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(54) A RADIOFREQUENCY CABLE CONNECTOR

(57) A radiofrequency cable connector for connecting two coaxial cables, comprising:
- means for electrically connecting the inner conductors (IC1, IC2) of the two coaxial cables;
- means for electrically connecting the shields (S1, S2) of the two coaxial cables, comprising:
-- a conductive ground block (GB1) adapted to receive the shield (S1) of the first cable, and being electrically connected to the shield (S2) of the second coaxial cable;
-- and pressing means (PP1, F1) for pressing the bare shield (S1) of the first cable against the conductive ground block (GB1);

The pressing means comprise a pressing part (PP1) and a fastener (F1) that can be set alternately in a stable pressing position, and in an stable opening position, this latter position enabling to introduce the bare shield (S1) of the first coaxial cable between the pressing part (PP1) and the conductive ground block (GB1).

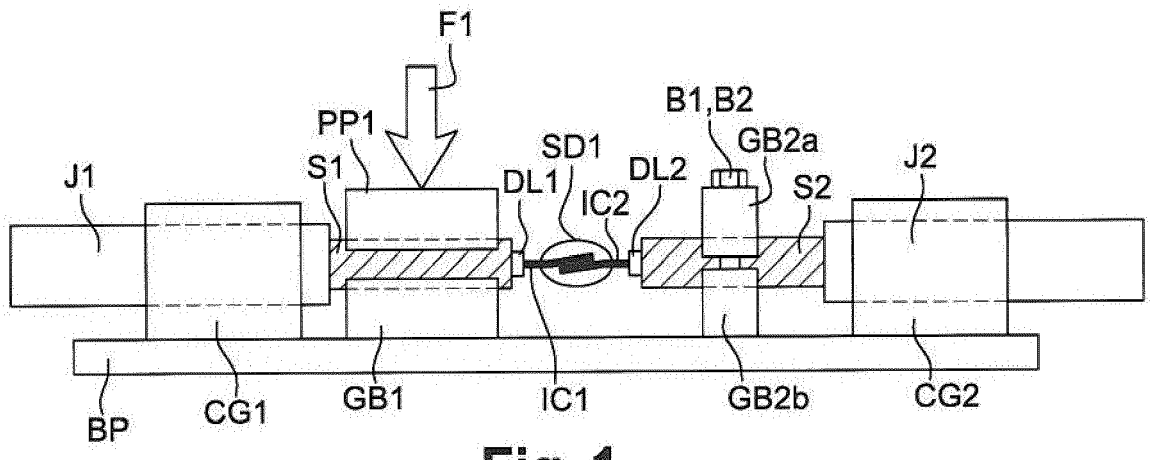

Fig. 1

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Description

BACKGROUND OF THE INVENTION

Field of the invention

[0001] The present invention generally relates to the manufacturing of radiofrequency (RF) equipment, in particular wireless base stations. A base station antenna - as lot of other radiofrequency devices - comprises several radiofrequency subcomponents such as radiating elements, feeding networks, filters, etc, connected altogether. More peculiarly, the invention concerns the connection of two coaxial cables.

[0002] When a final product is made of a small number of such subcomponents, the risk to have one of such subcomponent not performing properly may be low, and so the risk to detect a dysfunction during the test of the final product sounds limited as well. Moreover, if reparation is needed, due to the limited number of subcomponents, it sounds pretty easy to quickly find the root cause and solve the issue.

[0003] The risk is very much higher when a final product comprises a lot of subcomponents, in particular if these subcomponents are complex. Before assembling a base station, for instance, it is necessary to perform radiofrequency and intermodulation product pre-tests, i. e. tests on the subcomponents, before implementing them in a base station. Performing a pre-test means characterizing all the subcomponents as regards their radiofrequency performances (such as insertion losses, impedance matching, etc) and as regards their intermodulation performances. This is done by temporarily connecting each subcomponent to at least one test bench. For saving time, the subcomponent must be quickly connected and disconnected.

[0004] There are many other circumstances where a quick RF connection is needed.

Description of the prior art

[0005] A trivial solution consists in attaching a coaxial RF connector at each input and output of the RF subcomponents to be pre-tested, or attaching a coaxial cable terminated by a coaxial RF connector. Then each subcomponent can then be used as a "standalone device", i. e. can be quickly connected to one or several test benches, and quickly disconnected after the pre-test. After the pre-test, the coaxial connector can be used for a permanent connection to a wider subcomponent or inside the final product.

