

**FLEXIBLE AND LIGHTWEIGHT SEAT-TO-SEAT CABIN CABLE SYSTEM  
AND METHOD OF MANUFACTURING SAME**

This application claims priority to U.S. provisional patent application Serial No.

5 60/718,547, filed September 19, 2005.

**TECHNICAL FIELD**

The present invention relates to a cable system construction and method of manufacture and in particular, to a cable system that is relatively lighter in weight and more flexible than conventional cables used in such applications as the cabin of an airplane or other  
10 vehicles, for transmitting data and power.

**BACKGROUND ART**

Typically in buses, trains, aircraft, etc., multiple rows of seats are provided and arranged so as to provide a walkway or aisle. Rows of seats are disposed on each side and along the length of such an aisle or walkway.

15 The passenger seats provide a variety of electronic functions such as on aircraft where in-flight entertainment provides audio programming, video programming and communication systems such as telephone service. To convey the power and data signals needed to and from all of the passenger seats, fixed length cables or wiring harnesses are typically used to electrically couple one row of seats to another row of seats.

20 A change in distance between the rows of seats typically requires replacement of the fixed length cables with those having the correct length for the new configuration. This is a time-consuming and expensive operation. Moreover, the spacing between seat rows is not always consistent throughout the aircraft or vehicle.

The tight physical conditions through which such cables must be installed and/or  
25 removed in and around such rows of seats makes the use of cables that are not flexible and have a relatively high stiffness and weight per unit length undesirable for seat-to-seat cabling

in such applications as commercial aircraft.

To address the difficulties of fixed length cable assemblies in vehicles such as aircraft, applicant has invented the Adjustable Length Cabling System disclosed in PCT patent application no. PCT/US2005/010289, the contents of which are herein incorporated by  
5 reference.

### **SUMMARY OF THE INVENTION**

The lightweight, greater flexibility and decreased size of the cabin cable system of the present invention provide advantages in such applications as the cabin of commercial airlines.

10 Both the lower weight of the cabin cable and the ability to store extra cable (allowing a flexible length system) result in a significant weight savings for commercial airlines. This weight savings can mean lower fuel costs and can also result in the economic advantage of being able to carry more freight on that airliner.

The increased flexibility and smaller diameter of the cabin cable of the present  
15 invention as compared to traditional cables provides advantages as well. A tighter bend radii than conventional cables allows for facilitated installation in tighter spaces. As a result, space constraints in the usually overcrowded passenger cabin installations are alleviated so as to reduce the time normally needed for installation and/or replacement thereof.

Multiple signals can be carried through a single cable of the present invention so that  
20 a single assembly can handle such systems as an in-flight entertainment system, a communication system such as an in-flight phone, and/or in-seat power supply systems.

Fine stranded wire, Litz wire, or non-Litz wire may be used, which meets the voltage, temperature and flammability requirements of commercial aircraft such as FAA FAR 25.869, as well as the specifications and regulations of JAA and CAA, and is ISPSS compliant. Litz  
25 wire serves to minimize weight and maximizes mechanical flexibility -- while meeting the environmental requirements associated with commercial aircraft. For example, a seventy-

five inch long cabin cable of the current invention may weigh approximately 0.78 lbs., while the same length conventional, commercial aircraft seat-to-seat cabling may weigh approximately 1.16 lbs.

5 The outer jacket surrounding the multi-conductor cable is preferably a high temperature braided fabric such as nylon so as to: provide the desired high degree of mechanical flexibility; be lightweight; and meet the stringent environmental requirements of a commercial aircraft.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheets of  
10 drawings, wherein like reference numerals refer to like parts.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1A is a perspective partial view of a prior art cable installation.

Fig. 1B is a perspective partial view of an adjustable length cable system of the  
15 present invention

Fig. 1C illustrates a row of passenger seats.

Fig. 2 is a cross-sectional view of one embodiment of a cable of the present invention.

Fig. 3 is a cross-sectional view of an individual Litz wire bundle taken along its  
length.

20 Fig. 4 is a cross-sectional view of another embodiment of a cable of the present invention.

Fig. 5 is a side elevational view of the cable of Fig. 4 having four conductors.

Fig. 6 is a cross-sectional view of a power cable of the present invention.

Fig. 7 is a side elevational view of the power cable of Fig. 6.

25 Fig. 8 is a cross-sectional view of a harness cable of the present invention.

Fig. 9 is a side elevational view of the harness cable of Fig. 8 wherein the data cable is

separated from the power cable.

Fig. 10A is a schematic diagram of a harness and connector assembly of the present invention.

Figs. 10B and 10C are side elevation views of the assembly of Fig. 10A.

5 Fig. 11A is a schematic diagram of a harness and connector assembly of the present invention.

Figs. 11B and 11E are side elevation views of the assembly of Fig. 11A.

