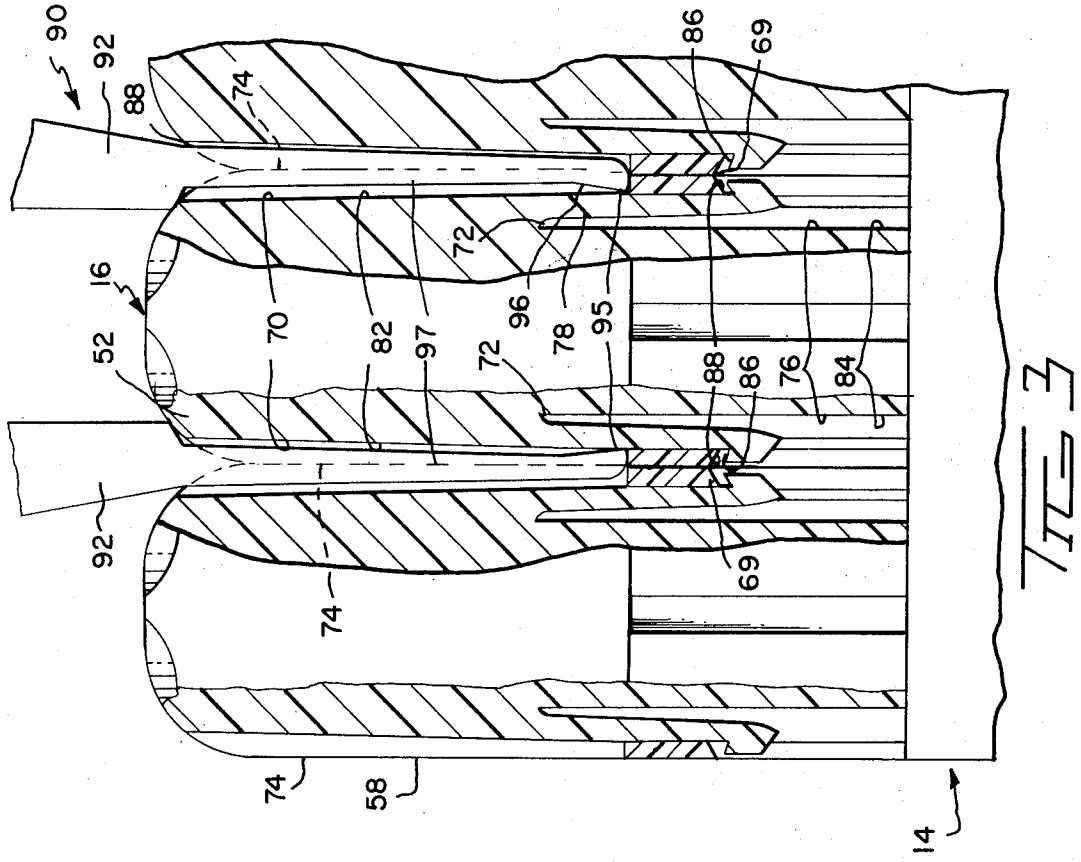
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FIG. 7

