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Schumacher

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[54] **MINIATURE COAXIAL CABLE ASSEMBLY**

[75] Inventor: **William Ludlow Schumacher,** Camp Hill, Pa.

[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

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[21] Appl. No.: **208,955**

Related U.S. Application Data

[63] Continuation of Ser. No. 106,468, Jan. 14, 1971, abandoned.

[52] **U.S. Cl.** ..... **174/105 R,** 174/36, 174/113 R, 174/117 F

[51] **Int. Cl.** **H01b 7/08**

[58] **Field of Search** ..... 174/117 R, 117 F, 174/117 FF, 115 G, 105 R, 113 R, 36, 103, 102 R; 333/96, 84 M, 84 R; 156/47, 51, 52, 53, 54, 55, 56; 29/624

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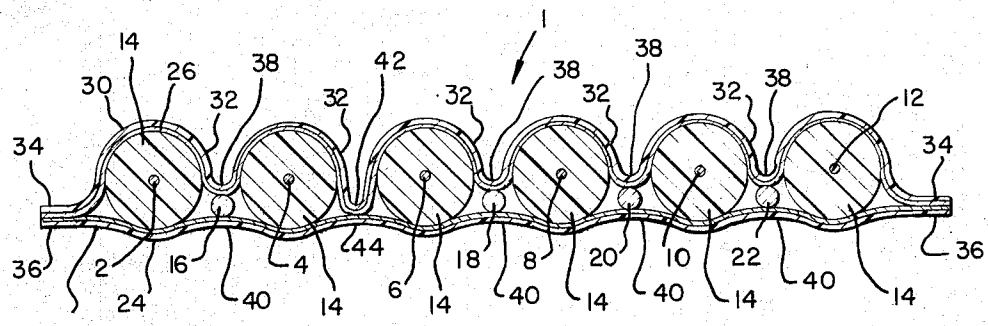
Primary Examiner—Bernard A. Gilheany
Assistant Examiner—A. T. Grimley
Attorney—William J. Keating et al.

[57] **ABSTRACT**

The present invention relates to a miniature flexible coaxial cable assembly and a method of fabricating the same wherein a plurality of continuous, individually sheath dielectric covered coaxial cable center conductors are located in parallel spaced relationship with their longitudinal axes substantially coplanar. A plurality of continuous drain wires are distributed among the center conductors with their longitudinal axes being coplanar, but offset from the coplanar center conductor longitudinal axes. The center conductors and drain wires are sandwiched between ribbons of conductive foil which are provided thereover with a continuously applied layer of insulation material. The assembly is then bonded along a plurality of lines of contact extending longitudinally of the continuous wires. If the insulation layer is applied by continuous extrusion, such bonding will additionally result in a protective jacket for the assembly.

