US 20080272649A1

(19) **United States**

(12) **Patent Application Publication**

Order et al.

(10) **Pub. No.: US 2008/0272649 A1**

(43) **Pub. Date: Nov. 6, 2008**

(54) **ELECTRICAL CONNECTIVITY SYSTEM FOR USE IN A VEHICLE**

(75) Inventors: **Kim L. Van Order**, Hamilton, MI (US); **Eric S. Deuel**, Allendale, MI (US); **Lance M. Hilbelink**, Jenison, MI (US); **Leif Norland**, Holland, MI (US); **Scott T. Williams**, Holland, MI (US)

Correspondence Address:
FOLEY & LARDNER LLP
777 EAST WISCONSIN AVENUE
MILWAUKEE, WI 53202-5306 (US)

(73) Assignee: **Johnson Controls Technology Company**

(21) Appl. No.: **10/977,476**

(22) Filed: **Oct. 29, 2004**

Related U.S. Application Data

(60) Provisional application No. 60/515,980, filed on Oct. 31, 2003.

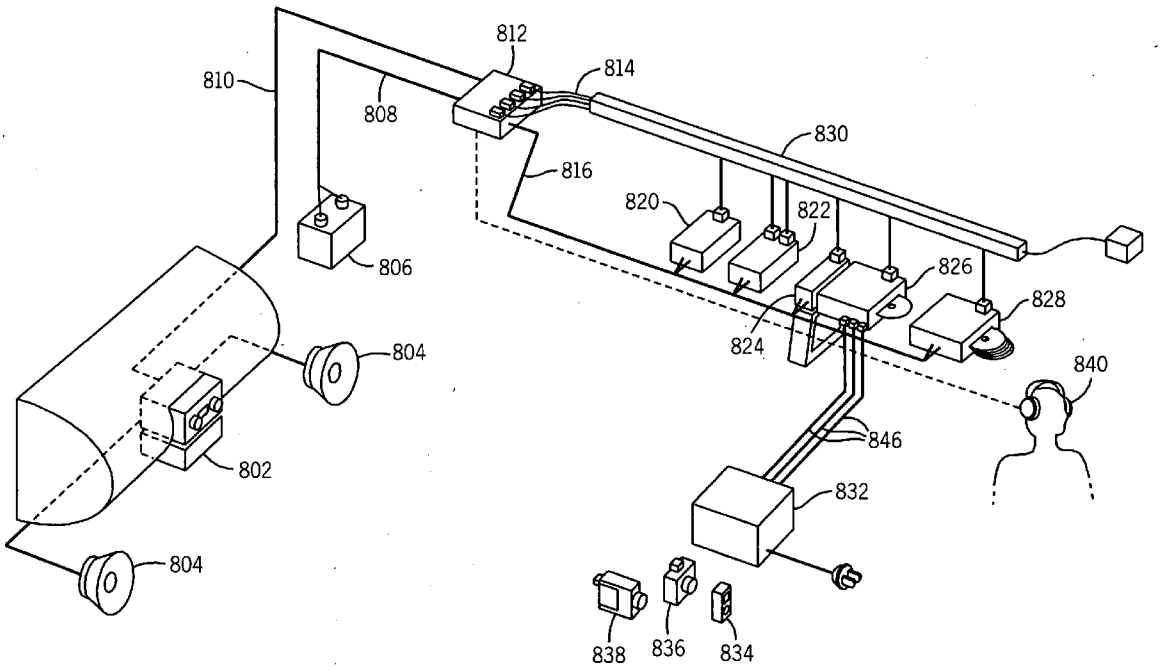
Publication Classification

(51) **Int. Cl.**
B60L 1/00 (2006.01)
G06F 13/42 (2006.01)

(52) **U.S. Cl.** **307/10.1**; 340/825

(57) **ABSTRACT**

An electrical connectivity system for use in a vehicle includes a first plurality of electrical devices a first plurality of electrical devices coupled to at least one utility carrier and a control module coupled to the at least one utility carrier. The first plurality of electrical devices are configured to communicate a plurality of utilities on the at least one utility carrier. The control module is also coupled to a second plurality of electrical devices and is configured to control the selection and distribution of the plurality of utilities to the second plurality of electrical devices. The control module includes a user interface configured to receive user input commands regarding the selection of utilities distributed to the second plurality of electrical devices. The control module and second plurality of electrical devices may be mounted to a modular system in the vehicle.