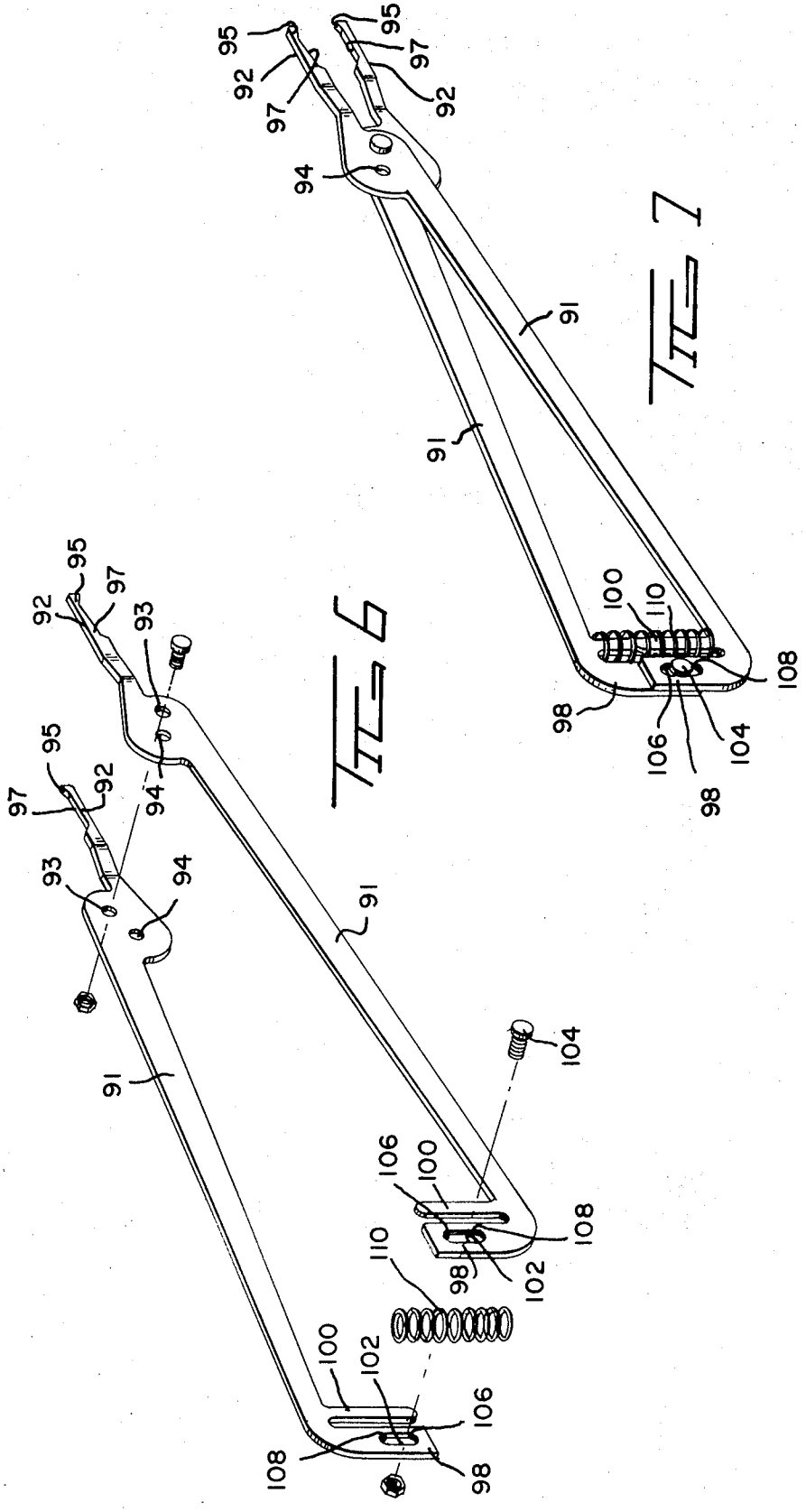

FIG. 7

FIG. 8

LATCHING SYSTEM FOR AN ELECTRICAL CONNECTOR ASSEMBLY AND A TOOL FOR ACTUATING SAID SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention broadly relates to an electrical connector assembly and more particularly is concerned with a latching system which provides individual connections between connector plugs and connector receptacles of the assembly which allows the plugs and receptacles to be positioned respectively in closely packed stacks wherein by only the use of a tool each plug in the closely packed stack of plugs is individually engageable with a receptacle in the closely packed stack of receptacles and is individually disengageable from the receptacle without disturbing adjacently positioned plugs in the same and adjacent receptacles. The present invention is also more particularly concerned with the tool required for the actuation of the latching system which has two generally parallel elongated arms which facilitate gripping of an individual plug during its insertion into, and extraction from, a receptacle simultaneously as the tool arms actuate the latching system.

1. Description Of The Prior Art

Transmission networks in the telephone industry include thousands of electrical conductor wires. Typically, these wires are electrically and mechanically terminated at the rear bay of main or intermediate frames installed at central offices of telephone companies. These wires may serve any of a variety of functions such as carrying incoming or outgoing signals, or carrying signals between the main frame and various test equipment installed at the central office.

The primary purpose of the main frame is to provide a central location at which interconnections between these wires can be made as desired on the front bay of the frame. Typically, the wires terminated at the rear bay of the frame are electrically and mechanically attached to contact terminals mounted in the frame, the attachment being made by either the wire-wrap or soldering techniques. These techniques provide a more or less permanent connection in the sense that the wires cannot be readily detached from the terminals. While permanent connections between the terminals and the wires at the rear bay of the frame are ordinarily desirable, such connections between interconnecting wires and the terminals at the front bay of the frame are not desirable since these connections need to be frequently detached to change the interconnections between the wires terminated at the rear bay of the fame.

One type of interconnection system which has been used heretofore involves terminating the ends of the interconnecting wires to jacks which are pluggable into the main or intermediate frames. These jacks are retained in the frame by conventional detents on the contact terminals mounted in the jacks which mate with conventional complementary detents on the contact terminals mounted in the frame when the respective contact terminals on the jack and the frame are mated.

The incorporation of the detent retention system into the mating contact terminals of the jack and the frame creates certain problems.

On the one hand, if the detents and contact terminals are designed such that a high extraction force is required to unmate them to thereby avoid frequent accidental removal of the jacks from the frame, the plating on the contact surfaces at which the electrical connection is made will be subjected to a high degree of wear each time the jack is removed from the frame which will lead to the need for frequent repair or replacement of the contact terminals in the jack and frame. Furthermore, in view of the fact that an operator may be making hundreds of interconnections each day, an extraction force of from five to ten pounds for each jack imposes a heavy burden on the stamina of the averaege operator.

On the other hand, if the detents and contact terminals are designed such that a low extraction force is required to unmate them, the jacks become susceptible to being accidentally removed from the frame merely by the act of spreading apart of the various interconnecting wires in order to find the jack which the operator desires to remove from the frame. Also, jacks utilizing this type of retention system which has a low extraction force encourages removal thereof by pulling on the interconnecting wires which emanate from the jack.

Furthermore, jacks of the aforementioned type when plugged into the frame cannot be positioned in relation to each other in a closely packed stack since some space is required between adjacent ones of the jacks to allow removal of individual jacks either by hand or by a tool which is inserted through an end of the jack to hook it and then pull it from the frame. This extra space needed between the jacks is compensated for by the utilization of small diameter or light weight contact terminals in both the jacks and the frame. However, the use of small diameter or light weight, and inherently less durable, terminals shortens the effective life span of the terminals and thereby hastens the time when repair or replacement of the terminals will be required.

OBJECTS AND SUMMARY OF THE INVENTION

The connector assembly incorporating the latching system of the present invention, and the actuation of this system and the insertion and extraction of the connector plugs of the assembly by the use of the specifically designed tool of the present invention, eliminate all of the aforementioned problems and disadvantages of the above described interconnection system used heretofore.

An object of the invention, therfore, is to provide a connector assembly in which the retention of individual connector plugs within the connector receptacles is achieved by a novel mechanical latching system which is separate from the electrical and mechanical mating connection between the contact terminals respectively of the plug and receptacle whereby larger diameter, heavier weight, contact terminals may be utilized in the plugs and receptacles of the assembly which enhances the integrity of the connector assembly and significantly lengthens the life span of the terminals used therein.

Another object of the invention is to provide a latching system which allows the connector plugs and connector receptacles of the connector assembly to be disposed respectively in closely packed stacks wherein mateable contact terminals mounted respectively within the plugs and receptacles which provide inter-

connections between a multiplicity of electrical conductor wires terminated to the contact terminals of the receptacles on the rearward side of the receptacles facilitate the provision of the multiplicity of conductor wires in a dense arrangement whereby any space available for the installation of the connector assembly which constitutes the frame is maximumly utilized.

A further object of the invention is to provide a positive latching system separate from the contact terminals of the plugs and receptacles which in allowing the plugs and receptacles to be disposed respectively in closely packed stacks necessitates the use of a specifically designed tool to actuate the system and to achieve rapid insertion and extraction of the plugs into and from the receptacles which thereby eliminates accidental removal of the plugs caused by spreading of the interconnecting wires to find the desired plug and discourages pulling on the interconnecting wires to extract the plugs.

These and other objects of the invention are achieved in a preferred embodiment thereof wherein a latching system for providing an individual connection between each of an array of closely stacked connector plugs and each of an array of closely stacked connector receptacles includes first interengaging means disposed at spaced intervals along an interior surface of each of two parallel aligned elongated walls of each receptacle which walls receive a plurality of plugs in a row therebetween, a channel defined in each of two opposite sides of a rearward portion of each plug, an access passageway defined at each of the two opposite sides of the rearward portion by each of the channels therein together with respective facing like channels on the rearward portions of adjacent plugs, a flexible latch arm connected to the rearward portion of each plug within at least one of the channels at a position therein short of the front end of the rearward portion, and second interengaging means disposed on the end of the latch arm and aligned with one of the first interengaging means of the receptacle and coupled therewith when the plug is received in the receptable.