8 Claims, 5 Drawing Figures



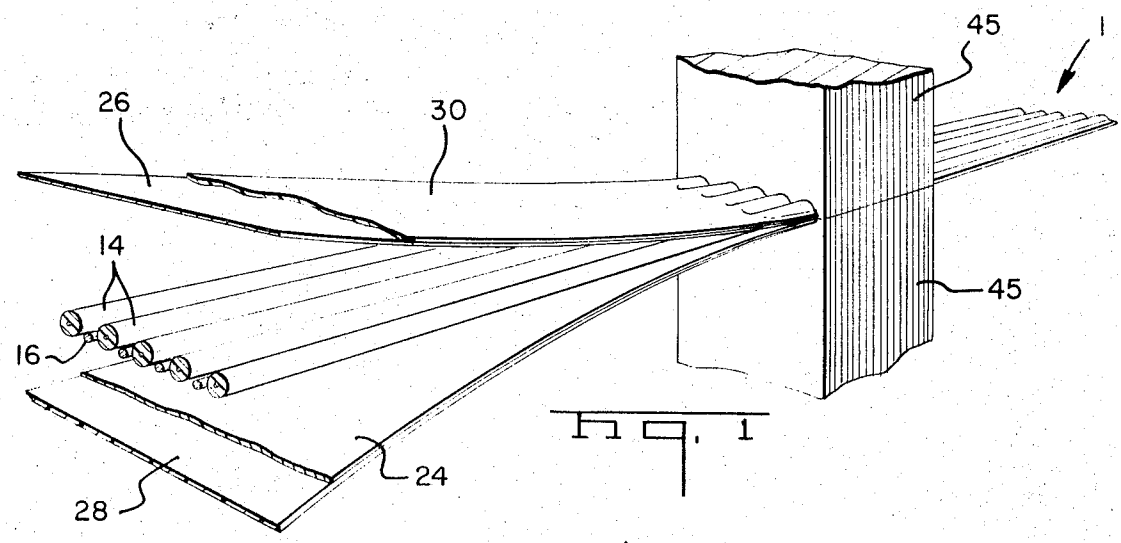


Fig. 1

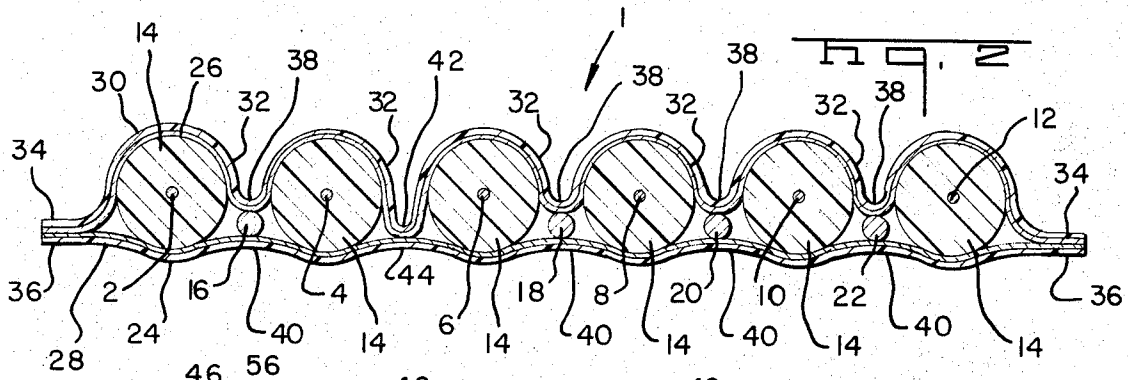


Fig. 2

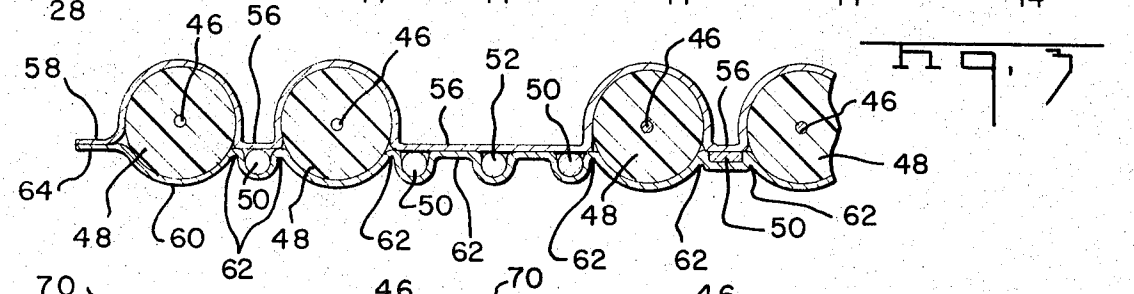


Fig. 3

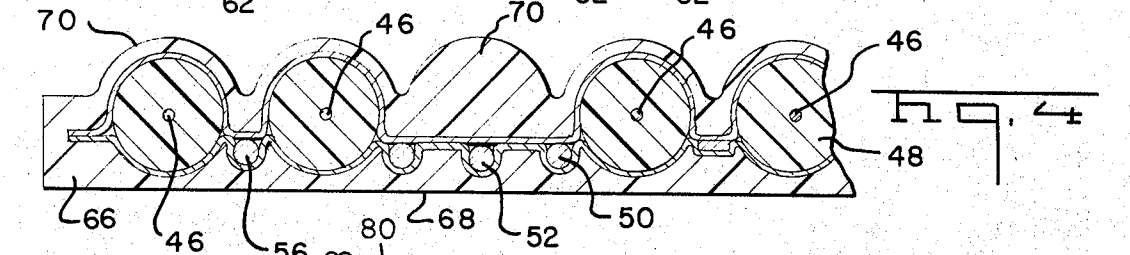


Fig. 4

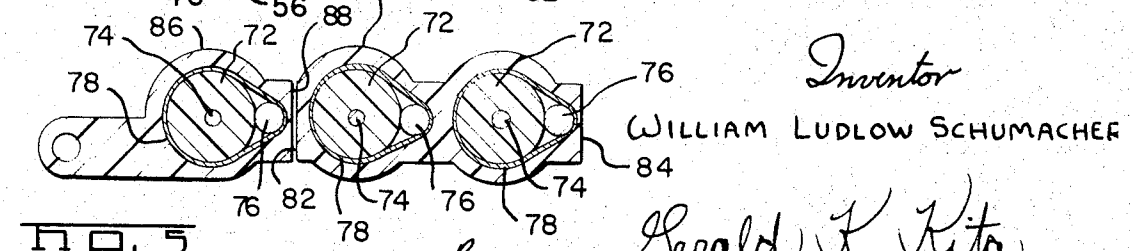


Fig. 5

Inventor
WILLIAM LUDLOW SCHUMACHER

By: Gerald K. Kita

MINIATURE COAXIAL CABLE ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation application of application, Ser. No. 106,468, filed Jan. 14, 1971 now abandoned.

FIELD OF THE INVENTION

The present invention relates to a flexible coaxial cable assembly including a plurality of coaxial cables having a common ground and provided with individual drain wires, which assembly may be miniaturized and the coaxial cables located on precisely located center spacings.

BACKGROUND OF THE PRIOR ART

There has been a long existing need in the prior art for miniaturized coaxial cables on precisely located center spacings. Due to a requirement for miniaturization, difficulty is experienced in stripping the coaxial cables of surrounding insulation and outer conductor material. It is often desired to associate a separate drain wire with a miniature coaxial conductor, with the result that difficulty in stripping the coaxial conductor is further aggravated by a need for searching for the end of the drain wire before stripping it of insulation.

SUMMARY OF THE INVENTION

The present invention alleviates the difficulties present in the prior art and provides a miniaturized, flexible coaxial cable assembly which is readily stripped of surrounding insulation and outer conductor material. The assembly according to the invention is further provided with a plurality of individual drain wires which are easily located in the assembly and are readily stripped of insulation. The assembly according to the invention is advantageously fabricated by a continuous process wherein the coaxial conductors and drain wires are sandwiched between layers of a conductive foil and, either simultaneously, or subsequently provided thereover with a continuously applied layer of insulation material. The assembly is bonded together by a continuous process along selected lines of contact extending longitudinally of the parallel center conductors and drain wires. The foil layers advantageously provide a common potential conductive shielding for the coaxial cables in the assembly.

OBJECTS OF THE INVENTION

It is therefore an object of the present invention to provide a flexible assembly of coaxial conductors on precisely located center spacings with unshielded drain wires associated therewith.

Another object of the present invention is to provide an article of continuous manufacture including precision spaced coaxial conductors provided with a common potential shielding.

A further object of the present invention is to provide a miniaturized coaxial cable assembly utilizing a plurality of coaxial conductors and unshielded drain wires.