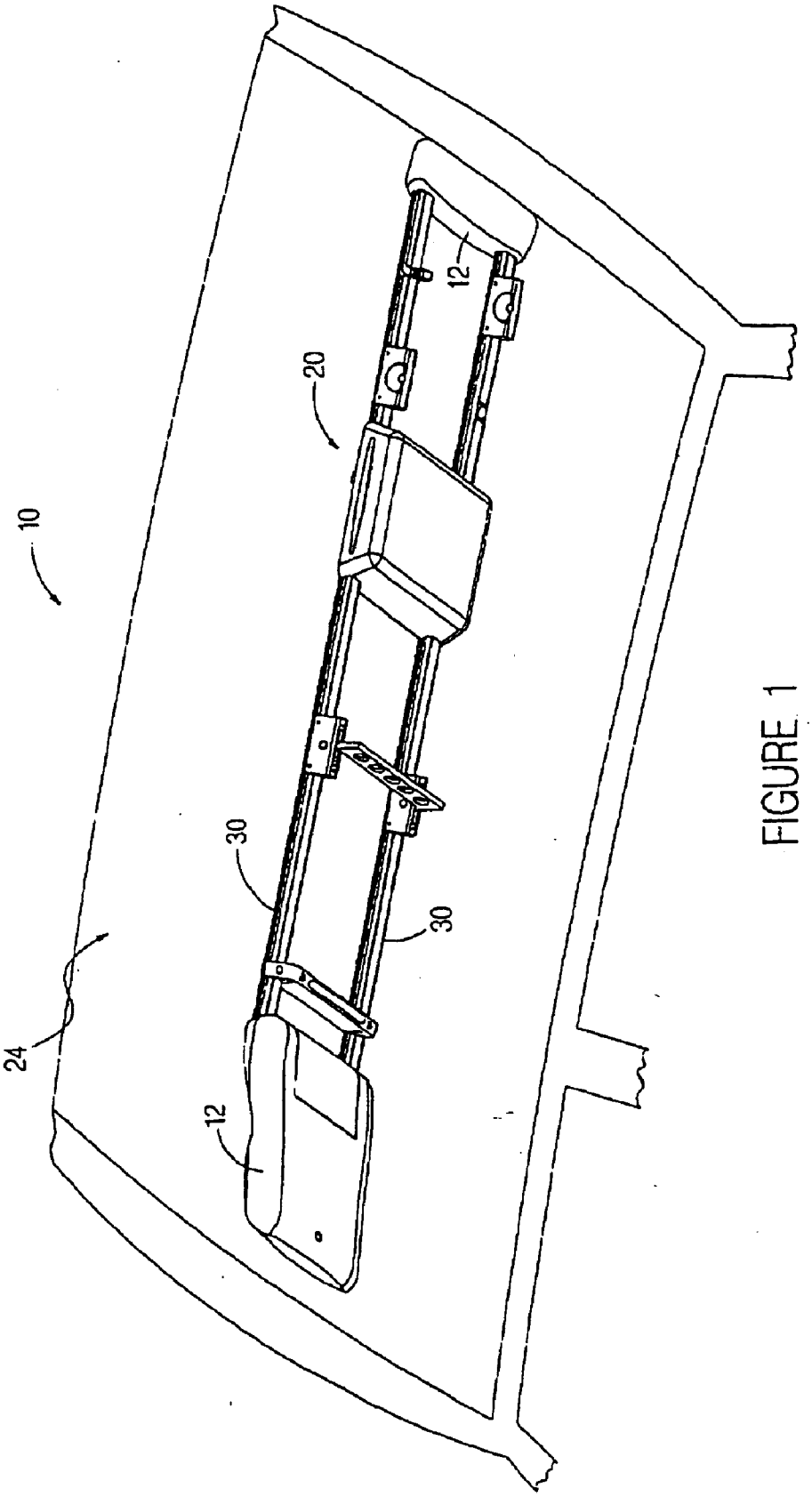


FIGURE 1

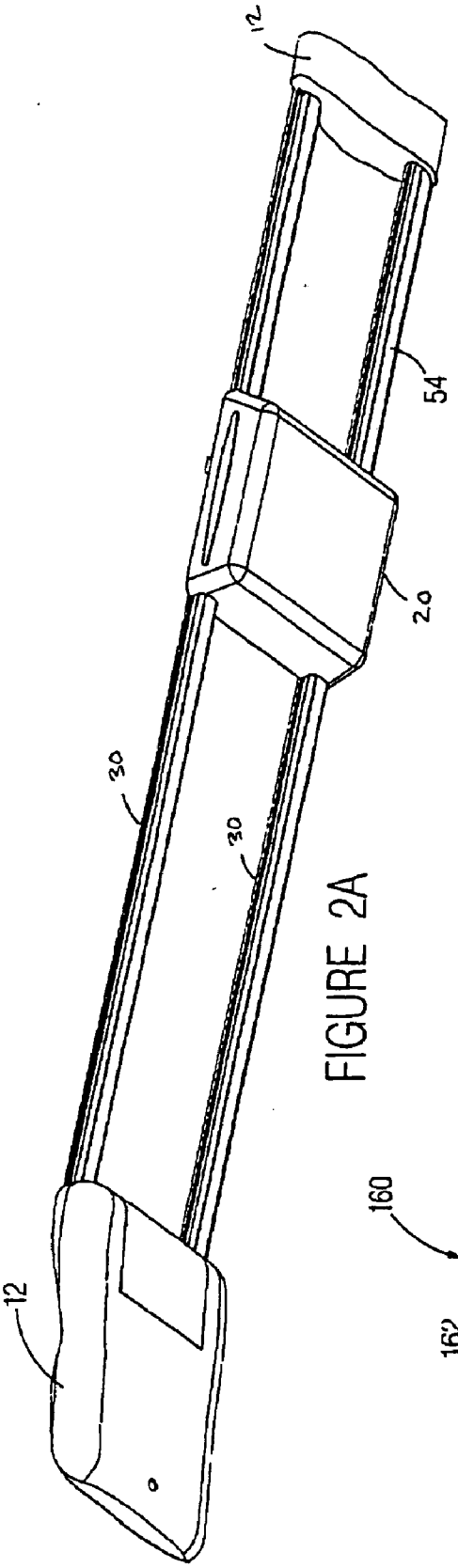


FIGURE 2A

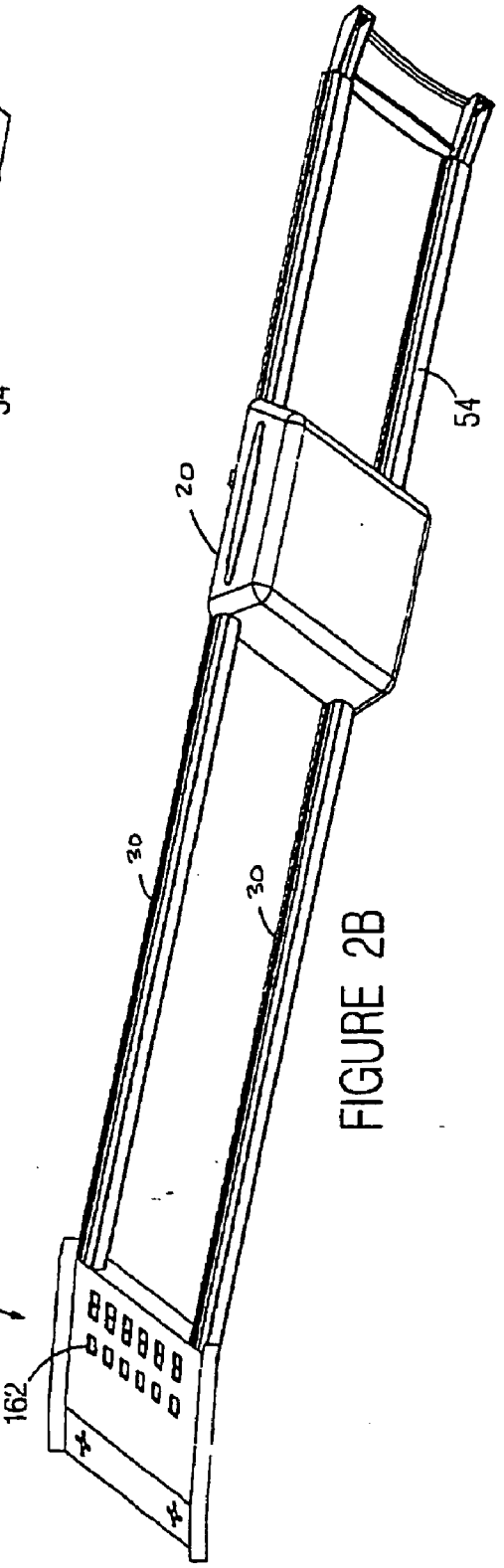


FIGURE 2B

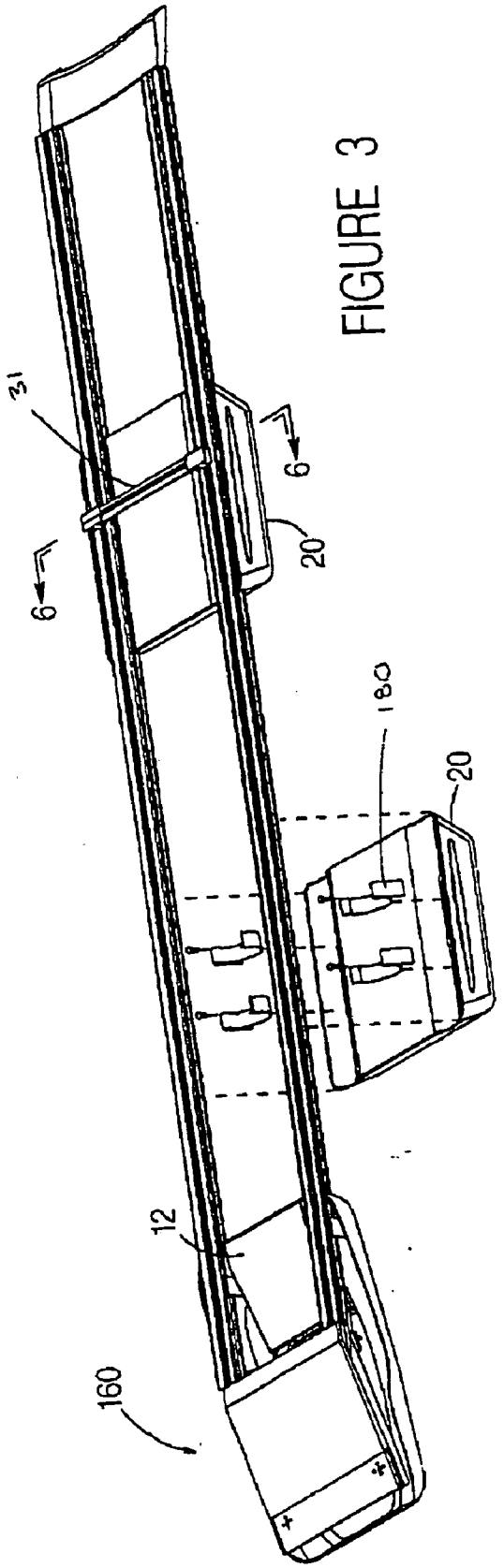


FIGURE 3

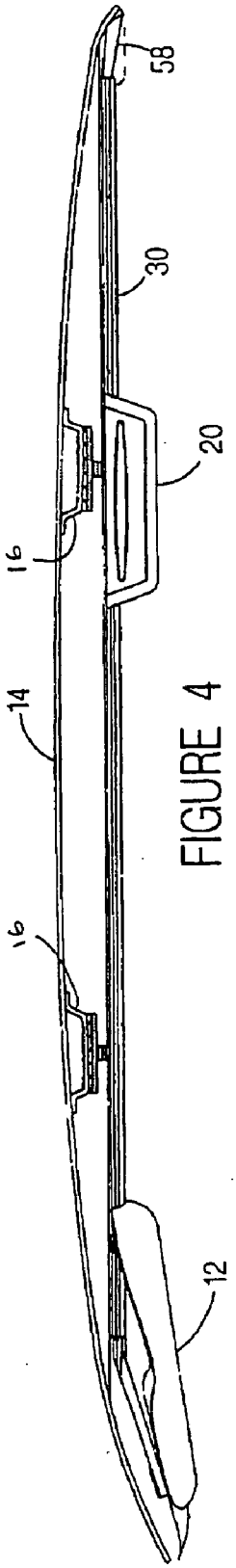


FIGURE 4