Also, in a preferred embodiment of the invention the latching system is actuated by a tool which further is used to grip each of the plugs during insertion and extraction of the plug into and from the receptacle. The depth of the access passages defined at each of the two opposite sides of the rearward portion of each plug accommodates two elongated arms of the tool. Each of the tool arms has an inwardly-directed shoulder on the end thereof which is engageable with each of the flexible latch arms at an actuating position therealong located forwardly of the location of connection of the latch arm and along the rearward portion of the plug. In the case of the plug having only one latch arm, one of the tool arm shoulders would engage the forward end of a bottom wall of the channel simultaneously as the other tool arm shoulder engages the latch arm. Each of the tool arms further has an interior surface portion adjacent to each of the shoulders which is shaped to engage the bottom wall of the channel rearwardly of the location of connection of the latch arm to the channel when the tool arms are moved toward each other. Movement of the tool arms toward each other accordingly moves the tool arm shoulders toward each other which forces the flexible latch arms to pivotally flex toward each other which displaces the second interengaging means of the latch arm from the first interengaging means of the receptacle and simultaneously causes the tool arm interior surface portions to engage the channel bottom walls, whereby the plug may be readily extracted from the receptable without disturbing the adjacent plugs of the array of closely stacked plugs in the same and adjacent receptacles.

Other objects and attainments of the invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described an illustrative embodiment of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purpose of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of the following detailed description reference will be frequently made to the attached drawings in which:

FIG. **1** is a perspective view of an electrical connector assembly embodying the principles of the present invention having two-contact and four-contact connector plugs disposed in closely packed stacks in the same and adjacent connector receptacles disposed in closely packed stacks and further illustrating two of the two-contact connector plugs and one of the four-contact connector plug disengaged from the connector assembly with a tool gripping the four-contact connector plug and the tool gripping one of the two-contact connector plugs;

FIG. **2** is a top plan view of the connector assembly embodying the principles of the present invention with some two-contact and four-contact connector plugs received in the receptacles of the connector assembly;

FIG. **3** is an enlarged fragmentary sectional view of the connector assembly taken along line **3—3** of FIG. **2** showing a four-contact connector plug prior to extraction from a connector receptacle by the use of the tool;

FIG. **4** is an enlarged fragmentary sectional view of the connector assembly similar to that of FIG. **3** showing the four-contact connector plug during its extraction from the connector receptacle by the use of the tool;

FIG. **5** is an enlarged fragmentary sectional view of the connector assembly taken along line **5—5** of FIG. **2** showing a two-contact connector plug prior to extraction from a connector receptacle by the use of the tool; FIG. **6** is an exploded, perspective view of the tool shown in fragmentary form in FIGS. **1** and **3** through **5**; and

FIG. **7** is a perspective view of the tool of FIG. **6** illustrating the tool in assembled form.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in greater detail to the various figures of the drawings wherein like reference characters refer to like parts, there is shown at **10** in FIGS. **1** and **2** an electrical connector assembly for disengageably interconnecting a multiplicity of electrical conductors **12**, the assembly forming the preferred embodiment of the

present invention. The assembly **10** is comprised by a plurality of connector receptacles **14** which in the preferred embodiment of the invention receive a plurality of four-contact connector plugs **16** and/or a plurality of two-contact connector plugs **18.**

Each of the receptacles **14** may be molded from a suitable flame-resistant plastic insulating material such as poly terephthalate resin to form a substantially rigid one-piece structure.

Each of the receptacles **14** is comprised by a rectangular block **20** and a plurality of hood portions **22** arranged in a row on, and integrally formed with, the block **20.** Each of the hood portions **22** is defined by two pairs of oppositely disposed, and interconnected, walls **24, 26** which extend from the block **20.** Each wall **24** of the one pair of walls is integrally connected with a like wall **24** of the corresponding one pair of walls of adjacent hood portions **22.** At least one wall **26** of the other pair of walls of the hood portions **22** forms a common partition wall between adjacent ones of the hood portions **22.**

In the preferred embodiment of the invention, a plurality of longitudinal cavities **27** are defined through the block **20** of each receptacle, the cavities being disposed in spaced apart relation from each other and aligned in two rows. A plurality of contact terminal posts **28** emanate from the cavities at the rearward end of the block **20** of each receptacle **14.**

The posts **28** are electrically and mechanically connected to contact terminal pins **30** which are also mounted within the same longitudinal cavities **27** of each block **20.** The pins **30,** being mounted in cavities **27** and thus disposed in substantially the same spaced apart relation from each other as the posts **28** and aligned in the same two rows, emanate from the cavities **27** at the forward end of the block **20** of each receptacle **14.** The hood portions **22** divide the pins **30** into groups of four with two pins in each of two rows within each hood portion **22.**

The contact terminal posts **28** are of the known type and adapted to be electrically and mechanically connected to the multiplicity of electrical conductors **12,** in the preferred embodiment of the invention, by the conventional wire wrap technique as used in the telephone and communications industry. The contact terminal posts **28** and pins **30** heretofore referred to are merely illustrative of the types of terminals used in conjunction with the preferred embodiment of the invention and are not per se a part of the invention. Therefore, for purposes of brevity and clarity in this detailed description of the invention, the electrically and mechanically interconnected posts **28,** pins **30** and conductors **12** may be characterized as first conductor means **32.**

Each wall **24** of the one pair of walls of each hood portion **22** has a window **34** formed therein which opens onto both an exterior surface **36** and an interior surface **38** of the wall **24.** The window **34** is partially defined by a shoulder **40** (see also FIG. **3**) which faces toward the block portion **20** of the receptacle **14.** The function and purpose of the shoulder **40** will be described in detail later. The window **34** does not necessarily need to be formed completely through the wall **24.** It is so formed for convenience in the molding of the receptacle **14.** However, it is readily seen that the shoulder **40** could be formed in teh wall **24** such that it only opened onto the interior surface **38** of the wall **24.**

Each wall **26** of the other pair of walls of each hood portion **22** has guide means **42** formed on the interior surface **44** of the wall **26.** Also, polarizing means **46** are formed at one of the four corners of intersection between the walls **24, 26** of the two pairs of walls defining each hood portion **22.**

The receptacles **14** are disposable together in a closely packed stack as shown in FIG. **1** wherein sach stack the exterior surfaces **36** of the walls **24** of each hood portion **22** and the corresponding sides **48** of the block **20** which are coplanar with the exterior surfaces **36** are positionable against like exterior surfaces **36** and sides **48** of adjacent receptacles **14.**

As shown in FIGS. **1** and **2,** the connector assembly **10** includes three receptacles **14** with each receptacle having four hood portions **22.** However, it is readily apparent that the rectangular blocks **20** of the assembly **10** could be any desired length so as to have any desired number of hood portions **22** extending therefrom according to the area desired to be encompassed by the connector assembly when the assembly is incorporated into the main or intermediate frames used in the telephone industry. Further, the receptacles **14** could be molded together so as to integrally form a total one-piece structure rather than molded as the individual one-piece rectangular receptacles **14** shown in FIGS. **1** and **2.**

Each of the connector plugs **16, 18** may be molded from a suitable flame-resistant plastic insulating material such as polycarbonate resin to form a substantially rigid one-piece structure.