Figs. 11C and 11D illustrate two charts directed to the use of a 7-pin and a 10-pin connector in the harness and connector assembly of Fig. 10A or 11A.

10 Fig. 12A is a schematic diagram of a power cable and connector assembly of the present invention.

Figs. 12B and 12C are side elevation views of the assembly of Fig. 12A.

Figs. 12D and 12F are enlarged views of the 7-pin connection of one embodiment of a power cable.

15 Fig. 12E illustrates a chart directed to the use of a 7-pin connection in the power cable and connector assembly.

Fig. 13A is a schematic diagram of a data cable and connector assembly of the present invention.

Figs. 13B and 13D are side elevation views of the assembly of Fig. 13A.

20 Figs. 13C and 13E are enlarged views of the ends of 10-pin connections.

Fig. 13F illustrates a chart directed to the use of a 10-pin connector to the data cable and connector assembly.

### **DETAILED DESCRIPTION OF THE DRAWINGS**

25 While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail several specific embodiments,

with the understanding that the present disclosure is to be considered merely an exemplification of the principles of the invention and the application is limited only to the appended claims.

Typically cabin cables are installed below the seats 11 in a commercial airplane, as shown in Figures 1A to 1C. An adjustable length cable system of is shown as 10 in Figure 1B. While the row of seats depicted in Figure 1C shows three adjacent seats, any other number of seats could be used and not depart from the scope of the present invention. Furthermore, while Litz wire is shown and disclosed, it is appreciated that other types of wires, including but not limited to bare copper wires, coated copper wires or silver wires, may be used and not depart from the scope of the present invention.

A cross-section of one embodiment of the cabin cable 20 of the present invention is shown in Figure 2. In one embodiment, individually insulated strands of Litz wire are used to maximize flexibility and minimize weight. Individual Litz wire bundles 21 may then be insulated with a thin insulating material such as Teflon®. One or more of the Litz wire bundles are grouped together into a cable. A thin jacketing layer such as Teflon® jacketing 23, in this example 3 mil, may be provided around this bundle. A nylon braiding or other suitable layer of high temperature braiding material 24 is then used to surround the bundles of Litz wire 21. Some of the Litz wire bundles may be grouped together and surrounded by conductive shielding 22, such as 38 AWG tinned copper or other suitable conductive shielding. The thin jacketing layer of Teflon® may be provided around the shielding.

An individual Litz wire bundle 21 is shown in longitudinal cross-section in Figure 3 with twisted wire conductors 25 that may be covered by a thin layer (e.g., 3 mil layer) of Teflon® as a Teflon jacket 23, which is then covered by braiding 24.

Another embodiment of the data cable for the present invention 40 is shown in Figures 4 and 5. In this embodiment, four conductors 425 comprise 26AWG conductors of

Litz wire, with each conductor 425 having a different color from among such colors as red, blue, yellow and green. Double shielding 426 is provided around the four conductors 425 and comprises, in one embodiment, 38AWG tinned copper with an inner shield minimum of 90% coverage and an outer shield minimum of 85% coverage. Outside the double shielding  
5 426, a thin Teflon® jacket can be applied. Outside all of the foregoing is braid 424. The desired cable characteristics include passing FAA FAR 25.869 for flammability, a temperature limit of 200°C and a voltage rating of 600VAC.

Figures 6 and 7 show another embodiment of a power cable 60 comprising five bundles of stranded Litz wire bundle of 16AWG conductors 627 and one Litz wire bundle of  
10 24AWG conductors 628. In one embodiment, the single Litz wire bundle conductor 628 is preferably white, while the five Litz wire bundle conductors 627 are each preferably provided in one of the following colors: black; red; blue; yellow and green. The. A Teflon® jacket 623 of about 3 mil can be provided around the Litz wire bundled conductors 627 and 628. Around all of the foregoing is the braid 624.

15 An embodiment of a seat-to-seat power and data harness cable 80 is shown in Figures 8 and 9 having a 26AWG, 100 Ohm Litz wire bundle data cable 825, together with five 16AWG stranded Litz wire conductors 827 and one 24AWG Litz wire conductor 24. These six Litz wire bundles 827 and 828 can be bundled by Teflon® jacket 826 such as, but not limited to, a 3 mil Teflon® layer. Braid 824 surrounds Teflon® jacket 826 and bundled  
20 conductors 827 and 828. Cabling is preferably done in a planetary manner, so as to be as round as possible.

The voltage reading as for the other cables described herein is preferably 600 VAC. The temperature rating, as with the other cables, is at least 200°C. The flammability standard, as with all the cables described herein, is that it must pass FAA FAR 25.869.

25 As shown in Figure 9, Data Cable bundle 825 may be separable from power cable

portion 827/828 in Cable 80.