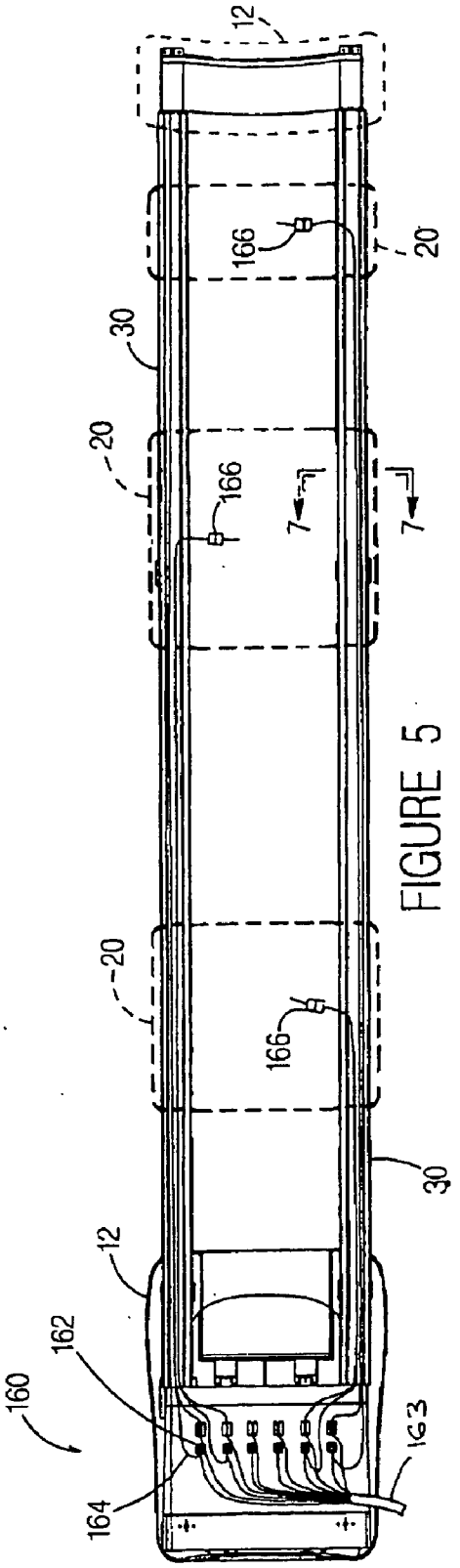


FIGURE 5

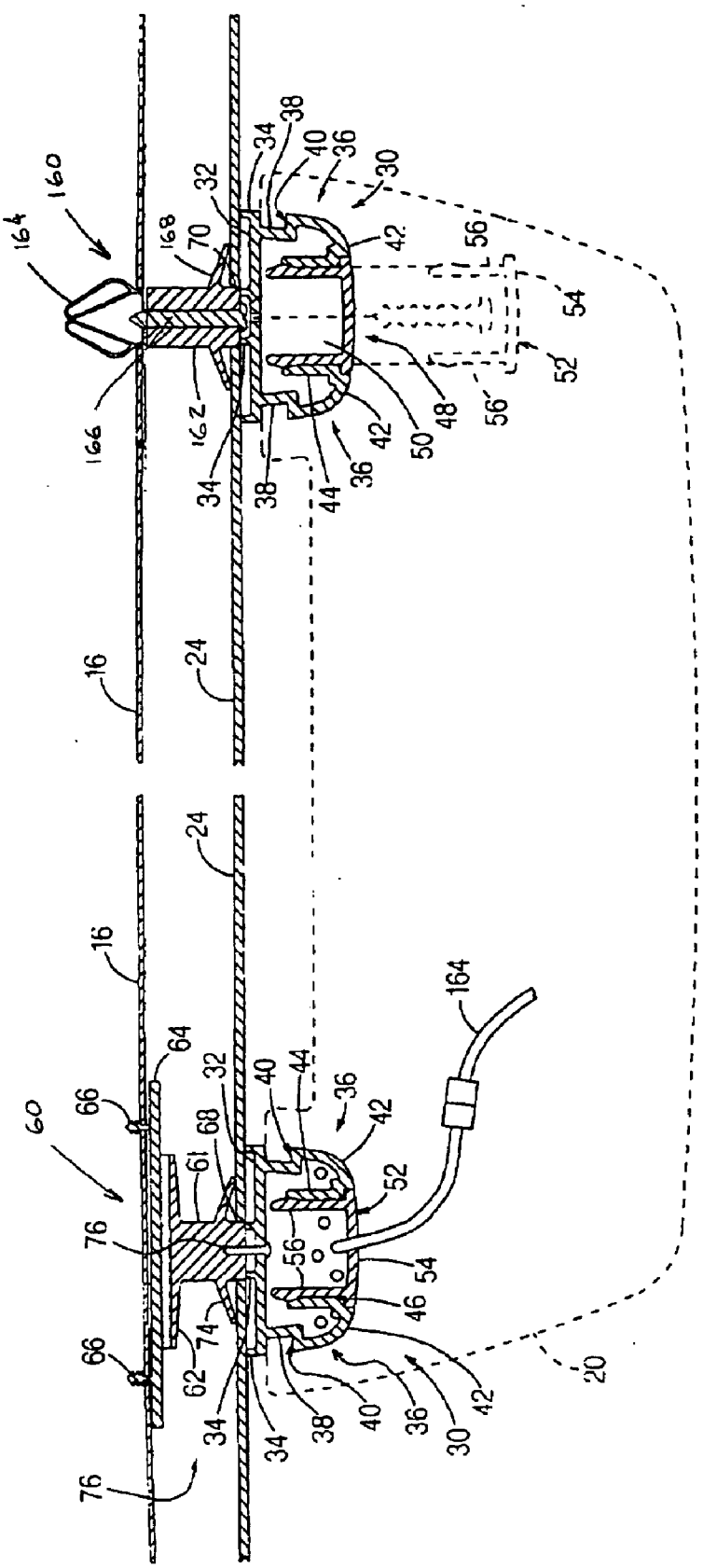

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FIGURE 6

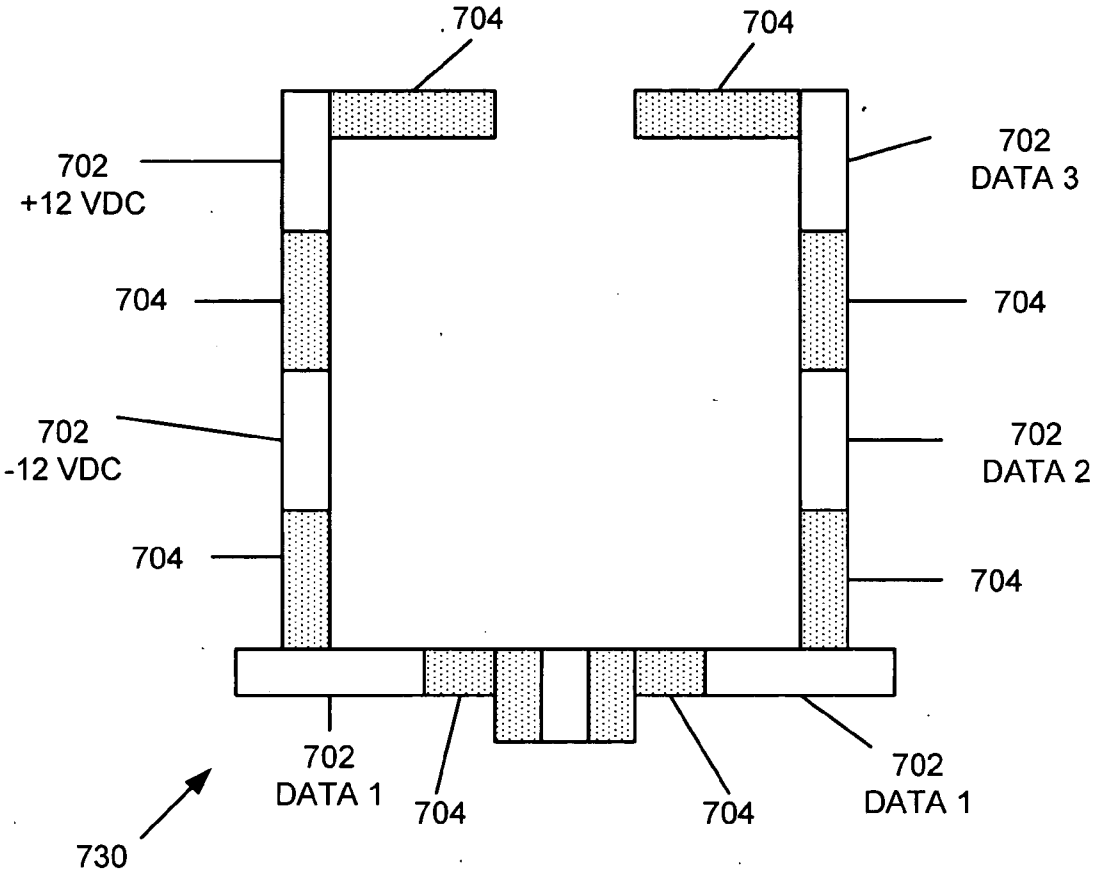
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FIG. 7A