The four-contact connector plugs **16** will now be described in detail. The two-contact connector plug **18** which will be described later is substantially identical to one-half of the four-contact connector plug **16.** Therefore, most of the features of the plug **18** will be readily apparent upon a reading of the following description of the plug **16.**

Each of the plurality of four-contact connector plugs **16** in the assembly **10** is rectangular in cross-section and comprised by a forward portion **50** and a rearward portion **52.** The forward portion **50** of each plug **16** is receivable within each hood portion **22** of the receptacles **14.** In the preferred embodiment of the invention, when the forward portion **50** is received within the hood portion **22,** two pairs of opposite sides **54, 56** of the forward portion **50** are disposed against the interior surfaces **38, 44** of the two pairs of opposite walls **24, 26** of the hood portions **22.** Further, when the forward portion is received within the hood portion **22,** the rearward portion **52** extends from the hood portion **22.** The rear portion **52** has two pairs of opposite sides **58, 60** which correspond to the two pairs of opposite sides **54, 56** of the forward portion **50.**

The cross-sectional thickness of the rearward portion **52** between its opposite sides **58** is greater than the cross-sectional thickness of the forward portion **50** between its opposite sides **54** by an amount approximately equal to twice the thickness of the wall **24** of the hood portion **22** with such cross-sectional thickness of the rearward portion **52** between its sides **58** being distributed in relation to that of the forward portion **50** in such a way that each side **58** of the rearward portion **52** is displaced outwardly from the corresponding side **54** of the forward portion **50** through a distance equal to

the thickness of the wall **24** of the hood portion **22** whereby each of the sides **58** of the rearward portion **52** is substantially coplanar with the corresponding exterior surface **36** of the walls **24** of the hood portions **22.**

Furthermore, the cross-sectional thickness of the rearward portion **52** between its opposite sides **60** is also greater than the cross-sectional thickness of the forward portion **50** between its opposite sides **56** by an amount approximately equal to the thickness of the wall **26** of the hood portion **22** with such cross-sectional thickness of the rearward portion **52** between its sides **56** being distributed in relation to that of the forward portion **50** in such a way that each side **60** of the rearward portion **52** is displaced outwardly from the corrsponding side **56** of the forward portion **50** through a distance equal to one-half of the thickness of the wall **26** of the hood portion **22** whereby each of the sides **60** of the rearward portion **52** is substantially coplanar with an imaginary plane which extends through the wall **26** of the hood portion **22** so as to bisect the thickness of the wall **26.**

It is readily apparent that when the forward portions **50** of adjacent plugs **16** are received in adjacent hood portions **22** of the same receptacle **14** and of adjacent receptacles **14,** the rearward portions **52,** having the above-described proportioned cross-sectional thicknesses and displaced sides in relation to those of the forward portions **50,** will be positioned against each other in a closely packed stack as illustrated in FIGS. **1** and **2.**

In the preferred embodiment of the invention, each plug **16** has four longitudinal cavities **62** defined therethrough, the cavities **62** being disposed in spaced apart relation from each other and aligned two in each of two rows, and further preferably aligned with the cavities (not shown) in the block **20** of the receptacles **14** when the plugs **16** are received in the receptacles **14.** In the preferred embodiment, the cavities **62** are substantially circular in cross-section. The largest cross-sectional dimension (the diameter) of each cavity **62** in the rearward portion **52** of each plug **16** and the relative displacement of each of the cavities **62** one from the other governs the cross-sectional dimensions of the rearward portion **52.** A plurality of lead wires **64** (FIG. **1**) emanate from the cavities **62** at the rear end of the rearward portion **52** of the plug **16.** The wires **64** are electrically and mechanically secured to contact terminals (not shown) which are mounted in the cavities **62** which, in turn, are electrically and mechanically connected to terminal sockets (not shown) also mounted in the cavities **62** and open at the front end of the plug **16,** the sockets being proportioned to receive, and electrically and mechanically mate with, the pins **30** of the receptacle **14** when the plug **16** is received within the hood portion **22** of the receptacle **14.** The lead wires **64** of any one of the plugs **16, 18,** the wires being shown in fragmentary form in FIG. **1,** may provide the interconnection between any other of the plugs **16, 18** as desired. These wires **64** thus constitute the interconnecting wires which provide electrical communication between desired pairs of wires **12** which are terminated at the rear end of the receptacles **14.** The lead wires **64,** contact terminals (not shown) and terminal sockets (not shown) heretofore referred to are merely illustrative of the types of electrical contact components used in conjunction with the perferred embodiment of the invention and are not per se a part of the invention. Therefore, for the purposes of brevity and clarity in this detailed description of the invention, these components may be characterized as second conductor means **66.**

Plug **16** further includes guide means **67** disposed on its forward portion **50** on each of the opposite sides **56** of the forward portion **50** which guide means **67** interengage with the guide means **42** on each of the interior surfaces **44** of the receptacle hood portion walls **26** to assist in the insertion of the plug **16** into the hood portion **22.** Also, polarizing means **68** are formed at one of the four corners of intersection between the sides **54, 56** of the forward portion **50** which polarizing means **68** match the polarizing means **46** of each receptacle hood portion **22** to insure proper orientation of the insertion of the plug **16** into the receptacle hood portion **22.**