[0006] Considering:

- the cost of such RF coaxial connectors, satisfying both radiofrequency and intermodulation performance conditions despite the high power level that may be applied and the potentially wide frequency range,
- the overall number of connectors needed,
- the manufacturing operations required to install such RF coaxial connectors onto the subcomponents, and connect then disconnect them, several times during various required pre-tests (with associated risks to damage them),

it is desirable to be able to perform such pre-tests without such costly and somewhat fragile coaxial RF connectors.

[0007] In many other circumstances, the coaxial connectors can be considered as costly and somewhat fragile.

[0008] The aim of the present invention is to provide a better connection solution for two coaxial RF cables.

SUMMARY OF THE INVENTION

[0009] The object of the invention is a radiofrequency cable connector for connecting two coaxial cables,

- a first coaxial cable comprising,
  - -- an outer insulating jacket,
  - -- a conducting shield,
  - -- a dielectric layer,
  - -- an inner conductor,
- a second coaxial cable comprising,
  - -- an outer insulating jacket,
  - -- A shield,
  - -- A dielectric layer,
  - -- An inner conductor,
- means for electrically connecting the inner conductors of the two coaxial cables;
- means for electrically connecting the shields of the two coaxial cables, comprising:
  - -- a conductive ground block adapted to receive the shield of the first cable, and being electrically connected to the shield of the second coaxial cable;
  - -- and pressing means for pressing the bare shield of the first cable against the conductive ground block;

characterized in that said pressing means comprise a pressing part and a fastener that can be set alternately in a stable pressing position for pressing the bare shield of the first cable against the conductive ground block, and in an stable opening position, this latter position enabling to introduce the bare shield of the first coaxial cable between the pressing part and the conductive ground block.

[0010] The stable opening position provides a broad space between the pressing part and the conductive ground block, so that it is possible to quickly introduce

the bare shield of the first coaxial cable between the pressing part and the conductive ground block. Then the closing position quickly provides a good contact between the shield and the ground block. Conversely, the opening position provides a broad space between the pressing part and the conductive ground block, so that it is possible to quickly release the bare shield of the first coaxial cable, and then quickly draw the first cable out of the connector without any risk to damage the shield or the connector. Thus it is possible to make a temporary reliable connection to the shield of the first coaxial cable without any soldering, crimping, or wrapping operation on the shield of the first cable

[0011] Other features and advantages of the present invention will become more apparent from the following detailed description of embodiments of the present invention, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In order to illustrate in detail features and advantages of embodiments of the present invention, the following description will be with reference to the accompanying drawings. If possible, like or similar reference numerals designate the same or similar components throughout the figures thereof and description, in which:

- Figure 1 represents a first embodiment of the connector according to the invention, comprising only one solder.
- Figure 2 represents a second embodiment of the connector according to the invention, comprising not any solder.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] On Figures 1 and 2 we consider embodiments that can be quickly connected and quickly disconnected. For instance, they are well suited for connecting a subcomponent to a pre-test bench. We consider subcomponents that do not comprise coaxial connectors at their inputs and outputs (otherwise the use of mating coaxial connectors would be imposed on the side of the pre-test benches). The subcomponents are supposed to comprise a mere coaxial cable at each of their inputs and outputs. We consider a pre-test bench comprising a mere coaxial cable attached to each of its inputs and outputs. In this case, the aim is to quickly connect and disconnect a first coaxial cable to a permanent second coaxial cable without any classical coaxial connector.

[0014] These coaxial cables may be of different types. In any case, each coaxial cable comprises two coaxial conductors: an outer shield and an inner conductor, separated by a dielectric layer. The dielectric layer is surrounded by the shield. The shield is surrounded by an overall dielectric protection layer. The shield is often constituted by a braid. A connection between the two coaxial cables implies a connection from shield to shield, and a connection from inner conductor to inner conductor.

[0015] On **Figures 1 and 2**, a first coaxial cable, connected to a subcomponent comprises:

- An outer insulating jacket J1.
- A shield S1 constituted by a metal braid.
- A dielectric layer DL1.
- An inner conductor IC1.

[0016] A second coaxial cable, connected to a pre-test comprises:

- An outer insulating jacket J2.
- A shield S2 constituted by a metal braid.
- A dielectric layer DL2.
- An inner conductor IC2.

[0017] Note that the connector may be permanently fixed to the second coaxial cable, whereas it must be quickly connected and disconnected from the first cable, to temporarily enable the pre-test of a subcomponent.

[0018] **Figure 1** represents a first embodiment of the connector according to the invention. It permits to avoid any "permanent" contact onto the shields, such as solders, crimps, wrappings, etc. As concerns the inner conductors, a compromise is done in this first embodiment, considering that soldering only the inner conductors altogether may represent a valid option: The inner conductor is often made from a unique wire, and so a limited number of unsoldering and re-soldering operations sounds feasible without drastically increasing the risks to reduce RF intermodulation performances.