A further object of the invention is to provide a cable assembly of a plurality of coaxial conductors having a plurality of drain wires, located adjacent to a surface of the assembly and relatively recessed with respect to an opposed surface of the assembly.

Still another object of the present invention is to provide a coaxial cable assembly including a plurality of coaxial conductors and drain wires, all precisely spaced and located in the assembly and readily stripped of insulation material.

Still a further object of the invention is to provide a coaxial cable assembly with a plurality of coaxial conductors sandwiched between conductive layers and insulation layers which are bonded along lines of contact located between adjacent coaxial conductors and adjacent the locations of drain wires in the assembly.

Other objects and many attendant advantages of the present invention will become apparent upon perusal of the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic perspective illustrating the method of assembling a coaxial cable assembly according to the present invention;

FIG. 2 is an enlarged detail cross section of a preferred embodiment of a coaxial cable assembly according to the present invention;

FIG. 3 is an enlarged fragmentary detail cross section of a modification of the preferred embodiment shown in FIG. 2, and further illustrating the coaxial cable assembly prior to application of outer insulation layers thereon; and

FIG. 4 is an enlarged detail fragmentary cross section of the preferred embodiment illustrated in FIG. 3, provided thereover with layers of one selected type of insulation material.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With more particular reference to FIG. 2 of the drawing, there is illustrated generally at **1**, a coaxial cable assembly including a plurality of parallel spaced coaxial cable center conductors **2, 4, 6, 8, 10** and **12,** each individually surrounded by a continuous cylindrical dielectric sheath **14.** Any desired plurality of conductors may be provided, even though six are illustrated in detail. The assembly **1** also includes a plurality of parallel spaced conductors or drain wires **16, 18, 20** and **22.** The drain wires are selectively distributed among the adjacent spaced coaxial conductors **2–12,** and are of circular cross section. However, the drain wires **16–22** may be of any desired cross section configuration.

As shown in FIG. **2,** the drain wire **16** is selectively provided between the spaced pair of coaxial conductors **2** and **4.** The drain wire **18** is selectively disposed between the spaced coaxial conductors **6** and **8.** The drain wire **20** is disposed adjacent to the single coaxial conductor **10.** The drain wire **22** is disposed adjacent to the single coaxial cable conductor **12.** Thus, the drain wires may be selectively distributed between adjacent pairs of coaxial conductors or associated with but a single coaxial conductor. Additionally, no drain wire is shown between the spaced coaxial conductors **4** and **6.** Thus, any desired distribution of the drain wires may be effected without departing from the scope of the invention. The center conductors **2–12** and the distributed drain wires are sandwiched between layers **24** and **26,** respectively, of a conductive material, such as metal foil in continuous ribbon configurations. To complete the assembly, the foil layers **24** and **26** are respectively provided thereover with layers **28** and **30** of an electrical insulation material which may also be of continuous ribbon configurations. The conductive foil layers **24** and **26** provide a common electrical shielding

for all of the coaxial conductors within the assembly, and the insulation layers **28** and **30** electrically insulate the assembly. As shown in the assembly, the longitudinal axes of the coaxial cables are coplanar and positioned on precisely located center spacings. The longitudinal axes of the drain wires within the assembly are also coplanar but offset from the coplanar axes of the center conductors. The layers **26** and **30** of the assembly are provided with alternate raised portions overlying the center conductors and recessed portion **32** overlying each of the distributed drain wires, with the conductive layer **26** contacting each drain wire along a line of contact extending longitudinally of each drain wire. Thus the layers **26** and **30** provide one surface of the assembly with corrugations formed by the raised and recessed portions **32.** The layers **24** and **28** comprise an opposed surface of the assembly with the conductive layer **24** contacting each of the distributed drain wires along a line of contact extending longitudinally of each drain wire. In the resultant assembly, the drain wires are substantially recessed with respect to the surface formed by the layers **26** and **30,** and are located substantially adjacent to the opposed surface formed by the layers **24** and **28.**