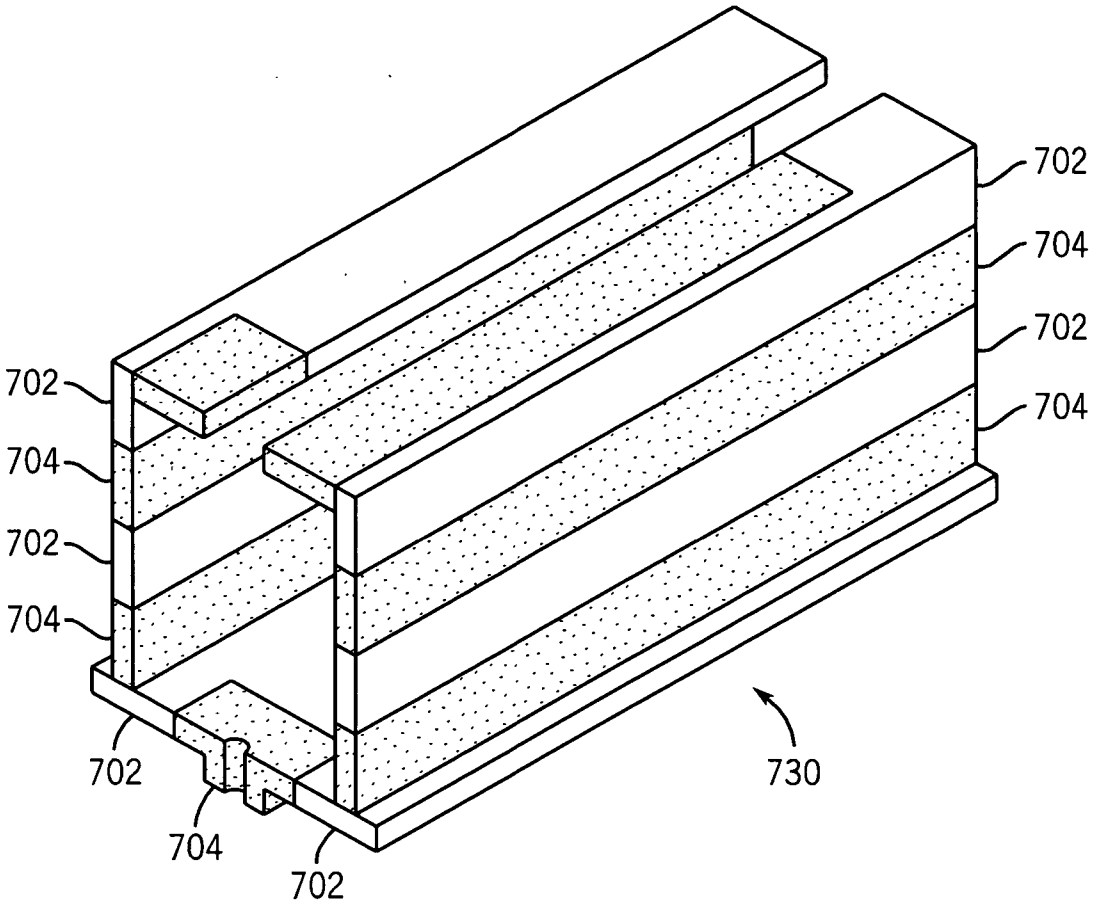

FIG. 7B

FIG. 8

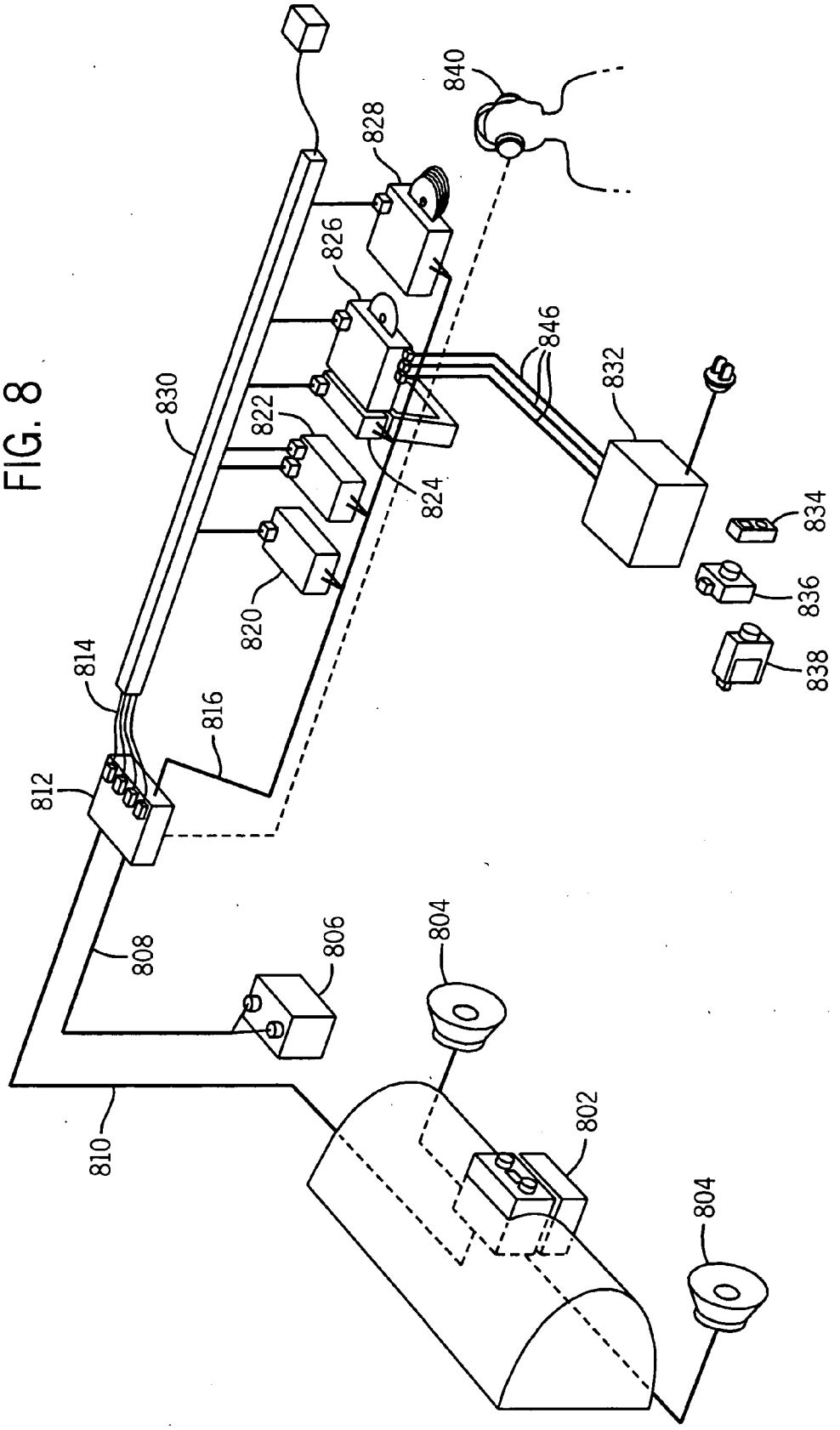
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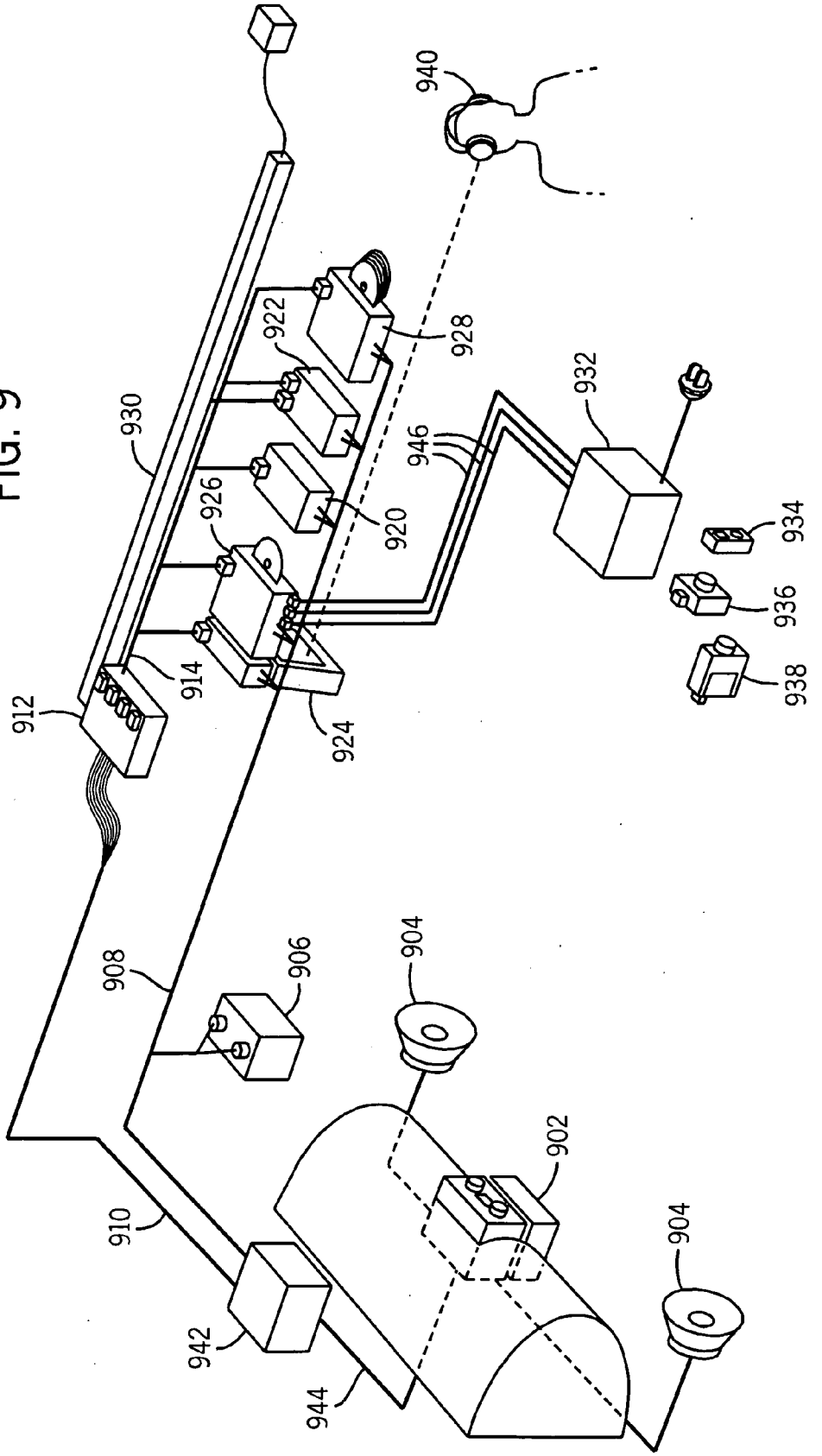
FIG. 9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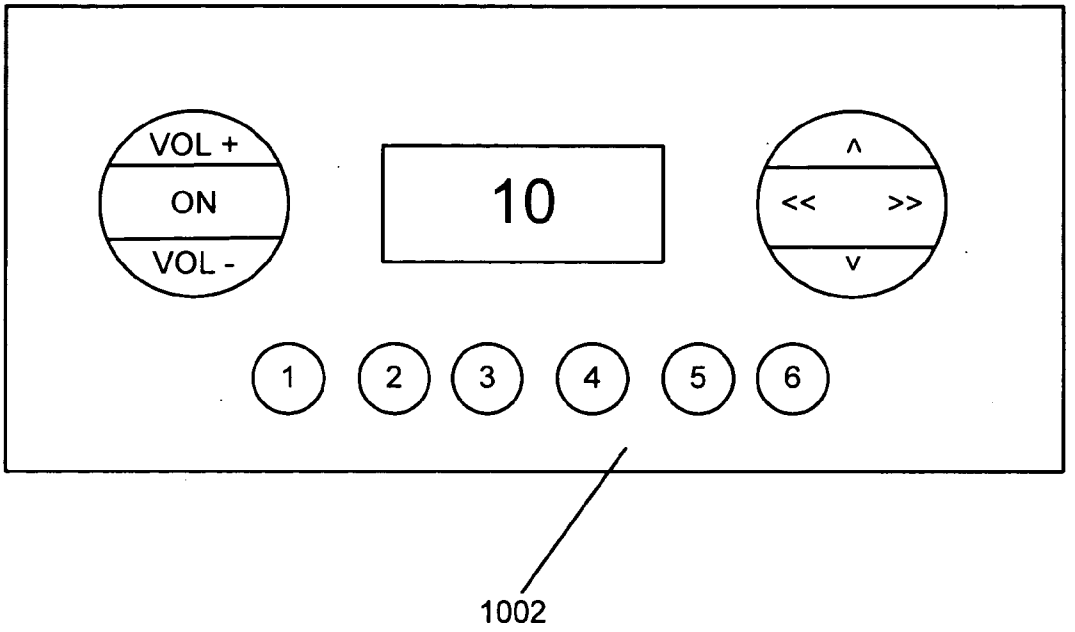

FIG. 10

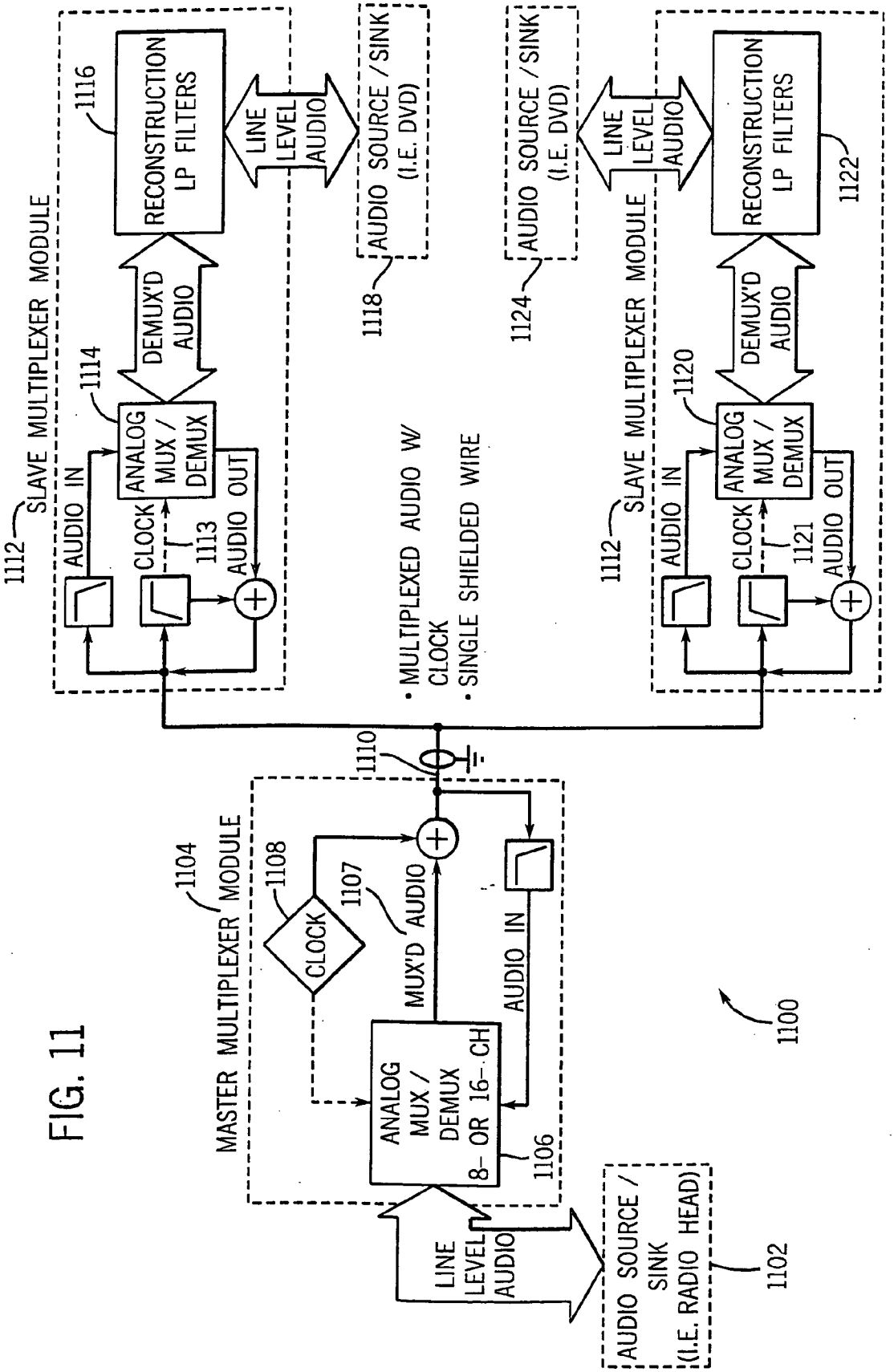
1100
1102
AUDIO SOURCE / SINK (I.E. RADIO HEAD)
LINE LEVEL AUDIO
1104
MASTER MULTIPLEXER MODULE
ANALOG MUX / DEMUX 8- OR 16- CH
1106
CLOCK
1108
MUX'D AUDIO
1107
AUDIO IN
1110
• MULTIPLEXED AUDIO W/ CLOCK
• SINGLE SHIELDED WIRE
1112
SLAVE MULTIPLEXER MODULE
AUDIO IN
ANALOG MUX / DEMUX
1114
CLOCK
1113
AUDIO OUT
DEMUX'D AUDIO
RECONSTRUCTION LP FILTERS
1116
LINE LEVEL AUDIO
AUDIO SOURCE / SINK (I.E. DVD)
1118
AUDIO SOURCE / SINK (I.E. DVD)
1124
SLAVE MULTIPLEXER MODULE
AUDIO IN
ANALOG MUX / DEMUX
1120
CLOCK
1121
AUDIO OUT
DEMUX'D AUDIO
RECONSTRUCTION LP FILTERS
1122

FIG. 11

ELECTRICAL CONNECTIVITY SYSTEM FOR USE IN A VEHICLE

PRIORITY

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 60/515,980, filed Oct. 31, 2003, titled "Electrical Connectivity System For a Vehicle," hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to electrical devices and modular systems for a vehicle and, in particular, to an electrical connectivity system for a distributing data, audio, video and command/control information to electrical devices in a vehicle and for control of electrical devices in a vehicle.