Turning now also to FIGS. **3, 4,** and **5,** there is illustrated a latching system **69** incorporated in the receptacles **14** and plugs **16, 18** of the connector assembly **10** of the present invention. The latching system **69** includes a first channel **70** defined in each of the two opposite sides **58** of the rearward portion **52** of each plug **16.** The channel **70** originates at the rear end of the rearward portion **52** and extends to a position of termination **72** located short of the front end of the rearward portion **52** of the plug **16.** Each of the first channels **70** extend inwardly from each of the outermost exterior surfaces **74** on each of the two opposite sides **58** of the rearward portion **52** and between adjacent ones of the cavities **62** disposed in the plug **16** adjacent to each of the exterior surfaces **74.** Each of the first channels **70** have cross-sectional dimensions which are limited in their magnitude by the displacement of the adjacent cavities **62** one from the other and from each of the respective exterior surfaces **74** such that the positions and dimensions of the channels **70** with respect to the cavities **62** do not interfere with, or disrupt, the desired overall dense arrangement of a multiplicity of the second conductor means **66** within the array of closely packed stack of plugs **16, 18.** Accordingly, consistent with the desired overall dense arrangement of the second conductor means **66,** the depth of each of the first channels **70** may at a maximum be substantially equal to the thickness of the wall **24** of the receptacle hood portion **22.**

The latching system **69** further includes a second channel **76** defined in each of the two opposite sides **58** of the rearward portion **52** and in each of the two corresponding opposite sides **54** of the forward portion **50** of each plug **16.** The channel **76** originates at the location of the termination position **72** of the first channel **70** within the rearward portion **52** and extends into the corresponding side **54** of the forward portion **50.** The second channel **76** has a truncated cone shape in cross-section and a relatively greater depth than the first channel **70.** Greater structural integrity is required in the rearward portion **52** than in the forward portion **50** since a latch arm **78** is anchored to the rearward portion **52** and the force required to actuate the latch arm **78** and to grip the plug **16** is applied by a tool, as will be described hereinafter, against the rearward portion **52.** Therefore, the depth of the second channel **76** may extend partially between the cavities **62** while the depth of the first channel **70** preferably should not.

When the plugs **16** are arranged in their closely packed stack, each of the first and second channels **70,**

76 are aligned with, and face, like channels **70, 76** in each rearward portion **52** of the adjacent plugs **16.** However, the hood portion wall **24** is interposed between the portions of the like second channels **76** in each forward portion **50** of the adjacent plugs **16.**

The latching system **69** also includes a flexible latch arm **78** which is connected to the rearward portion **52** of the plug **16** at each of the termination positions **72** of the first channels **70** and extends within each of the second channels **76.** The exterior surface **80** of each of the latch arms **78** merges from, and is substantially coplanar with, a bottom wall **82** of each of the first channels **70** and also substantially coplanar respectively with each of the two opposite sides **54** of the forward portion **50** when the latch arms are in their unflexed positions. Each of the latch arms **78** are displaced outwardly from a bottom wall **84** of each of the second channels **76** such that the latch arms **78** may be flexed inwardly toward the second channels **76.** Each of the latch arms **78** include a shoulder **86** on the free end thereof which projects outwardly from the exterior surface **80** of each of the latch arms **78** and faces toward the rearward portion **52** of the plug **16.** Shoulders **40** which are formed in the walls **24** of each of the receptacle hood portions **22** were referred to earlier. These shoulders **40** are included in the latching system **69.** Each of the shoulders **86** is aligned with, and overlies, each of the shoulders **40** formed in the walls **24** of the receptacle hood portion **22** in which the plug **16** is received when each of the latch arms **78** are in their unflexed positions to thereby secure the plug **16** within the receptacle hood portion **22.**

Each latch arm **78** is flexibly movable about its location of connection **72** between a latching position, as shown in FIG. **3,** wherein the latch arm **78** is unflexed and the shoulder **86** on the latch arm **78** is disposed in a coupling or engaging position in overlapping relation with the shoulder **40** of wall **24** of the receptacle hood portion **22** to thereby prevent extraction of the plug **16** from the receptacle **14,** and an unlatching position, as shown in FIG. **4,** wherein the latch arm **78** is flexed inwardly toward the second channel **76** and the shoulder **86** on the latch arm **78** is displaced from its coupling or engaging position in relation to the shoulder **40** of the wall **24** of the receptacle hood portion **72** inwardly from the location of connection **72** to thereby allow extraction of the plug **16** from the receptacle **14.** The latch arm **78** is normally biased to assume its substantially unflexed or latching position. The latch arm **78** also includes a camming surface **87** on the tip of the free end thereof which slopes outwardly and rearwardly from the tip. The camming surface **87** is engageable against the top portion of the wall **24** aligned with, and displaced above, the shoulder **40** of the receptacle hood portion wall **24** and causes the latch arm **78** to flex inwardly toward the second channel **76** when the plug **16** is inserted into the receptacles **14** by hand.

The first channel **70** and the latch arm exterior surface **80** on each of the opposite sides **58** of the rearward portion **52** of the plug **16** together with a like first channel **70** and a like latch arm exterior surface **80** on adjacent plugs **16** define an access passageway **88** on each of the opposite sides **58** of the rearward portion **52** of the plug **16.**

There is also shown in fragmentary form in FIGS. **1** and **3** through **5,** and in unassembled and assembled forms respectively in FIGS. **6** and **7,** a tool **90** of the plier type having two elongated handles **91** which are pivotally hinged together adjacent one of their respective ends at openings **93** or **94** depending upon whether the tool **90** is to be used in conjunction with plugs **16** or plugs **18.** Each of the tool handles **91** at their aforementioned respective one ends has an elongated arm **92** extending therefrom beyond the hinged location of the handles **91,** the arms **92** being generally parallel to each other. Each of the tool handles **91** with the arm **92** extending therefrom may be fabricated as a one-piece structure by any suitable known process, such as by stamping, from any suitable known material such as steel sheet metal, or the tool handles **91** could be separately made from a suitable known plastic material by any suitable known molding process wherein the handles **91** are molded onto the arms **92** which may be stamped out from steel sheet metal.

Each of the tool arms **92** are movable toward each other when the tool handles **91** are squeezed together. Each of the tool arms **92** has an inwardly-directed shoulder **95** on the free ends thereof which shoulder **95** is engageable with each of the flexible latch arms **78** at an actuating position **96** therealong located forwardly of the location of connection **72** of the latch arm **78** and short of the front end of the rearward portion **52.** Each of the tool arms **92** further has an interior surface portion **97** adjacent to each of the shoulders **95** which surface portion **97** is shaped to engage the bottom wall **82** of each of the first channels **70** rearwardly of the location of connection **72** of the latch arm **78** to the first channel **70** when the tool handles **91** are squeezed together.