To complete the assembly, the layers **26, 30, 24** and **28** are bonded together at their respective longitudinal side margins **34** and **36** along a continuous line of mutual contact. Additionally, the layers **30** and **34** are bonded to each of the drain wires along a line of contact **38** extending longitudinally of each drain wire. The layers **24** and **28** are bonded to each drain wire along a line of contact **40** along the longitudinal axis of each of the distributed drain wires. Additionally, the layers **26** and **30** are bonded to the layers **24** and **28** along lines of contact **42** and **44** between adjacent coaxial conductors where no drain wire is provided. Bonding along such lines of contact is accomplished by ultrasonic welding techniques, for example. However, it should be understood that other bonding techniques may be utilized. The completed assembly comprises a plurality of precisely spaced coaxial connectors with distributed drain wires precisely located substantially adjacent one surface of the assembly. The locations of the center conductors and drain wires are thus predictable. Since bonding of the assembly is limited to selected lines of contact, the insulation and conductive layers are easily stripped from the coaxial conductors and the drain wires. With center conductors and the drain wires predictably located in the assembly, they are easily found in the assembly and stripped of the layers **24, 26, 28** and **30.** If desired, the insulation layers **28** and **30** may be first provided with the conductive layers **26** and **26** as a coating thereon prior to incorporation into the assembly shown in FIG. **2.** Alternatively, the conductive and insulation layers may comprise separate ribbons sequentially bonded to the assembly as described.

In the assembly of the FIG. **2** embodiment, reference will be made to FIGS. **1** and **2.** The former figure shows the center conductors with their outer sheaths **14** and the distributed drain wires, one of which is shown at **16,** of continuous longitudinal configurations and maintained on precisely located center spacings. Continuous ribbons **24** and **26** of a conductive material is provided over the assembly. Outer layers **28** and **30** of electrical insulation material is provided over the ribbons **24** and **26.** The completed assembly is then passed between a pair of cooperating ultrasonic welding dies, schematically illustrated at **45.** The dies **45** weld the layers **24, 26, 28** and **30** along the continuous lines of contact described with respect to the FIG. **2** embodiment. Alternatively, the conductive layers **24** and **26** may be first bonded along the continuous lines of contact, with the insulating layers **28** and **30** sequentially provided over and subsequently bonded to the layers **24** and **26** along the lines of continuous contact. Such can be accomplished by a single pass through sequential pairs of welding dies similar to the dies **45.** In still another modification, the conductive layers **24** and **26** may comprise conductive layers already connected to the insulating layers **28** and **30** prior to being bonded to the FIG. **2** assembly.

FIG. **3** illustrates another preferred embodiment of the invention. With reference to the figure, a subassembly comprising plurality of spaced exemplary coaxial conductors **46** are provided thereover with an individual sheath **48** of dielectric material. As in the embodiment of FIG. **2,** the conductors and associated dielectric sheaths are of continuous parallel configuration with the longitudinal centerlines of the coaxial conductors **46** being coplanar. Distributed among the coaxial conductors **46** are a plurality of conductors or drain wires **50.** As in the embodiment of FIG. **2,** the drain wires may be of circular or rectangular or any other desired configuration. In each of the embodiments of FIGS. **2** and **3,** the coaxial cable center conductors **2, 4, 6, 8, 10, 12** and **46** are positioned in their respective assemblies on precisely located center spacings. As shown in FIG. **3,** a drain wire **52** may be selectively substituted for a normally occurring coaxial cable center conductor **46.** Accordingly, the longitudinal axis of the drain wire **52** is located on a center spacing between the precisely center spaced adjacent coaxial conductors **46.** As shown in FIG. **3,** the longitudinal axes of the center conductors **46** are coplanar. The longitudinal axis of the drain wires **50** and **52** are also co-planar but offset from the longitudinal axes of the center conductors **46.** As above described with reference to the embodiment of FIG. **2,** in similar fashion the drain wires **50** may be selectively distributed among the spaced center conductors **46** and associated with either a single or a pair of such center conductors as described.