BACKGROUND OF THE INVENTION

[0003] Modular storage compartments in the forward portion of a vehicle are generally known and include consoles and structures for mounting items such as lamps, small storage compartments and electronic instrumentation such as compasses, temperature displays and clocks. Such modular systems typically have mounting configurations that permanently attach such articles to a structural portion of the vehicle, whereby installation of article options are typically conducted in a factory setting during vehicle construction and often requires user-selection of the desired articles prior to vehicle assembly, or user acceptance of preinstalled option packages. Typically, each electrical article or device attached to a modular system or located elsewhere in the vehicle is controlled separately by an occupant of the vehicle (e.g., a driver or passenger). For example, each article may include a user interface (e.g., buttons, display, etc.) used to select and/or control the operation of the article. In addition utilities (e.g., power, data, audio, video, control signals, etc.) need to be distributed to each electrical article attached to a modular system or located elsewhere in the vehicle.

[0004] Accordingly, it would be advantageous to provide a modular system for interchangeably mounting a wide array of selectively removable, user-oriented articles that are adapted for use within, or in conjunction with, a vehicle. It would also be advantageous to provide a control module that is configured to provide a single point of control and a user interface for multiple electrical articles in a vehicle, such as electrical articles mounted to a modular system. It would also be advantageous to provide an electrical connectivity system to distribute or communicate utilities such as power, data, audio, video and/or command and control signals to and/or between electrical devices in a vehicle.

SUMMARY

[0005] In accordance with an embodiment, an electrical connectivity system for use in a vehicle includes a first plurality of electrical devices coupled to at least one utility carrier, the first plurality of electrical devices configured to communicate a plurality of utilities on the at least one utility carrier and a control module coupled to the at least one utility carrier and a second plurality of electrical devices and configured to control the selection and distribution of the plurality of utilities to the second plurality of electrical devices. The control module includes a user interface configured to receive user input commands regarding the selection of utilities distributed to the second plurality of electrical devices. The second plurality of electrical devices may be mounted to a modular system in the vehicle. The control module may also be mounted to a modular system in the vehicle. The plurality of utilities may include, for example, data signals, audio signals or video signals. The control module may be further configured to control the delivery of utility signals between the second plurality of electrical devices and the first plurality of electrical devices.

[0006] In accordance another embodiment, an electrical connectivity system for use in a vehicle includes a first plurality of electrical devices coupled to at least one utility carrier where the first plurality of electrical devices are configured to communicate a plurality of utilities on the at least one utility carrier. The system also includes a control module coupled to the at least one utility carrier and a second plurality of electrical devices. The control module is configured to control the operation of each device in the second plurality of electrical devices and includes a user interface configured to receive user input commands regarding the operation of at least one device of the second plurality of electrical devices. The control module may be further configured to control the distribution of the plurality of utilities to the second plurality of electrical devices. The plurality of utilities may include, for example, power, data signals, audio signals, video signals or control signals. In one embodiment, the second plurality of electrical devices are mounted to a modular system in the vehicle. The control module may also be mounted to a modular system in the vehicle. In another embodiment, the first plurality of electrical devices includes a power source and the at least one utility carrier includes a utility carrier for power.

[0007] In accordance with yet another embodiment, a system for transmission of multiple analog audio signals in a vehicle includes a first audio device, a first multiplexer module coupled to the first audio device and configured to combine a plurality of analog audio signals into a multi-channel audio signal, a single wire audio bus coupled to the first multiplexer module and configured to carry the multi-channel audio signal provided by the first multiplexer module, and a second multiplexer module coupled to the single wire audio bus and a second audio device, the second multiplexer module configured to receive the multi-channel audio signal, separate the plurality of analog audio signals in the multi-channel audio signal and provide at least one analog audio signal to the second audio device. In one embodiment, the single wire audio bus is further configured to bi-directionally communicate analog audio signals between the first audio device and the second audio device. Each channel of the multi-channel audio signal may be defined to communicate audio signals in a direction. In another embodiment, the first multiplexer module includes a first multiplexer/demulitplexer circuit. The second multiplexer module may include a second multiplexer/demulitplexer circuit.

[0008] In accordance with a further embodiment, a method for providing electrical connections in a modular system in a vehicle, the modular system including one or more elongated members adapted to be coupled to an interior portion of the vehicle includes providing a plurality of conductive segments on each elongated member and providing a plurality of non-conductive segments on each elongated member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention will be more readily understood by reference to the following description taken with the accompanying drawings, in which:

[0010] FIG. **1** is an upward-looking perspective view of a modular system mounted on a vehicle interior in accordance with an embodiment.

[0011] FIG. **2**A is an upward looking perspective view of a modular system with end cover trim pieces in accordance with an embodiment.

[0012] FIG. **2**B is an upward looking perspective view of a modular system with end cover trim pieces removed in accordance with an embodiment.

[0013] FIG. **3** is a downward looking perspective view of a modular system in accordance with an embodiment.

[0014] FIG. **4** is a side elevation of a modular system in accordance with an embodiment.

[0015] FIG. **5** is an upward looking bottom view of a modular system in accordance with an embodiment.

[0016] FIG. **6** is a cross sectional view of a modular system along line **6-6** of FIG. **3** in accordance with an embodiment.

[0017] FIG. **7**A is a cross-sectional view of a member of a modular system with segmented electrical portions in accordance with an embodiment.

[0018] FIG. **7**B is a perspective view of a member of a modular system with segmented electrical portion in accordance with an embodiment.

[0019] FIG. **8** is a block diagram of an electrical connectivity system in accordance with an embodiment.

[0020] FIG. **9** is a block diagram of an electrical connectivity system in accordance with an alternative embodiment.

[0021] FIG. **10** shows an exemplary user interface for a control module of the electrical connectivity system of FIGS. **8** and **9** in accordance with an embodiment.

[0022] FIG. **11** is a block diagram of an analog audio transmission system in accordance with an embodiment.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] Vehicles typically include a plurality of electrical devices/articles such as a radio, a CD player, a DVD player, a clock, a compass, a navigation system, etc. These electrical devices may be located throughout the vehicle. For example, a radio may be installed at the front of the vehicle in a dashboard as part of a radio head, a DVD player may be mounted to the roof or floor of a vehicle, a CD player may be installed in a trunk or glove compartment of the vehicle, or a compass may be located in a rear view mirror of a vehicle. In addition, a modular system, such as described herein, may be provided in a vehicle for interchangeably mounting one or more selectively removable articles, including electrical articles in the vehicle. In order to operate the electrical devices in a vehicle, power must be provided to the electrical devices at various locations within the vehicle. In addition, data, audio, video and/or command and control signals may be distributed to and/or between electrical devices or articles in the vehicle. For example, the audio signals from a CD player (e.g., located in a trunk or mounted to a modular system in the vehicle) may be communicated to an audio system in the vehicle so that the sound from the CD player may be heard over the vehicle speakers.

[0024] As mentioned above, a modular system may be provided in a vehicle so that additional articles, including electrical devices, may be installed in the vehicle. Referring to FIGS. **1** and **2**, a modular system **10** for mounting one or more articles **20** is shown schematically (exemplary articles will be further described herein) along an interior panel **24** (e.g. door or side panel, cover, headliner, etc.) of a vehicle according to a preferred embodiment. System **10** may also be adapted for mounting articles **20** along the sides of the vehicle such as door or side panels, or within the interior space of the vehicle such as cargo areas, in a manner similar to the method described herein. System **10** includes two generally parallel mounting members **30** such as rails, tracks, channels, holders, bars, rods, poles, etc. that are oriented in any desired configuration within a vehicle along interior panel **24**. Members **30** have a lateral spacing that is generally fixed for a particular vehicle style, but the spacing may vary between different vehicle styles and models and may have any lateral spacing suitable for mounting articles **20**. One or more positioners **31** shown schematically in FIG. **3** may be used to secure the lateral spacing of members **30** for receiving articles **20**. For overhead applications, members **30** may be oriented longitudinally, centered laterally within the vehicle, but may be located at any lateral position on the interior panel **24** to accommodate mounting of articles **20**. In an alternative embodiment, members **30** may be separated into a forward segment and/or a rearward segment (not shown) for adapting to roof windows or other discontinuities in the roof structures. Members **30** may also be oriented laterally along interior panel **24** to increase the flexibility and utility of the system for interchangeably receiving the articles **20**. In another alternative embodiment, a single member **30** may be used in conjunction with articles **20** that are adapted to selectively and interchangeably engage a single member **30**. In a further alternative embodiment, members **30** may be mounted to pillars (not shown) or other generally vertical support columns within the interior space of a vehicle to provide a system for attaching articles **20**. Such pillars may be secured by articles mounted to the members **30** for increased flexibility in attaching articles to the pillar-mounted members.

[0025] Referring to FIG. **6**, the structural shape of members **30** are shown according to a preferred embodiment. Members **30** have a generally hollow cross sectional shape as shown in FIG. **6**, and include a generally flat base **32** (e.g. back, contact surface, etc.) on the top of member **30** with several longitudinal ribs **34** projecting therefrom. Ribs **34** are provided at the outside edges to grip the surface of interior panel **24** and a pair of ribs **34** are located centrally for alignment with connectors **160** or **60** when members **30** are secured to the roof structure. Members **30** further include integral sides **36** having a recess **38** (e.g. notch, inset, slot, groove, channel, etc.) forming an outwardly projecting supporting ledge **40** (e.g. corner, shoulder, edge, etc.). Recesses **38** and ledges **40** provide an external structure for receiving and supporting the articles **20** (shown schematically) having corresponding structure adapted to mate with ledges **40**. In a particularly preferred embodiment, ledge **40** is horizontal (as shown) and ledge **40** and recess **38** are formed having an angle of 90 degrees or less for providing a structure for receiving articles **20**. In an alternative embodiment, member **30** may have a circular cross sectional shape (not shown) or any other shape where the exterior surface is configured to provide longitudinal recesses and ledges similar to recesses **38** and ledges **40** for receiving and supporting the articles **20**. In another alternative embodiment, member **30** may have a second recess and ledge (not shown) for providing an alternative article mounting interface and providing structure adaptable for mounting interlocks that may prohibit or allow installation of certain articles along particular locations of members **30**.