Each of the tool handles **91** includes at the other of their respective ends a slotted tab **98** which extends outwardly from the handle **91** in a direction transverse to the longitudinal direction of the handle **91,** and a support post **100** disposed adjacent to, and generally aligned parallel with, the slotted tab **98.**

The slotted tabs **98** have identical oblong slots **102** defined therein, which slots **102** are generally aligned with each other, when the tool is assembled as shown in FIG. **7,** in a direction transverse to the longitudinal direction of the handles **91** to receive a nutted pin screw **104** therethrough for coupling the tabs **98** together in a sliding contacting relationship to facilitate pivotal movement of the tool handles **91** toward and away from each other, through a predetermined length of stroke at the aforementioned other respective ends of the handles **91.** The maximum and minimum limits of the stroke through which the handles **91** may be moved are partially determined by the distance between the ends **106, 108** of the slots **102** which ends **106, 108** are disposed respectively remote from, and adjacent to, the handles **91.** The maximum limit of the stroke of the handles **91** is reached when the pin screw **104** is in contact with the remote ends **106** of the slots **102.** The minimum limit of the stroke of the handles **91** is reached when the pin screw **104** is in contact with the adjacent ends **108** of the slots **102.**

When the tool is assembled, the support posts **100** are disposed in sliding contacting relationship with each other and with a spring **110** retained by, and disposed loosely about, the support posts **100.** The spring **100** acts as a biasing means on the handles **91** to maintain the handles **91** at the maximum limit of their stroke.

The maximum limit of the stroke of the tool handles **91** is chosen such that when the tool handles **91** are pivotally hinged at openings **93** by a nutted pin screw **112** with the handles **91** disposed at the maximum limit of their stroke, the displacement between the inwardly-directed shoulders **95** of the tool arms **92** is preferably slightly greater than the cross-sectional thickness of the plug **16** between the first channels **70** of the plug **16.** Therefore, the tool arms **92** will be accordingly preset in alignment with the first channels **70** of the plug rearward portion **52** prior to insertion of the tool arms **92** along the first channels **70** which thereby eliminates any need for the tool operator to squeeze the handles **91** toward each other in order to independently establish the desired alignment between the tool arms **92** and the plug channels **70.** The minimum limit of the stroke of the tool handles **91** is chosen such that when the handles **91** are squeezed together to the minimum limit of their stroke, the inwardly-directed shoulders **95** of the tool arms **92** have flexed the latch arms **78** inwardly to their desired flexed positions whereby the plug **16** may be extracted from the receptacle **14.** Furthermore, the establishment of a minimum limit for the stroke of the handles **91** serves to prevent movement of the handles **91,** and thus of the arms **92,** and accordingly flexing of the latch arms **78** beyond the desired flexed position of the latch arms **78** in order to avoid over-flexing of the latch arms **78** which would possibly cause either the tool arms **92** or the latch arms **78** to ultimately structurally fatigue or breakoff. Thus, the establishment of the minimum stroke limit eliminates any need for the tool operator to subjectively guage the squeezing force which he applies to the tool handles **91.**

The strength of the tool arms **92** must be great enough to insure the structural integrity of the arms **92** during the transmission of the required amount of force therethrough to achieve flexing of the latch arms **78** to their unlatching position and gripping of the plug **16** with sufficient force to overcome the extraction force required to unmate the four second electrical conductors means **66** of the plug **16** from the four first electrical conductor means **32** of the receptacle **14,** the force being transmitted from the handles **91** via the tool arms **92** to the plug **16** when the operator squeezes the handles **91** together from the maximum limit of their stroke as shown in FIG. **3** to the minimum limit as shown in FIG. **4.**

The structural integrity of the tool arms **92** is assured when the cross-sectional dimensions of the tool arms **92** are proportioned in relation to the cross-sectional dimensions of each of the first channels **70** such that while the width of each first channel **70** is slightly greater than the width of each tool arm **92,** the maximum thickness of each tool arm **92** is greater than the depth of one of the first channels **70** but less than the depth of the access passageway **88** defined between two adjacent plugs by two facing first channels **70** disposed respectively on the adjacent plugs **16.** In other words, the depth of each of the first channels **70,** which depth is consistent with the desired overall dense arrangement of the multiplicity of second conductor means **66** within the array of closely packed stack of plugs **16,** is less than a predetermined clearance dimension required by the tool arms **92** for the insertion of each of the tool arms **92** along the respective opposite sides **58** of the rearward portion **52** of the plug **16.** However, each of the access passageways **88** have a depth greater than the clearance dimension required for insertion of each of the tool arms **92.**

Any one of the plugs **16** may be extracted from the receptacle hood portion **22** as follows. First, as shown in FIG. **3,** each of the two tool arms **92** are inserted into the respective access passageways **88** defined at the two opposite sides **58** of the rearward portion **52** of the plug **16.** When the shoulders **95** of the tool arms **92** are in contact with the latch arms **78** at an actuating position **96** located forwardly of the location of connection **72** and short of the front end of the rearward portion **52,** the tool arms **92** are moved inwardly toward the rearward portion **52.** This movement of the tool arms **92** forces pivotal movement of the latch arms **78** from their normal latching position to their unlatching position. Then, with the plug **16** so gripped between the interior surface portions **97** and the shoulders **95** the tool arms **92,** the plug **16** may be readily extracted from the receptacle **14** without disturbing the most closely adjacent plugs **16** in the array of closely stacked plugs **16.** Extraction of the plug **16** from the receptacle **14** causes unmating of the four second electrical conductor means **66** of the plug **16** from the four first electrical conductor means **32** of the receptacle **14.** Also, with the plug **16** so griped between the tool arms **92,** the plug **16** may be readily inserted into the receptacle **14** without disturbing the most closely adjacent plugs **16** in the array of closely stacked plugs **16.**

The two-contact connector plug **18,** as stated hereinbefore, is substantially identical to one-half of the four-contact connector plug **16.** That is, the plug **18** is comprised by one-half of the plug **16** when the plug **16** is bisected by an imaginary plane which is parallel to each of the two opposite sides **54,58** of the forward and rearward portions **50,52** of the plug **16.** Therefore, each of the plugs **18** includes two of the cavities **62,** two of the second conductor means **66** mounted in the respective cavities **62** in a row. The two second conductor means **66** are mateable with two adjacent ones of the first conductor means **32** being mounted in one of the two rows within a receptacle hood portion **22.** The plug **18** further includes a first side **114** identical to one of the two opposite sides **54,58** of the forward and rearward portions **50,52** of the plug **16;** therefore the first side **114** has first and second channels **70′, 76′,** a flexible latch arm **78′** with a shoulder **86′** and an access passageway **88′** defined at the first side **114.**