[0019] This first embodiment comprises:

- A metal base plate BP supporting all the parts of the connector according to the invention.
- A first cable guide CG1 comprising a cylindrical hole with a diameter slightly greater than the diameter of the jacket J1 of the first cable, so that it can be easily inserted through the cable guide CG1. The jacket J1 has been stripped off along 2.5 centimeters, for instance. The dielectric layer DL1 has been stripped off along 1.5 centimeter, for instance.
- A first grounding device comprises a metal ground block GB1 fixed to the base plate BP, and a pressing part PP1, each comprising a groove less deep than the radius of the bare shield S1. These grooves receive and retain the bare shield S1 of the first cable. The pressing part PP1 is preferably made of a dielectric material.
- A fastener F1 that can be alternatively placed in two stable positions. A closing position applies a controlled force onto the pressing part PP1 for moving it towards the grounding block GB1. An opening position provides a broad space between the pressing part PP1 and the grounding block GB1.

- A second cable guide CG2 comprising a hole with a diameter slightly greater than the diameter of the jacket J2 of the second cable, so that it can be easily inserted through the cable guide CG2. The jacket J2 has been stripped off along 2.5 centimeters, for instance. The dielectric layer DL2 has been stripped off along 1.5 centimetre, for instance.
- A second grounding device comprises a metal ground block GB2b fixed to the base plate BP, and a symmetrical metal ground block GB2a, each comprising a groove less deep than the radius of the shield S2. These grooves receive and retain the bare shield S2 of the second cable. Two bolts B1, B2 link the metal ground blocks GB2a and GB2b to the base plate BP. They apply a defined force between the metal ground blocks GB2a and GB2b so that the second coaxial cable is clamped by the ground blocks GB2a and GB2b, and so that the shield S2 of the second cable has a good electrical contact with the grounding blocks GB2a, GB2b. The ground blocks GB2a and GB2b and the ground block GB1 are electrically connected via the metal base plate BP
- The ends of the bare inner conductors IC1 and IC2 are very close. A solder SD1 links the bare parts of the inner conductors IC1 and IC2. In collaboration with the metal base plane BP, they are equivalent to a short microstrip transmission line, with a first transition, from a coaxial cable to a microstrip line, at one end, and a second transition, from a microstrip line to a coaxial cable, at the other end. To make it efficient, as concerns both RF and intermodulation performances, the dimensions of the parts of the connector must be adapted to the types of the RF cable used, and the pressing force must be carefully defined.

[0020] For connection, the fastener F1 is laced in an opening position that provides a broad space between the pressing part PP1 and the conductive ground block GB1, so that it is possible to quickly introduce the bare shield S1 of the first coaxial cable between the pressing part PP1 and the conductive ground block GB1. An operator (this operation may also be automatized) places the first coaxial cable thru the cable guide CG1, and then activates the fastener F1 to apply a proper force onto the bare shield S1 via the pressing part PP1. Then the operator solders the bare inner conductors IC1 and IC2 together. At this moment the RF connection is available and so the RF or intermodulation pre-tests can be performed.

[0021] A closing position quickly provides a good contact between the shield S1 and the ground block GB1.

[0022] Conversely for disconnection, the opening position provides a broad space between the pressing part PP1 and the conductive ground block GB1. To release the first cable (linked to the subcomponent) after the pretest, the operator unsolders the inner conductors IC1 and IC2 and then releases the fastener F1.

[0023] Thus it is possible to make a temporary reliable connection to the shield S1 of the first coaxial cable without any soldering, crimping, or wrapping operation on the shield of the first cable.

[0024] One can see that limited operations were accomplished on the inner conductors IC1 and IC2, and so, the risk to damages the first or the second cable, or to cause drifts of the RF or intermodulation performances, during the pre-tests, is very low.

[0025] Figure 2 represents a second embodiment of the connector according to the invention. It has the advantage of quickly making a connection to the first cable without any soldering, crimping, wrapping operation.

[0026] The cables are guided by same cable guides CG1, CG2 as in the first embodiment, and the shields S1 and S2 are electrically connected by same means as in the first embodiment: Grounding block GB1, pressing part PP1, fastener F1, grounding blocks GB2a, GB2b, and bolts B1, B2.

[0027] It differs from the first embodiment by inserting different connecting means between the bare ends of the inner conductors IC1, and IC2. These connecting means comprise an insulating block IB fixed on the base plane BP and supporting a conductive strip CS parallel to the base plane BP. In collaboration with the metal base plane BP, they constitute a microstrip transmission line linking the two coaxial cables.

