(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 124 288 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.08.2001 Bulletin 2001/33

(51) Int Cl.[7]: **H01R 13/03**, H01R 39/20, H01R 39/24

(21) Application number: **01102994.9**

(22) Date of filing: **08.02.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **11.02.2000 US 499535**

(71) Applicant: **LITTON SYSTEMS, INC.**
Woodland Hills, California 91367-6675 (US)

(72) Inventors:
- **Crockett, Russell L.**
  Christiansburg, Virginia 24073 (US)
- **Witherspoon, Barry K.**
  Blacksburg, Virginia 24060 (US)

(74) Representative: **MÜLLER & HOFFMANN**
Patentanwälte
Innere Wiener Strasse 17
81667 München (DE)

(54) Noble metal clad brush wire and slip ring assembly

(57) A slip ring and brush assembly utilizes gold cladding brush wires in sliding or rotating contact with a gold covered slip ring. The metallurgical bonding of the gold cladding to the underlying wire minimizes cracking of the precise metal surface as compared to plated materials while avoiding the high cost of a gold alloy monofilament wire. Other noble metals may be used in place of gold.

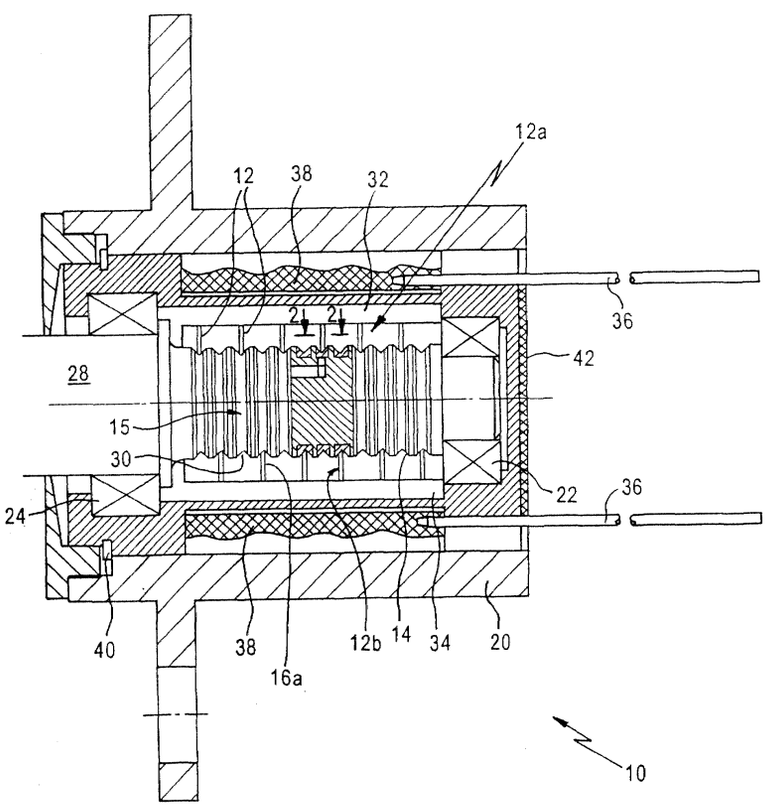

FIG. 1

EP 1 124 288 A1

Description

Technical Field

[0001] The present invention relates generally to slip ring and wire brush assemblies and, more particularly, to the use of noble metal materials forming a surface layer of a wire brush.

Background Art

[0002] Slip ring assemblies are well known in the prior art and generally comprise a rotating conductive ring in contact with a non-rotating brush mounted in a suitable brush holder. The brush is often a monolithic wire element comprising a gold alloy brush wire or a gold plated wire running against a gold plated ring. Gold or other noble metals are highly preferred since it has been known for some time that to achieve performance over long periods of time (years) with contact resistance variations in the low milliohm levels, noble metals and noble metal alloys must be used in the electrical contact zone rather than base metals.

[0003] Gold alloy brush wires can be expected to operate for long periods of time with minimal contact resistance variations. However, gold alloy wires are relatively expensive since the gold content is high.

[0004] Gold plated wires are also known and tend to be less expensive than gold alloy wires since the gold plating covers a less expensive base metal. However, the gold plating is susceptible to cracking, especially when the gold plated brush wire is bent to a particular radius of curvature for certain types of applications. Additionally, from a manufacturing standpoint, the manufacture of plated wires require a more substantial capital investment in view of the need for plating baths and equipment, and also create environmental disposal problems and additional related expense.