A top layer of conductive metal foil **54** is provided over the center conductors and drain wires and is provided with generally recessed planar portions **56** overlying and covering each of the drain wires **50** and **52.** The layer **54** also includes lateral side margins, one of which is shown at **58.** The assembly is further provided with a bottom conductive layer **60** of foil or other suitable material having recess portions **62** on each side of every drain wire **50** and **52.** Such recess portions **62** abut against the recessed portions **56** of the layer **54** along lines of contact extending parallel to the longitudinal axes of the drain wires and center conductors. The layer **60** is further provided with lateral side margins, one of which is shown at **64,** abutting a respective side margin **58** along lines of mutual contact extending parallel to the drain wires and center conductors of the FIG. **3** embodiment. Along such lines of contact the layers **54** and **60** are bonded together, for example, by ultrasonic welding or other suitable techniques.

The subassembly of FIG. **3** is especially suited for continuous fabrication according to the schematically illustrated process shown in FIG. **1.** More particularly

the center conductors **46** and the drain wires **50** and **52** may be of continuous longitudinal configuration and suitably maintained in place according to their desired center spacings. Welding along the described lines of contact may then be accomplished by passing the subassembly continuously through a pair of ultrasonic welding dies such as the dies **45** of FIG. **1.**

The FIG. **3** subassembly may then be provided thereover with conductive layers similar to the layers **28** and **30** of the embodiment illustrated in FIG. **2.** More particularly, such layers **28** and **30** are placed in overlying relationship on the conductive layers **60** and **54** and the subassembly is again passed through the same welding dies, thus bonding the layers **28** and **30** along the identical lines of contact adjacent each of the drain wires **50** and **52.**

With reference to FIG. **4,** an alternative insulation technique for the FIG. **3** subassembly is illustrated. In FIG. **4,** an outer jacket **66** encapsulates the subassembly of FIG. **3,** and is applied by a molding or continuous extrusion process. As shown, the jacket is provided with a planar surface **68** and projecting portions **70** covering the dielectric sheathed center conductors **46.** For ease in fabrication, a raised portion **70** is provided at each expected center space location of a sheathed center conductor **46.** Accordingly, where a drain wire **52** is substituted for a normally located center conductor **46,** the corresponding raised portion **70** will include a relatively massive application of insulating material advantageously applied automatically during the molding or extrusion process.

Other modifications and embodiments of the invention are to be covered by the scope of the appended claims.

For example, FIG. **5** is a fragmentary enlarged cross section of yet another embodiment according to the present invention. With reference to FIG. **5,** a pair of parallel elongated generally cylindrical dielectric sheaths **72** each having a center conductor **74** of a coaxial cable, are similar to the dielectrics **14** and **48** of the previously described embodiments. Each dielectric sheath **72** has associated therewith an elongated ground wire conductor, **76,** similar to the ground wire conductors **16** or **58** of the previous embodiments. A sheath of relatively thin electrically conducting foil **78** is generally of tubular construction and encircles each dielectric sheath **72** and its adjacent ground conductor **76** along their entire elongated lengths thereof. For example, as in the previously described embodiments, the embodiment shown in FIG. **5** may be modified by eliminating any desired ground conductor **76,** in which case, the tubular foil **78** will encircle only the remaining dielectric **72.** To complete the subassembly, the pair of foil encircled dielectric sheaths **72** are located in adjacent relationship and provided thereover with a molded or extruded dielectric layer **80** similar to the layer **70** described in conjunction with FIG. **4.**

In accordance with the objects of the present invention, which objects are applicable to all the embodiments described herein, each ground wire conductor, such as the conductor **76,** is precisely located with respect to a corresponding dielectric sheath **72** within the outer surrounding dielectric insulation layer, such as the layer **80.** None of the ground wire conductors are, for example, spirally wrapped about a corresponding dielectric sheath. This is highly advantageous, since upon stripping the outer insulation sheath from the assembly, each ground conductor is precisely located within an assembly, with each dielectric sheath and its corresponding center conductor being exposed in precisely located and predictable positions, thereby enabling termination thereof to a standard connector block, not shown. Thus, according to the present invention, none of the exposed ground wire conductors or center conductors need be reoriented before they are terminated to a standard connector block.