[0028] The bare inner conductor IC2 of the second cable is permanently soldered to an end of this conductive strip CS. The bare inner conductor IC1 of the first cable can be pressed against the other end of the conductive strip CS, by a second insulating pressing part PP2. A second fastener F2 applies can apply a defined force on the insulating pressing part PP2. This second fastener F2 has two stable positions that can be chosen by a quick and simple manual (or automatic) operation.

[0029] For connection, an opening position provides a broad space between the pressing part PP2 and the conductive strip CS, so that it is possible to quickly introduce the bare inner conductor IC1 of the first coaxial cable between the pressing part PP2 and the conductive strip CS. A closing position applies a controlled force onto the pressing part PP2, so that the bare inner conductor IC1 of the first coaxial cable is clamped and has a good electrical contact with an end of the conductive strip CS.

[0030] Conversely for disconnection, the opening position provides a broad space between the pressing part PP2 and the conductive strip CS, so that it is possible to quickly release the bare inner conductor IC1 of the first coaxial cable, and then quickly draw the first cable out of the connector without any risk to damage the inner conductor IC1 or the connector.

[0031] The fastener F2 is a mechanical device that can block or release the inner conductor IC1 of the first cable by a quick and simple manual (or automatic) operation. Its manufacturing is within the scope of a man skilled in the art.

[0032] The function of the microstrip line constituted by the conductive strip CS and the metal base plane BP is impedance matching at the junctions with the two cables. The geometrical characteristics of the conducting strip CS and of the insulating block IB, as well as the dielectric characteristics of this latter, are chosen such that the impedance of the microstrip line is identical to the impedances of the two cables (These impedances are identical). So it is possible to perform accurate impedance measurements, scattering parameter measurements, etc, as well as intermodulation measurements. To release the first cable, the operator quickly releases the two fasteners F1 and F2. There is no need to desolder anything. The first coaxial cable can be easily installed and removed.

[0033] In other examples, the solder SD2 can be replaced by a pressing part similar to the pressing part PP2, and a fastener similar to the fastener F2. The ground blocks GB2a, GB2b and the bolts B1, B2 can be replaced by a ground block similar to the ground block GB1, a pressing part similar to the pressing part PP1, and a fastener similar to the fastener F1. In such a case the connector is symmetrical, and both coaxial cables can be easily installed and removed.

Claims

1. A radiofrequency cable connector for connecting two coaxial cables,

- a first coaxial cable comprising,
  - -- an outer insulating jacket (J1),
  - -- a conducting shield (S1),
  - -- a dielectric layer (DL1),
  - -- an inner conductor (IC1);
- a second coaxial cable comprising,
  - -- an outer insulating jacket (J2),
  - -- A shield (S2),
  - -- A dielectric layer (DL2),
  - -- An inner conductor (IC2);
- means for electrically connecting the inner conductors (IC1, IC2) of the two coaxial cables;
- means for electrically connecting the shields (S1, S2) of the two coaxial cables, comprising:
  - -- a conductive ground block (GB1) adapted to receive the shield (S1) of the first cable, and being electrically connected to the shield (S2) of the second coaxial cable;
  - -- and pressing means (PP1, F1) for pressing the bare shield (S1) of the first cable against the conductive ground block (GB1);

characterized in that said pressing means comprise a pressing part (PP1) and a fastener (F1) that can be set alternately in a stable pressing position for pressing the bare shield (S1) of the first cable against the conductive ground block (GB1), and in an stable opening position, this latter position enabling to introduce the bare shield (S1) of the first coaxial cable between the pressing part (PP1) and the conductive ground block (GB1).