[0026] Beneath ledges **40**, sides **36** include inwardly curved lower sections **42** that terminate into a return bend **44** provid-

ing internal corners **46** to create a longitudinal opening **48**. Opening **48** creates a passage **50** (e.g. channel, path, conduit, tunnel, etc.) within members **30** for routing utility carriers such as wires, cables, fiber optics, etc. as shown schematically in FIGS. **5** and **6**. A removable cap **52** is provided generally along the entire length of member **30** having a cover **54** to cover opening **48** and retain utility carriers, and may have a flush fit with member **30**, or may have projecting contours, ribs, or other decorative or useful structure (not shown). Cap **52** includes two inwardly projecting legs **56** that fit within opening **48** and are removably retained in place by an interference type, snap-fit engagement with return bends **44**. Opening **48** may be entirely or partially concealed by inserting one or more caps **52** having segments of various lengths tailored to create an access pattern within members **30**. The access pattern may be created or modified at any time for selectively providing access to opening **48** along the length of member **30**. Member **30** and cap **52** are preferably made of acrylonitrile butiadene styrene (ABS) plastic in an extrusion process, and may be provided in a wide variety of colors designed to accent an interior trim color scheme. Alternatively, members **30** and cap **52** may be made of aluminum or any other suitable material, wherein members **30** or cap **52** may also serve as a conductor for transmitting low voltage electrical power from a vehicle supply source to articles **20** mounted on members **30**. The outer surface of the aluminum members is preferably anodized which provides an insulating layer on the exterior of the member, which may be selectively removed to provide a custom-tailored electrical conductivity access pattern. Portions of members **30** and cap **52** that are not otherwise enclosed by articles **20** may also have a separate insulating cover (not shown) that snap fits into recesses **38** and ledges **40** to electrically isolate members **30** from consumer contact or inadvertent contact with an electrical ground. Members **30** and cap **52** may also be made of any other material suitable for forming an elongated support member and receiving mounting structure from articles **20** to be supported therefrom.

[0027] Referring to FIG. **4**, members **30** are secured to the vehicle according to a preferred embodiment. The ends of members **30** are rigidly attached to the forward and rearward edges of the roof frame (e.g. beams, headers, bows, cross-pieces, etc.—not shown) by welding, brazing or fastening with conventional fasteners (not shown). Members **30** may have ends attached directly to the frame, or members **30** may be attached to the roof frame via fixtures shown schematically as brackets **58**. Brackets may also be provided to support the ends of member segments that abut a roof discontinuity such as a sunroof, etc. The forward and rearward end connections of members **30** are covered by suitable trim components shown schematically as a bezel or molding **12**. Members **30** may have a side profile that is straight, or a side profile that is slightly curved or bowed (not shown) to correspond with the panel profile **14** (shown as a roof panel). In an alternative embodiment, members **30** may be secured to door panel structures (not shown) or to pillars or other support columns (not shown) within the interior of the vehicle. Such support columns may be permanently fixed to the interior vehicle structure or may be removably or retractably attached to vehicle structure such as the floor, roof or sides of the vehicle to create a modular system for attaching articles within any interior location of a vehicle.

[0028] Referring further to FIGS. **4** and **6**, a structural support system for the interior span of members **30** is shown according to a preferred embodiment. The interior span of members **30** are coupled to the roof structure of the vehicle using connectors **160** (e.g. Z-axis clips) having a spacer portion **162** with spring clip **164**. Fastener **166** may be used to secure member **30** to spacer portion **162** and for securing spacer portion **162** to spring clip **164** to ensure the structural integrity of system **10**. Spacer portion **162** may project through an aperture **70** in panel **24** to provide secure abutment with the back of member **30**, and supports **168** may project outwardly from spacer portion **162** to provide support to panel **24** around aperture **70**. Connectors **160** are attached to one or more lateral frame members **16** (e.g. beams, roof bows, door panels, floor panels, cross headers, etc.) at a lateral position along frame member **16** corresponding to the installation position of members **30**. An alternative connector type may also be used such as that shown by connector **60** in FIG. **6**. Connectors **60** have a spacer portion **61** and a base portion **62** coupled to a platform **64** that is attached to frame member **16** by finned-plugs **66** (e.g., "Christmas tree connectors") or by a structural adhesive (not shown) such as "BETAMATE 73705" which is a polyurethane adhesive manufactured by the Dow Chemical Corporation and available through Sound Alliance, LLC located in Auburn Hills, Mich. In an alternative embodiment, connectors **60** may be attached to frame member **16** by a two-piece reclosable fastener system (not shown) such as "DUAL LOCK"® having mushroom-head shaped projections and manufactured by the Minnesota Mining and Manufacturing Company, or by a nylon "VELCRO"® hook and fastener structure available from Velcro USA Inc. located in Manchester, N.H. The end of connector **60** opposite from base **62** has a pedestal section **68** that extends through aperture **70** in panel **24** to engage base **32** of members **30**. The end of pedestal **68** is configured to abut ribs **34**, and an annular projection **72** extending from the end of pedestal **68** is configured to be captured between longitudinal ribs **34** to improve lateral stability of members **30**. Connectors **60** further include supports **74** (wings, braces, arms, etc.) to support the back surface of panel **24** in the proximity of aperture **70**. In a preferred embodiment, connectors **160** and **60** are made from ABS, polycarbonate or other suitable plastic and spring clip **164** is made from heat-treated spring steel or wire, however, connectors **160** and **60** may have any shape and material composition appropriate for transferring the load from system **10** through members **30** to frame member **16**, and connector **60** may be attached to frame member **16** by any suitable means providing the appropriate tensile strength. Connectors **160** and **60** have a spacer length corresponding to the gap **76** between frame member **16** and panel **24**. Following panel **24** installation over pedestal **68** of connectors **60** in the vehicle, members **30** may be positioned over panel **24** and aligned with connectors **160** or **60**, whereby members **30** are secured by a threaded fastener or **166** or **76** through base **32** and into connector **160** or **60**. In alternative embodiments, other connector structures may be used such as solid blocks (not shown), and panel **24** may be provided without apertures **70** whereby a fastener penetrates the base, panel and the connector. In another alternative embodiment, members **30** may be bowed into a shallow arch-like profile (not shown) and installed with a compression fit between the forward and rearward ends of the roof frame, or other vehicle structure such as floor and roof panels, thus obviating or minimizing the need for mid-span connectors. Further, members **30** may be mounted against panel **24**, or alternatively panel segments may be positioned around members **30**.

[0029] Referring further to FIG. **1**, a variety of articles **20** may be mounted to members **30** according to a preferred embodiment. Articles **20** may include storage compartments (with or without key-lock access control) tailored to hold tissues, sunglasses, remote control devices, wireless phones, pagers, personal data assistants (PDA), walkie-talkies, binoculars, cameras, first aid or road-side emergency kits, tools, baby-care products and supplies, arts and crafts supplies, toys, sporting goods, books, maps, hunting and fishing equipment, and many other articles for which readily accessible storage in a vehicle may be useful. Such storage compartments may either be fixed or designed for pull-down, drop-down or rotational access where the compartment is recessed during storage and extended for access during usage. Articles **20** may also include handles, brackets, fixtures (e.g. starter block) for mounting racks, cages, or support pillars for optionally receiving members **30** to mount additional articles **20** in a cargo area, lighting equipment, power adapters and outlets, lighters; visual display screens; audio equipment; media displays; digital video disc players; GPS receivers; cargo storage racks, straps or tie-downs; garment hangers, rods or racks; insulated hot or cold-storage containers, mobile office workstation components, portable air compressors or vacuum cleaners, cargo netting and holders; occupant safety features; specially-adapted consumer-use products such as travel tables, camping gear, pet barriers, luggage, etc.; brackets having rigid, swiveling or rotating couplers for removably receiving such consumer use products; storage racks having fixed or retractable support members for storing skis or other gear; and any other articles which may be useful in conjunction with traveling, working or other vehicle use.

[0030] Articles **20** are adapted to be selectively positionable along members **30**, however, articles that may deemed to create a distraction to the vehicle operator, such as video displays and the like, are provided with a mounting interlock feature which prevents their installation in certain prohibited positions along the members, for example, allowing video monitors to be installed only in a rearward portion of the vehicle. The interlock function may be accomplished by altering the cross sectional shape or profile of a portion of the members (not shown) or providing a second recess and ledge (not shown). Particular articles **20** may be provided with a mounting profile for engaging members **30** that includes a projection (not shown) that extends into passage **50** whereby installation of a blank (not shown) within a particular portion of passage **50** along member **30** will prevent mounting such articles in the selected locations. Alternatively installation of articles may be selectively restricted by otherwise altering the profile of the members to fit only selected article mounting profiles and may be accomplished by adding a shim (not shown) along one or more sides of member **30** or in connection with the passageway of the member.

[0031] Articles **20** suitable for suspension from a single member are configured for attachment to a single member **30** by having means for releasably connecting to the recess **38** and ledge **40** on each side of a member **30**. Articles **20** that are more suitable for suspension from two members **30** are configured having a first means on one side of the article for attaching to the recess **38** and ledge **40** on one or both sides of the first member **30**, and are configured having a second means on the opposite side of the article for attaching to the recess **38** and ledge **40** on one or both sides of the second member.

[0032] Various components or methods may be used for attaching articles **20** to members **30** as described in U.S. Pat. No. 6,668,260, entitled "Modular System For A Vehicle," issued Dec. 30, 2003 and herein incorporated by reference in its entirety.

[0033] As mentioned above, electrical articles installed in the vehicle, including those mounted to the modular system **10**, are typically coupled to a power source as well as to other devices in the vehicle in order to transmit and/or receive data, audio, video and/or command and control signals. Such signals may be provided to and between electrical devices in a vehicle via a wired connection, for example, a vehicle bus. Modular system **10** may be configured to distribute power and data to/from the articles attached to members **30** of modular system **10**. Referring to FIGS. **3** and **5**, a utility interface **160** for system **10** is shown schematically according to a preferred embodiment. Interface **160** is included within the cover **12** for communicating with passageways through the roof structure (not shown) and interfacing with members **30**. Interface **160** includes a series of ports **162** (e.g. connectors, receptacles, jacks, plugs, etc.) for facilitating the interconnection of conventional utility carriers **163** (e.g. wires, cables, conductors, harnesses, etc.) for delivering utilities (e.g. electrical power, voice and data communication signals, RF transmission signals, instrumentation signals, etc.) between a supply source (not shown) and articles **20** mounted to members **30**. Utilities may be routed from the utility supply source (e.g. a battery, antenna, receiver, transmitter, etc.—not shown) through utility carriers **163** that interconnect the supply source and the ports **162** provided in interface **160**. Utility interface **160** may be provided in either the forward or rearward portion of the vehicle.