Another object of the present invention is to provide a coaxial cable assembly including a plurality of coaxial conductors and drain wires precisely spaced and located in a common outer insulation layer, with the insulation layer provided with lateral margins that may be joined to an adjacent margin provided on an outer insulation layer of another similar coaxial cable assembly.

As shown in FIG. **5,** the surrounding insulation layer **80** is provided with a first lateral margin and a second lateral margin **82** and **84,** respectively. Another surrounding insulation layer **86,** of another coaxial cable assembly provided with at least one dielectric sheath **72** encircling a center conductor **74** and surrounded by an encircling tubular foil layer **78,** includes a lateral margin **88** which may be placed in adjacent relationship with respect to the margin **82.** According to the features attributable to the present invention, the adjacent insulation layers **80** and **86** may be advantageously terminated to a common connector block, not shown, the fabrication technique of the present invention enabling all the center conductors **74** and the associated drain wires **76** to be precisely located in the assembly so as to eliminate the need for reorienting the conductors before termination to the common connector block. If desired, the margins **82** and **88** may be secured together by an adhesive or by heat sealing, for example. It should be understood that the insulation layers **80** and **86** may assume many different configurations and that if provided with lateral margins such as the margins **82, 84** and **88** such configurations may be placed in adjacent relationship to provide any desired number of center conductors **74** or drain wires **76.**

What is claimed is:

1. A coaxial cable assembly, comprising:

a. first and second conductive layers in continuous longitudinal configurations;

b. a plurality of parallel spaced center conductors, each of said center conductors individually provided thereover with a dielectric sheath;

c. a plurality of drain wires selectively distributed among said spaced center conductors;

d. the longitudinal axis of said center conductors being coplanar;

e. the longitudinal axis of said drain wires being coplanar;

f. said center conductors and said drain wires being disposed between said first and said second conductive layers with said drain wires being bonded thereto along lines of contact; and

g. insulation material overlying each of said conductive layers.

2. The structure as recited in claim **1,** wherein, said drain wires are parallel and positioned between adjacent pairs of center conductors.

3. The structure as recited in claim **1,** wherein, the longitudinal axes of said center conductors are located on predictable center spacings.

4. The structure as recited in claim 1, wherein, said drain wire longitudinal axes are straight.

5. The structure as recited in claim 1, wherein, said longitudinal axes of said drain wires are coplanar and located offset with respect to the coplanar axes of said center conductors.

6. The structure as recited in claim 1, wherein, said drain wires are recessed with respect to one surface of said assembly and are located adjacent to an opposed surface of said assembly.

7. The structure as recited in claim 1, wherein said first and second conductive layers abut each other along lines of contact extending parallel to the longitudinal axes of said drain wires.

8. A flat multi-conductor coaxial cable assembly, comprising:

a. a plurality of parallel, spaced center conductors, the longitudinal axes thereof being coplanar, and further each of said center conductors being individually provided thereover with a dielectric sheath;

b. a conductive tubular foil surrounding each of said dielectric sheaths; and

c. a plurality of longitudinally coplanar drain wires each of which extends parallel to each of said center conductors and intimately contacting said foil sheath surrounding said dielectric sheath, further the position of each of said drain wires relative to said center conductor being substantially constant and determinable without cutting into said flat multiconductor coaxial cable.

* * * * *