The plug **18** additionally includes a second side **116** which corresponds to the aforementioned imaginary bisecting plane and is disposed opposite to the first side **114.** The second side **116** of the plug **18** will be disposed against a like second side **116** of another plug **18** when both of the plugs **18** are received adjacent one another in the same receptacle hood portion **22** (see FIG. **2**). Each of the plugs **18** additionally further includes a third channel **118** defined in the second side **116,** the channel **118** originating at the rear end of the rearward portion **52′** of the plug **18** and extending to the front end of the rearward portion **52′.** The third channel **118** of one plug **18** together with a facing like third channel **118** on the second side **116** of the adjacent plug **18** defining another access passageway **120** which has substantially the same dimensions as the access passageway **88′** at the first side **114.**

When the tool **90** is utilized in conjunction with the two-contact plug **18,** the tool handles **91** are pivotally hinged at openings **94** by the nutted pin screw **112** in-

stead of at openings **93.** With the maximum and minimum limits of the stroke of the ends of the tool handles **91** disposed remote from their hinged location remaining the same when the tool handles **91** are pivotally hinged together at openings **94** as when the handles **91** were hinged together at openings **93,** the change of the pivotal axis of the handles **91** from openings **93** to openings **94** shortens the displacement between the shoulders **95** of the tool arms **92.** The position of openings **94** is chosen in relation to openings **93** such that when the handles **91** are disposed at the maximum limit of their stroke, the displacement between the shoulders **95** of the tool arms **92** is preferably slightly greater than the cross-sectional thickness of the plug **18** between the first channel **70'** and the third channel **118** of the plug **18.** Therefore, the tool arms **92** will be accordingly preset in alignment respectively with the first channel **70'** and the third channel **118** of the rearward portion **52'** of the plug **18** prior to insertion of the tool arms **92** therealong which thereby eliminates any need for the tool operator to squeeze the handles **91** toward each other in order to independently establish the desired alignment between the tool arms **92** and the channels **70', 118** of the plug **18.** Further, the position of openings **94** is chosen in relation to openings **93** such that when the handles **91** are disposed at the minimum limit of their stroke, the shoulders **95** of the tool arms **92** have flexed the one latch arm **78'** inwardly to its desired flexed position whereby the plug **16** may be extracted from the receptacle **14.** When the tool handles **91** are disposed at the minimum limit of their stroke, the shoulder **95** of one tool arm **92** engages the latch arm **78'** at the actuating position **96'** therealong and has moved the latch arm **78'** to its flexed (unlatching) position; simultaneously therewith, the interior surface portion **97** of that one tool arm **92** engages the bottom wall **82'** of the first channel **70'** and the shoulder **95** of the other tool arm **92** engages the forward end of the third channel **118** of the rearward portion **52'** of the plug **18** to thereby sufficiently grip the plug **18** for insertion or extraction of the plug **18** into and from the receptacle **14.**

Any one of the plugs **18** may be extracted from the receptacle hood portion **22** as follows. First, as shown in FIG. **5,** each of the two tool arms **92** are inserted into the respective access passageways **88', 120** defined respectively at the first and second sides **114,116** of the rearward portion **52'** of the plug **18.** When the shoulders **95** of the tool arms **92** are in contact respectively with the latch arm **78'** at the actuating position **96'** and the forward end of the third channel **118,** the tool arm **92** in contact with the latch arm **78'** is moved inwardly toward the rearward portion **52'.** This movement of the tool arm **92** forces pivotal movement of the latch arm **78'** from its normal latching position to its unlatching position and engagement of the interior surface portion **97** of the one tool arm **92** with the first channel **70.** Then, with the plug **18** so gripped between the tool arms **92,** the plug **18** may be readily inserted into, and extracted from, the receptacle **14** without disturbing the most closely adjacent plug, one being a plug **18** in the same receptacle hood portion **22,** and the others being either four-contact plugs **16** or two-contact plugs **18** in adjacent receptacle hoods **22.** Extraction of the plug **18** from the receptacle **14** causes unmating of the two second electrical conductor means **66** of the plug **18** from the two first electrical conductor means **32** of the receptacle **14.**

As shown in FIGS. **1** and **2,** the connector assembly **10** includes two two-contact connector plugs **18** and five four-contact connector plugs **16** received in respective hood portions **22** of the receptacle **14.** However, it is readily apparent that the plugs **16,18** can be arranged in any combination of two-contact and four-contact plugs as desired. It is also readily apparent that, without departing from the principles of the invention, some of the walls **26** which form common partition walls between adjacent ones of the hood portions **22** could be omitted and that two or more of the plugs **16** could be molded so as to integrally connect at their opposite sides **56,60** respectively of their forward and rearward portions **50,52** to form eight-contact or 12-contact plugs if desired. Also, two or more of the plugs **18** could be molded so as to integrally connect at their opposite sides which correspond to the opposite sides of the plugs **16** to form four-contact or six-contact plugs if desired. In each of the above-described modified forms of plugs **16,18** only one set of the latching system **69** would need to be provided on the modified plugs.

However, since the connector assembly **10** forming the preferred embodiment of the invention is particularly adapted for use in the telephone industry, the four-contact plugs **16** and the two-contact plugs **18** are the preferred types of plugs. In the telephone industry, a pair of conductor wires which comprises a loop is required in order to transmit a message in the form of electrical signals, hence, the preference for the two-contact plug is order to provide the interconnections which close the loop. In the case of local telephone service, only one pair of wires is required. However, in the case of long-distance telephone service, two pairs of conductor wires which comprise two loops are required to transmit a message since an amplifier which operates electrically in only one direction must be electrically tied into each of the two loops. Hence, a four-contact plug is preferred in the case of long-distance telephone service in order to provide the interconnections which close each of the two loops.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts and that changes may be made in the form, construction and arrangement of the connector assembly and tool described without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

What is claimed is:

1. Interconnecting means for changeably interconnecting a multiplicity of wires comprising:

a plurality of receptacle members, each of said receptacle members comprising a rectangular housing, said housings being arranged in a tightly packed stack with their wide sides against each other, each of said housings comprising a body portion and a hood portion, a plurality of barrier walls extending transversely between said wide sides in said hood portion, said barrier walls dividing said hood portion into a plurality of rectangular cells, contact

terminals in said body portion having contact ends extending into said cells,

a plurality of plug members, each of said plug members being dimensioned to fit snugly into one of said cells, each of said plug members having an axially extending groove extending on two opposite sides thereof, and having cantilever latching arms, said grooves being in alignment with said arms,

said sidewalls having openings therein for cooperation with said latching arms whereby,

adjacent plug members have said recesses in alignment to provide an opening for admission of an extrattion tool to remove an individual plug member from one of said receptacles.