[0034] Utilities may be distributed from interfaces **160** via additional utility carriers **164** that interconnect between interfaces **160** and articles **20**. The utility carriers **164** may be distributed throughout system **10** by routing the carriers **164** through passage **50** in members **30** where the carriers **164** are concealed behind cover **54** (shown in FIG. **6**) and articles **20**. Articles **20** are mounted over members **30** and their covers segments **54**, whereby one or more gaps or other openings corresponding to access and egress locations for utilities carriers **164**, interfacing with articles **20** may be provided in cover **54**, behind article **20**, to create a utilities access pattern. The access pattern is adaptable to future changes or modifications in the article selection package by making suitable changes in the removable cover **54** of members **30**. Articles **20** and utility carriers **164** may be provided with mating connectors **166** to facilitate ease of installation, replacement or reconfiguration of articles **20** within the system **10**. Alternatively, articles **20** may be provided with a fixed length of utility carrier for routing through passage **50** to interface **160**, where the carrier includes a terminal at the outward end configured for directly connecting with interface **160**. To provide additional flexibility in distributing utilities to various articles, an article **20** may be configured to serve as a utility storage or junction box for housing additional utility distribution devices or components and for storing excess quantities of utility carrier that may be desirable for accommodating future changes to the article selection package.

[0035] Alternatively, as mentioned above with respect to FIGS. **5** and **6**, a low-voltage electrical power in the range of approximately 12-42 volts DC or other suitable voltage range for powering articles **20** may be routed to articles **20** via members **30**, where members **30** are fabricated entirely or

partially from aluminum or other electrically conductive material. Members **30** may also be fabricated from a non-conducting material such as plastic, where a conducting material such as copper or aluminum is integrally formed with member **30** in the shape of a longitudinal conducting strip, rail or bar (not shown) to provide a uniform electric current access path from interface **160** to articles **20**. Such conducting material may be affixed to member **30** by ultrasonic welding, molding, interference-type snap insert, or vacuum metallization. Articles **20** are provided with an electrically conductive contactor (not shown) that projects outwardly from a surface of article **20** and is configured to contact member **30** or a conducting strip thereon (not shown) and remains concealed between member **30** and article **20** when article **20** is installed on member **30** to provide a conductive electrical path to article **20**. The contactor may be spring-biased for urging the contactor into continuous contact with member **30** or a conducting strip when article **20** is mounted on members **30**. In a preferred embodiment where a system with two parallel members are used, one member **30** would have a positive electrical polarity (i.e. battery potential) and the second member **30** would have a negative electrical polarity (i.e. ground). For embodiments using a single member, two longitudinal conducting strips (not shown) may be used on member **30** to provide positive and negative conductors, corresponding to appropriately positioned contactors on an article **20** configured to mount to a single member **30**.

[0036] As mentioned previously, member(s) **30** may be fabricated entirely or partially from aluminum or other electrically conductive material and therefore act as a conductor for transmitting low voltage electrical power from a power source to articles mounted on members **30**. Alternatively, other utilities may also be provide by a conductive member **30**. One method to provide electrical connections to an article mounted to parallel members, as discussed above, involves providing one member with a positive electrical polarity (i.e. battery potential) and providing the second member with a negative electrical polarity i.e., ground). Alternatively, conducting strips may be used on a member **30** to provide positive and negative conductors. In another embodiment, a member or members is provided with segmented electrical portions corresponding to various electrical utilities (e.g., power, data, etc.). FIG. **7**A is a cross-sectional view of a member of a modular system with segmented electrical portions in accordance with an embodiment. FIG. **7**B is a perspective view of a member of a modular system with segmented electrical portions in accordance with an embodiment.

[0037] Referring to FIG. **7**A, member **730** includes multiple electrical segments or portions **702** that each may provide electrical connections such as positive electrical polarity (e.g., +12 VDC), ground (e.g., −12 VDC), data signals (e.g., DATA**1**, DATA**2**, DATA**3**), etc.. Portions **704** of member **730** are non-conductive. Accordingly, multiple electrical connections may be provided on member **730**. A single member or multiple members (e.g., parallel members) may each be configured to include multiple electrical portions **702**. Each electrical portion **702** may be formed by extruding a dielectric material over portions of the conductive member **730**. The dielectric material may be a polymer such as Poly Vinyl Chloride (PVC), ABS, a blend of polymers, or other appropriate polymer. The non-conductive portions **704** of member **730** may be, for example, fabricated from a non-conducting material or a non-conducting material or insulating cover may be provided to isolate the conductive material of member **730** from contact with an article. Electrical portions **702** may extend along the entire length of member **730** as shown in FIG. **7**B. In an alternative embodiment, electrical portions **702** may be divided into segments along the length of member **730** in order to control which areas of member **730** is provided with power or other utilities. Alternatively, the electrical portions **702** may not run continuously along the entire length of the member **730**, but only along certain portions of the entire length of member **730** (e.g., at positions on member **730** where an article may be located). As discussed above, it may de desirable to prevent the installation of certain articles (or any articles at all) in certain positions along members **730**. For example, an article that may be deemed a distraction to the vehicle operator such as a video monitor may only be only be allowed to be installed in a rearward portion of the vehicle. Segments of electrical portions **702** may be selectively powered or an encoding may be implemented to identify whether an article may be connected at a particular location along the rail (i.e., to prevent unauthorized connection). A processor may be coupled to member **730** (e.g., a control module **812** as described in further detail below) to selectively power electrical portions of rail and/or to determine if an attached article has the proper code.

[0038] An article that may be mounted to member **730** will include contact points configured to contact the appropriate electrical portions **702**. A member **730** with electrical portions **702** may be used to provide the multiple electrical circuit connections for various utilities for an article. The cross-sectional shape of member **730** shown in FIGS. **7**A and 7B is exemplary and it should be understood that electrical segments or portions **702** may be provided for a variety of cross-sectional shapes of member **730**.

[0039] Returning to FIGS. **3** and **5**, in another embodiment, conducting strips may be used as an article positioning interlock along members **30** by altering the conducting strip longitudinal position along member **30** to provide a power interlock profile. The power interlock profile ensures that contactors for certain articles will properly interface with the conducting strips only when articles are installed at locations on members **30** corresponding to a mating conducting strip position. For example, video display articles may have contactors positioned to match a conducting strip position corresponding only to a location rearward of the front seats of the vehicle. Similarly, other consumer articles that may create a distraction to a vehicle operator may be electrically interlocked so that they are operable only when installed in positions that are pre-established by the power interlock profile. Insulating cover segments (not shown) may be provided that are adapted to cover portions of members **30** that remain exposed after installation of the article selection package to prevent consumer exposure or electrical shorts to ground with the energized portions of system **10**.

[0040] Each article **20** installed on modular system **10** as well as devices located elsewhere in the vehicle is typically controlled separately (e.g., using a user interface of each article or device) by an occupant of the vehicle. FIG. **8** is a block diagram of an electrical connectivity system for use in a vehicle in accordance with an embodiment. Conventional utility carriers **808**, **810** (e.g., wires, cables, conductors, harnesses, fiber optics, etc.) are used to deliver utilities (e.g., power, data, audio, video and/or command and control signals) between a supply source (e.g., radio head **802**, power source **806**) and articles mounted on members **830**. Radio

head **802** includes an audio system (e.g., a radio, speakers **804**, etc.) that is coupled to a utility carrier (e.g., an audio bus, a vehicle bus **942** (shown in FIG. **9**)). Accordingly, information and signals from other devices in the vehicle that are coupled to the utility carrier may be accessed by radio head **802**. Utility carrier **810** is coupled to radio head **802** and is configured to carry utilities such as data, audio, video, command signals, etc. between radio head **802** and a control module **812**.

[0041] Control module **812** is coupled to members **830** of a modular system and a power source **806**. Preferably, control module **812** is in a location visible and accessible to a driver of the vehicle, however, control module **812** may also be mounted in other locations in the vehicle (e.g., accessible to other vehicle occupants). Power source **806** (e.g., a battery) is connected to control module **812** via a conventional utility carrier **810**. In an alternative embodiment, shown in FIG. **9**, power source **906** is not coupled to a control module **912**, but is coupled directly to the modular system (e.g., members **930** and/or articles coupled to the modular system) via a utility carrier **908**. In other words, power is not directed through the control module **912** to the modular system. Returning to FIG. **8**, radio head **802** (and/or vehicle bus **942** shown in FIG. **9**) and control module **812** are configured to communicate via utility carrier(s) **810**.

[0042] Power or data received by control module **812** from utility carriers **808**, **810**, respectively, are distributed from (or to) control module **812** via utility carriers **814** and **816** to (or from) articles (e.g., rear HVAC **820**, XM radio **822**, display **824**, DVD player **826** and CD player **828**) installed on members **830**. Utility carriers **814**, **816** interconnect between control module **812** and the articles mounted on members **830**. As mentioned above, utility carriers **814**, **816** may be distributed throughout the modular system by routing the carriers through a passage **50** (shown in FIG. **6**) in members **830**, where the carriers are concealed behind a cover **54** (shown in FIG. **6**) and the articles. Articles are mounted to members **830** and may access utility carriers **814**, **816** via, for example, one or more gaps or openings corresponding to access and egress locations for utility carriers **814**, **816**. As described above with respect to FIGS. **3** and **5**, the articles and/or the utility carriers may be provided with a connector to facilitate installation.

[0043] Other electrical devices that are not installed or mounted to the vehicle, such as a video game system **832**, an MP3 player, a digital camera **836** or a digital video camera **838**, may be used in conjunction with an article, such as DVD player **826** and display **824**, that is installed or mounted in the vehicle. As shown in FIGS. **8** and **9**, an auxiliary input **846**, **946** (e.g., a utility carrier) may be used to connect, for example, a video game system **832**, **932** to DVD player **826**, **926** and display **824**, **924**. In another embodiment, control module **812** (**912** shown in FIG. **9**) may be used as a conduit for communication between any articles located in the vehicle, including articles not mounted to a modular system but located elsewhere in the vehicle. Accordingly, control module **812**, may be used to facilitate article to article communication in the vehicle. For example, a CD player mounted in a trunk may be coupled, either wired or wirelessly, to control module **812** which may be used to communicate, for example, audio or control signals between the CD player and a vehicle audio system.