Harness and connector assembly 90 is shown in Figures 10 and 11. Data portion 92 ends in connectors 93 while power portion 91 ends in connectors 94. Referring to Fig. 11C, the chart 96 for a 10-pin connector 93 shows how the pins shown and numerically labeled in  
5 Figures 11B and 11E may be assigned. The chart 95 for a 7-pin connector 94 shown in Figure 11D shows how those pins may be assigned.

Figures 12 and 13 show a power cable and connector assembly 120 and a data cable and connector assembly 124 respectively. In the embodiment shown, power cable 122 ends in 7-pin connectors 121. Chart 123 of Figure 12 shows how the pins of 7-pin connector 121  
10 shown and numerically labeled in the enlarged images shown in Figures 12D and 12F are used. With respect to data cable 124, chart 130 shows how the pins of 10-pin connector 125 shown and numerically labeled in the enlarged images of Figures 13C and 13E may be assigned.

The cabin cable of the present invention can be manufactured in the following  
15 preferred process. Individual wire strands are formed from the multi-stranded Litz wire or other copper, copper alloy or other comparable conductive wire. Such individual wire strands are then coated with insulating material, such as wire coating enamel or resin insulation. These multiple wire strands are formed into wire bundles of the desired size by a planetary cable wrapping system or other suitable cable-forming machinery. A very thin  
20 insulating material such as wire coating enamel or resin is then extruded over the bundles of wire strands. The bundles of wire strands are then twisted and/or shielded into cable assemblies as required. Though optional, a very thin insulating material can also be extruded over these cable sub-assemblies. The groups of wires are then formed into cable bundles. As an option, a very thin insulating material such as for example, a 3 mil layer of Teflon®  
25 jacketing material can be extruded over the finished cable subassemblies.

The cable is then measured and cut to length and prepared for braiding or other final outer jacket material. The ends of the individual wires are then prepared for connectorization and the individual wires are connectorized with terminals. The terminals are placed into the appropriate locations in the connector housings. The connector backshells and/or strain  
5 reliefs are then completed and the cable markings and codes are then added.

Although certain example methods, apparatus and methods of manufacture are described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

We claim:

1. A cable comprising:
  - one or more bundles of conductive wire comprising multiple strands;
  - each of the strands of the conductive wires being individually coated with an
- 5 insulation layer;
  - said bundles of conductive wire being covered by a layer of wire jacketing
- material; and
  - said one or more bundles of cable being further covered by a nylon braiding
- material.
- 10 2. The cable of claim 1 wherein said insulation layer comprises a Teflon coat.
3. The cable of claim 1 wherein said jacketing material comprises a Teflon coat.
4. The cable of claim 1 wherein said conductive wires are color coated.
5. The cable of claim 1 wherein said conductive wires comprise Litz wire.
6. The cable of claim 1 further comprising a conductive shield surrounding at
- 15 least one of said one or more bundles.
7. The cable of claim 1 wherein said cable comprises a power cable comprising
- five bundles of 16AWG conductors and one bundle of 24AWG conductors.
8. The cable of claim 7 wherein said 16AWG conductors comprise different
- colors selected from the set of black, red, blue, yellow and green.
- 20 9. The cable of claim 8 wherein said 24AWG conductor is white.
10. The cable of claim 1 wherein said conductive wires are selected from the
- group consisting of bare copper wires, coated copper wires and silver wires.
11. The cable of claim 1 wherein said cable comprises a bundle data cable, five
- stranded wire conductors and one 24AWG wire conductor.
- 25 12. The cable of claim 1 wherein said bundles of conductive wires comprises a

data cable bundle and a power cable bundle.

13. The cable of claim 12 wherein said data cable bundle is separable from said power cable bundle.

14. The cable of claim 1 wherein said braiding comprises nylon braiding.

5 14. A method for manufacturing a cable comprising:

- forming individual wire strands from flexible wire cable;
- coating said individual wire strands with insulating material;
- forming multiple wire strands into wire of desired sizes;
- extruding very thin insulating material over bundles of wire strands;
- 10 - twisting and/or shielding the wires into cable subassemblies;
- forming groups of wires into cables;
- coating the cables with a jacketing layer;
- measuring and cutting the cable to length and preparing for braiding or other

final outer jacket material; and

15 - covering prepared cables with braiding or other outer jacket material.

16. The method of claim 15 which further comprises the steps of:

- preparing ends of individual wires for connectorization;
- connectorizing individual wires with terminals; and
- placing terminals into appropriate locations in connector housings.

20 17. The method of claim 15 wherein said flexible wire cable is selected from the group consisting of: Litz wire, bare copper wires, coated copper wires and silver wires.

18. The method of claim 15 wherein said jacketing layer comprises Teflon.

19. The method of claim 15 wherein said insulating material comprises Teflon.

20. The method of claim 15 wherein said cables comprise a power cable.

21. The method of claim 15 wherein said cable comprises a power and data harness cable.