2. Interconnecting means for selectively and changeably connecting a first multiplicity of wires to a second multiplicity of wires, said interconnecting means comprising:

an electrical receptacle means comprising a housing having a mating face and a rearward face, first contact terminals in said housing extending through said housing to, and beyond, said mating face, said first multiplicity of wires being connected to said terminals adjacent to said rearward face, said housing having hood means completely enclosing said mating face and having barrier walls extending across said mating face between opposite sides of said hood means, said barrier walls and said hood means defining a plurality of individual cells,

a plurality of electrical plugs, each of said plugs comprising a housing having a forward end and a rearward end, said forward end of each plug being in one of said cells, second contact terminals in said plugs, said second contact terminals being mated wtih said first contact terminals,

said rearward ends of said plugs having their sides disposed closely against each other, each of said plugs having on two opposite sides thereof a groove extending along its rearward end to its forward ends, the grooves on the sides of adjacent plugs forming an opening between adjacent plugs,

each of said plugs having latch arm means on said two sides on its forward end, said latch arm means being disengageably latched to said barrier walls, whereby,

an extraction tool can be inserted into said openings to disengage said latch arm means of an individual plug thereby to permit extraction of said individual plug from said receptacle.

3. Interconnecting means as set forth in claim **2,** said cells and said plugs being generally rectangular.

4. Interconnecting means as set forth in claim **3,** said barrier walls having openings therein, said latch arm means having hook portions extending into said openings.

5. Interconnecting means for selectively and changeably interconnecting a first plurality of wires and a second plurality of wires, said interconnecting means comprising:

an electrical receptacle means comprising an insulating housing having a mating face and a rearward face, first contact terminals in said housing extending through said housing, to, and beyond, said mating face,

said housing having rectangular hood means surrounding said mating face, said hood means opposed parallel sides, barrier walls extending between each pair of opposite sides at predetermined intervals, said barrier walls and said hood means defining a plurality of individual rectangular cells, each of said cells surrounding a predetermined number of said first contact terminals

a plurality of electrical plugs, each of said plugs comprising a plug housing having a forward end and a rearward end, said forward ends being in said cells, second contact terminals in said plugs, said second contact terminals being mated with said first contact terminals,

said rearward ends of said plugs extending beyond said cells and having their sides disposed closely against each other, each of said plugs having on two opposite sides thereof a groove extending along its rearward end to its forward end, the grooves of the sides of adjacent plugs forming an opening between adjacent plugs,

each of said plugs having latching means on said two sides, said latching means being proximate to said forward ends, said latching being in engagement with said barriers and serving to latch said plugs in said cells, whereby

each of said plugs is individually removable from its respective cell upon insertion of a latch disengaging tool into the said openings extending inwardly on each side of said plug.

6. Interconnecting means as set forth in claim **5,** said receptacle means comprising a plurality of receptacle modules, each of said modules having a row of said cells, said modules being stacked against each other.

7. Interconnecting means as set forth in claim **6,** said latching means on each of said plugs comprising latch arms, said latch arms being in alignment with said grooves.

8. Interconnecting means as set forth in claim **7,** each of said modules having openings on opposite sides of each cell therein, said latch arms being in engagement with said openings.

9. Interconnecting means as set forth in claim **8,** said first contact terminals comprising contact pins, said second contact terminals comprising contact sockets.

10. Interconnecting means for selectively and changeably connecting a first multiplicity of wires to a second multiplicity of wires, said interconnecting means comprising:

a plurality of receptacle members, each of said receptacle members comprising a rectangular housing having a mating face and a rearward face, each housing having a hood extending from, and surrounding, its mating face, said hood defining an enclosure which surrounds said mating face, and a plurality of barrier walls extending at equally spaced intervals between two opposite sides of said hood and dividing said enclosure into a plurality of cells,

a plurality of electrical contact terminals in said housing, first wires connected to said conductors proximate to said rearward face, said terminals having contact portions extending into said cells,

a plurality of electrical plug members, each of said plug members having a mating end and a rearward end, said mating end being of reduced dimensions to fit snugly within one of said cells, each of said plugs having a forwardly facing shoulder between

said mating end and said rearward end, said shoulders being against the edges of said hoods and the edges of said barrier walls, and rearward portions of said plugs being tightly against each other,

a plurality of contact receiving cavities extending through said plugs and second electrical contact terminals in said cavities, wires secured to said terminals proximate to said rearward ends, said first terminals extending into said cavities and being mated with said second terminals,

each of said plugs having on two opposite sides a groove extending along its rearward end, to its forward end, an integral cantilever latch arm associated with each of said grooves, said latch arms being integral with said plug in said rearward portion and extending towards said forward portions, each of said latch arms having an outer surface which is coplanar with the floor of its respective groove and having a free end which is flexible towards said forward portion, and

openings in said hoods in engagement with said latch arms to latch said plugs in said cells whereby,

said grooves in adjacent plugs are in opposed aligned relationship and provide a recess for entry of an extraction tool for engagement with said latch arms thereby to permit flexure of said latch arms of an individual plug, disengagement of said latch arms from said openings and extraction of said plug from its cell.

11. An electrical plug adapted for use with an electrical receptacle which is capable of receiving a plurality of identical plugs in a closely packed arrangement, said plug comprising:

a rectangular housing having a rearward end and a forward end, a forwardly facing shoulder between said rearward end and said forward end, said shoulder being adapted to serve as a stop upon mating of said plug with said receptacle,

a groove extending forwardly on each of two opposite sides of said housing, a cantilever latch arm in each of said grooves, each of said latch arms extending towards said forward end of said housing and having outwardly facing surfaces which are coplanar with the floor of said groove, said latch arms having free ends which are adjacent to said forward end of said housing and having means on said free ends for engagement with said receptacle, said latch arms being flexible laterally towards said forward end of housing to permit engagement and disengagement of said free ends of said arms with said receptacle whereby,

adjacent plugs mated with said receptacle in the same orientation will have said grooves opposite to each other to provide passageways extending towards said forward ends of said plugs, said passageways permitting entry of an extraction tool to capable of flexing said latch arms to disengage an individual plug from said receptacle.

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