[0044] Control module **812** is configured to allow a user to select an article or device mounted to the modular system to be operated and to control the operation of the selected article. For example, a user may select to operate a DVD player **826**. Control module **812** preferably includes a user interface (not shown) from which a user may provide command and control functions. FIG. **10** shows an exemplary user interface **1002** for control module **812**. A user can control functions of the selected device such as Play, Stop, Volume, Disk/Track change, etc. using the user interface (e.g., buttons or switches) of control module **812**. Accordingly, control module **812** provides a single user interface and point of control and access from which a vehicle occupant (e.g., a driver) can control all of the electrical devices or articles mounted to members **830** of the modular system. As mentioned previously, control module **812** may also be used to control the communication between articles in the vehicle that are not mounted to the modular system. Control module **812** may also be configured to control or select the distribution of utilities to articles in the vehicle. For example, control module **812** may provide a single point of access (or a gateway) for the articles on the modular system to the radio head **802** or other in-vehicle devices. All of the audio outputs of the articles mounted to members **830** are connected to control module **812** via utility carrier(s) **814** or wireless communication. Accordingly, a user can select which device or article is being heard over the vehicle speakers **804**. In another embodiment, control module **812** may be configured to simultaneously broadcast a plurality of audio signals from the plurality of articles. The audio signals may be broadcast, e.g., by RF, IR or wired connections, to headphones **840** in the vehicle. Each set of headphones **840** includes a user interface (e.g., buttons, switches, a dial) to select one of the audio signals (e.g., channel A, B, or C) being simultaneously, broadcast in the vehicle cabin be control module **812**. A user may, therefore, select an audio signal from one of a plurality of sources to listen to on headphones **840**.

[0045] Control module **812** may be a stand alone module mounted to members **830** as shown in FIG. **8** or alternatively, control module **812** may be incorporated into another article. Control module may include various types of control circuitry, digital and/or analog, and may include a microprocessor, microcontroller, application-specific integrated circuit (ASIC), or other circuitry configured to perform various input/output, control, analysis, and other functions described herein. Utility carrier(s) **814** may be operated in accordance with a known standard or protocol that enables data, audio, video and command/control signals to be distributed to/from control module **812** to the articles mounted to members **830** so that the articles may be controlled from control module **812**, for example, a CAN or LIN network. In an alternative embodiment, utilities (e.g., audio, command signals, control signals, etc.) may be transmitted wirelessly between control module **812** and articles (e.g., DVD player **826**, Rear HVAC **820**) using known wireless transmission protocols, for example, Infrared (IrDA), Bluetooth, Wireless LAN (IEEE 802.11) or 900 MHz FHSS. Accordingly, control module **812** and an article mounted to the modular system may be configured to communicate wirelessly.

[0046] Various articles (e.g., XM radio **822**, a navigation system, etc.) mounted in the vehicle, such as on a modular system, may include a display for providing display information. However, if the article is mounted in the rear of the vehicle, the display information would not be visible to the driver of the vehicle. Accordingly, control module **812** may be configured to receive display information from an article and

provide such display information on a display of the control module interface (as shown in FIG. **10**). Alternatively, the display information may be provided to another display in a viewable location in the front of the vehicle. Control module **812** may also be configured to provide other features, for example, an audio muting feature that allows an operator to mute the system audio (e.g., over the vehicle speakers or headphones) or a synchronization feature that provides synchronization between audio and video channels.

[0047] As mentioned previously, various utilities including audio signals may be distributed between electrical articles or devices in a vehicle via conventional utility carriers (e.g., audio signals may be sent between a CD player in the trunk and the radio head or between an article on a modular system and the radio head). Due to the location of electrical devices throughout a vehicle, utilities, such as analog audio signals, may need to be transmitted over a distance in the vehicle, for example, from a rear seat device to a radio head at the front of the vehicle or through a modular system to the radio head. A system for transmitting multiple analog audio signals may include multiple wires, analog to digital and digital to analog converters and a multimedia digital data bus (e.g., IDB-1013 or MOST).

[0048] The system **1100** shown in FIG. **11** allows the transmission of a plurality of analog audio signals to multiple devices or articles in a vehicle. An analog multiplexer/demultiplexer is used to combine a plurality of analog audio signals (or channels) onto a single wire **1110** routed to multiple articles or devices in the vehicle. In one embodiment, up to sixteen analog audio channels are combined onto the single wire **1110**. Preferably, wire **1110** is a shielded wire that acts as the physical audio bus. The system reduces the size of the wire bundles required to distribute analog audio signals to devices throughout the vehicle. In addition, A/D converters, D/A converters and multimedia digital data buses are not required for transmission of the analog audio signals.

[0049] An audio source **1102** (e.g., a radio head) is coupled to a master multiplexer module **1104**. Audio source **1102** provides analog audio signals to and receives analog audio signals from master multiplexer module **1104**. Master multiplexer module **1104** is coupled to a single shielded wire **1110** that is coupled to multiple slave multiplexer modules **1112**. Preferably, each slave multiplexer module **1112** is coupled to other audio sources (or devices) **1118**, **1124** (e.g., a DVD player) in the vehicle which would communicate audio signals with the radio head. Master multiplexer module **1104** and slave multiplexer modules **1112** act as interfaces between the audio sources **1102**, **1118**, **1124** and the single wire audio bus **1110** used for transmission of analog audio signals between audio devices.

[0050] Master multiplexer module **1104** includes an analog multiplexer/demultiplexer circuit **1106** that is used to combine separate audio signals together in a single multi-channel signal **1107**. A clock signal **1108** is generated by master multiplexer module **1104** and is used to synchronize the slave multiplexer modules **1112**. The multiplexed audio signals **1107** are summed with the clock signal **1108** and sent on the single wire audio bus **1110**. Multiplexer/demultiplexer circuit **1106** may also receive analog audio signals from the single wire audio bus **1110** and may be used to separate out audio signals that may be provided to audio source **1102**.

[0051] Multiplexed audio signals transmitter on the single wire audio bus **1110** are received at a slave multiplexer module **1112**. At a slave multiplexer module **1112**, the clock signal and multiplexed analog audio signals are separated using high pass and low pass filters (not shown). Once the clock and multiplexed audio signals are separated, an analog multiplexer/demultiplexer circuit **1114**, **1120** is used to separate out the audio signals. Low pass reconstructions filters **1116**, **1122** may be applied to each audio signal to remove noise associated with the sampling and multiplexing process. The audio signal(s) may then be provided to an audio device **1118**, **1124**. The multiplexer/demultiplexer circuits **1114**, **1120** in the slave multiplexer modules **1112** may also receive audio signals from an audio source **1118**, **1124** to be transmitted on the single wire audio bus **1110**. As discussed above, multiple audio signals may be combined by multiplexer/demultiplexer circuit **1114**, **1120** into a single multi-channel signal that is summed with the clock signal **1113**, **1121** before being sent on the single wire audio bus **1110**.

[0052] In another embodiment, the system **1100** may be configured to be bi-directional so that audio signals may be sent in both directions (e.g., to/from the radio head) on the same wire. This would allow, for example, audio to be provided from the radio head to an article mounted on a modular system or vice versa so that a passenger could have the option to listen to either the vehicle radio or the article mounted to the modular system on, for example, a set of headphones. In order to transmit audio signal bi-directionally on the same wire **1110**, each channel would be defined as one direction or the other.

[0053] It is important to note that the construction and arrangement of the electrical connectivity system and modular system and devices as shown in the preferred and other exemplary embodiments are illustrative only. Although only a few embodiments of the present invention have been described in detail in this disclosure, those skilled in the art who review this disclosure will readily appreciate that many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter recited herein. Accordingly, all such modifications are intended to be included within the scope of the present invention as described herein. The order or sequence of any processes or method steps may be varied or re-sequenced according to alternative embodiments. Other substitutions, modifications, changes and/or omissions may be made in the design, operating conditions and arrangement of the preferred and other exemplary embodiments without departing from the exemplary embodiments of the present invention as expressed herein.

We claim:

1. An electrical connectivity system for use in a vehicle, the system comprising:

a first plurality of electrical devices coupled to at least one utility carrier, the first plurality of electrical devices configured to communicate a plurality of utilities on the at least one utility carrier; and

a control module coupled to the at least one utility carrier and a second plurality of electrical devices, the control module configured to control the selection and distribution of the plurality of utilities to the second plurality of electrical devices, the control module having a user interface configured to receive user input commands regarding the selection of utilities distributed to the second plurality of electrical devices.

2. A system according to claim 1, wherein the second plurality of electrical devices are mounted to a modular system in the vehicle.

3. A system according to claim 1, wherein the control module is mounted to a modular system in the vehicle.

4. A system according to claim 1, wherein the plurality of utilities includes at least one of data signals, audio signals or video signals.

5. A system according to claim 1, wherein the control module is further configured to control the delivery of utility signals between the second plurality of electrical devices and the first plurality of electrical devices.

6. An electrical connectivity system for use in a vehicle, the system comprising:

a first plurality of electrical devices coupled to at least one utility carrier, the first plurality of electrical devices configured to communicate a plurality of utilities on the at least one utility carrier; and

a control module coupled to the at least one utility carrier and a second plurality of electrical devices, the control module configured to control the operation of each device in the second plurality of electrical devices, the control module having a user interface configured to receive user input commands regarding the operation of at least one device of the second plurality of electrical devices.

7. An electrical connectivity system according to claim 6, wherein the second plurality of electrical devices are mounted to a modular system in the vehicle.

8. An electrical connectivity system according to claim 6, wherein the control module is mounted to a modular system in the vehicle.

9. An electrical connectivity system according to claim 6, wherein the first plurality of electrical devices includes a power source.

10. An electrical connectivity system according to claim 9, wherein the at least one utility carrier includes a utility carrier for power.

11. An electrical connectivity system according to claim 6, wherein the plurality of utilities includes at least one of data signals, audio signals, video signals or control signals.

12. A system for transmission of multiple analog audio signals in a vehicle, the system comprising:

a first audio device;

a first multiplexer module coupled to the first audio device and configured to combine a plurality of analog audio signals into a multi-channel audio signal;

a single wire audio bus coupled to the first multiplexer module and configured to carry the multi-channel audio signal provided by the first multiplexer module; and

a second multiplexer module coupled to the single wire audio bus and a second audio device, the second multiplexer module configured to receive the multi-channel audio signal, separate the plurality of analog audio signals in the multi-channel audio signal and provide at least one analog audio signal to the second audio device.

13. A system according to claim 12, wherein the single wire audio bus is further configured to bi-directionally communicate analog audio signals between the first audio device and the second audio device.

14. A system according to claim 13, wherein each channel of the multi-channel audio signal is defined to communicate audio signals in a direction.

15. A system according to claim 12, wherein the first multiplexer module includes a first multiplexer/demulitplexer circuit.

16. A system according to claim 12, wherein the second multiplexer module includes a second multiplexer/demulitplexer circuit.

17. A method for providing electrical connections in a modular system in a vehicle, the modular system including one or more elongated members adapted to be coupled to an interior portion of the vehicle, the method comprising:

providing a plurality of conductive segments on each elongated member; and

providing a plurality of non-conductive segments on each elongated member.

18. A method according to claim 17, wherein the plurality of conductive segments are formed by providing a conductive material on an elongated member at each conductive segment.

19. A method according to claim 17, wherein the plurality of non-conductive segments are formed by providing a non-conductive material on an elongated member at each non-conductive segment.

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