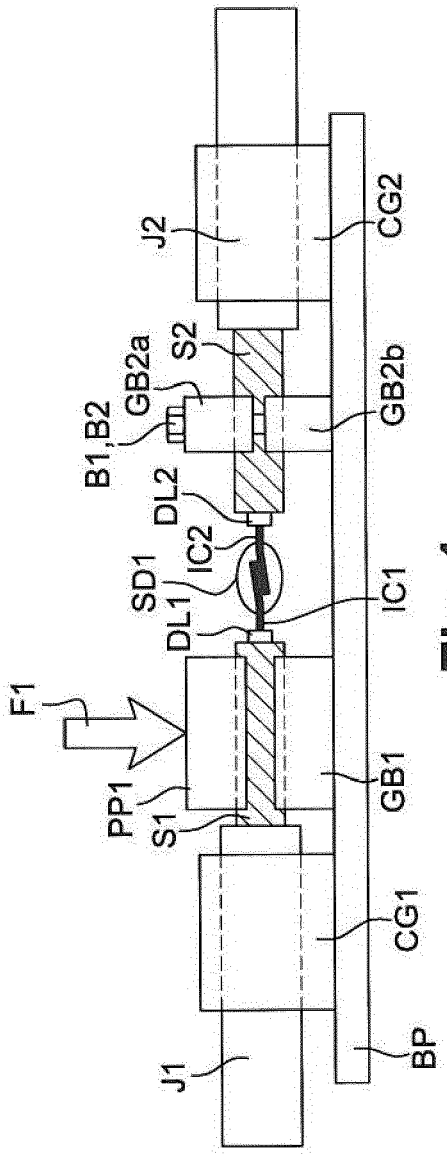
2. A radiofrequency cable connector according to claim 1, **characterized in that** said means for electrically connecting the inner conductors (IC1, IC2) of the two coaxial cables comprise guiding means (CG2) and fixing means (GB2) for maintaining the second coaxial cable in a position such that the two cables are aligned, face to face along a common longitudinal axis, so that the inner conductors are neighbour.

3. A radiofrequency cable connector according to claim 2, **characterized in that** said means for electrically connecting the inner conductors (IC1, IC2) of the two coaxial cables comprise solder (S).

4. A radiofrequency cable connector according to claim 3, **characterized in that** said means for electrically connecting the inner conductors (IC1, IC2) of the two coaxial cables comprise:

- a ground plane (BP),
- a conductive strip (CS),
- an insulating block (IB) placed between the ground plane (BP) and the conductive strip (CS), so that they constitute a microstrip line,
- means (SD2) for electrically connecting a first end of the conductive strip (CS) to the inner conductor (IC2) of the second coaxial cable;
- a second fastener (F2) associated to a dielectric pressing part (PP2) that can be set alternately in a stable pressing position, and in an stable opening position, the opening position enabling to introduce the bare inner conductor (IC1) of the first coaxial cable between the dielectric pressing part (PP1) and the second end of the conductive strip (CS), and the pressing position causing the dielectric pressing part (PP1) to press the inner conductor (IC1) of the first coaxial cable onto the other end of the conductive strip (CS).

5. A radiofrequency cable connector according to claim 4, **characterized in that** said means for electrically connecting a first end of the conductive strip (CS) to the inner conductor (IC2) of the second coaxial cable, is solder (SD2).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CG2
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GB2b
B1,B2
DL2
IC2
SD1
DL1
IC1
F1
PP1
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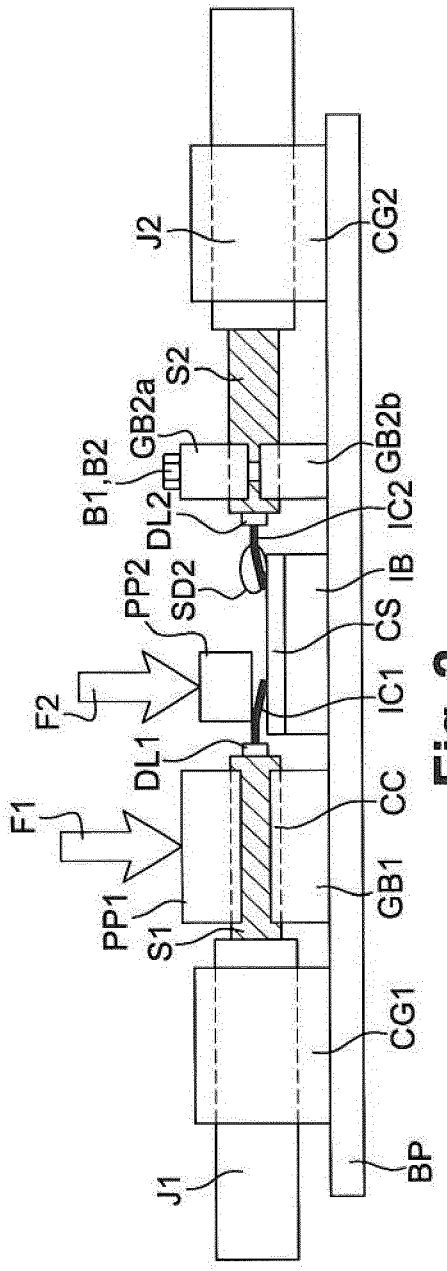
GB1
CG1
J1
BP

Fig. 1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DL2
IC2
PP2
SD2
IB
CS
F2
IC1
DL1
CC
F1
PP1
S1
GB1
CG1
J1
BP

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 15 30 6911

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)
H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 May 2016	Ferreira, João

CATEGORY OF CITED DOCUMENTS

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02-05-2016

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