Disclosure of the Invention

[0005] It is accordingly an object of the present invention to improve the structural integrity of brush wires having noble metal coverings.

[0006] Another object is to improve wear characteristics of noble metal covered brush wires.

[0007] Yet another object is to improve the structural integrity and wear characteristics of noble metal covered brush wires relative to platted wires while lowering costs relative to noble metal alloy wires.

[0008] This present invention relates to a slip ring and brush assembly including a slip ring in sliding contact with a brush wire. In a broad sense, the invention relates to an improvement wherein the brush wire includes a first material forming at least part of a wire core and a second material forming an outer layer metallurgically bonded to the first material.

[0009] In the preferred embodiment, the invention relates to a slip ring and brush assembly for transmitting electrical energy between a conductor and a shaft. One of the conductor and shaft is stationary while the other is rotating. The assembly comprises a noble metal covered slip ring surface formed on the shaft and at least one brush wire in contact with the noble metal covered slip ring surface and coupled to the conductor. In accordance with the invention, the brush wire includes a conductive core, an optional metal barrier layer covering the core, and a noble metal surface layer metallurgically bonded to one of the barrier layer and core.

[0010] The feature of metallurgically bonding the noble metal surface layer to the underlying core, either directly or through an intermediate metallurgically bonded barrier layer, advantageously results in better brush forming by providing intimate attachment conditions at the atomic level that minimizes cracking or peeling of the precious metal surface relative to prior art plating techniques. Brush wires formed with the metallurgically bonded noble metal surface also tend to be less expensive than gold or noble metal alloy wire by reducing the gold or noble metal content while retaining the same precious metal contact at the ring/brush interface for low noise and wear.

[0011] The brush wire according to the present invention utilizes an optional metal barrier layer to prevent diffusion between the conductor core and noble surface layer depending on the selection of materials between which diffusion may be a problem. In situations where a noble metal barrier layer is utilized, the barrier layer is preferably metallurgically bonded to the conductor core and the noble metal surface layer is in turn metallurgically bonded to the barrier layer.

[0012] In one preferred embodiment according to the invention, the brush wire comprises a copper center core, preferably Beryllium copper, with a nickel clad overlay barrier followed by a gold cladding on the outer surface of the nickel barrier.

[0013] Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, wherein only the preferred embodiments of the invention are shown and described, simply by way of illustration of the best mode contemplated of carrying out the invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious respects, all without departing from the invention. Accordingly, the drawing and description are to be regarded as illustrative in nature, and not as restrictive.

Brief Description of Drawings

[0014]

Fig. 1 is a detailed longitudinal cross-section of an exemplary brush assembly utilizing novel brush wires constructed in accordance with the present

invention;

Fig. 2 is an exploded perspective view taken along the line 2-2 of Fig. 1 of one of the brush wires;

Fig. 3 is a side elevational view of one of the brush wires; and

Fig. 4 is a detailed side view of a multifilament brush assembly.

Best Mode for Carrying out the Invention

[0015] FIG 1. is an exemplary illustration of a slip ring and brush assembly, generally designated with reference numeral 10, in which a series of brush wires 12 are in sliding contact with a slip ring surface 14 formed on a rotating slip ring assembly 15. The respective surfaces of the brush wires 12 and slip ring surface 14 are preferably gold covered to achieve good wear characteristics, low electrical resistance and increase current density as is well known. However, in accordance with the unique features set forth below, each brush wire 12 includes a surface layer 16 in the form of a gold cladding layer 16a that is metallurgically bonded in the preferred embodiment to an underlying conductive core 16b, either directly or through a diffusion layer 16c (see FIG. 2) that in turn is metallurgically bonded to the core. In this manner, the advantages of gold-on-gold low contact resistance are achieved while avoiding either the higher likelihood of fatigue and failure problems associated with gold plating, or the increased costs of gold alloy wire with their higher gold content.

[0016] Assembly 10 is representative of a large class of brush wire and slip ring assemblies in which the rotating conductive slip ring assembly 15 is contacted by a non-rotating brush 12 mounted in a suitable brush holder to provide flow paths for electrical power or signal. In FIG. 1, assembly 10 comprises a cylindrical housing 20 in which a pair of bearings 22 and 24 are disposed at opposite ends of slip ring assembly 15 to rotatably support one end of a rotating shaft 28. A series of brush wires 12 are disposed in axially spaced location in respective contact with annular grooves 30 formed along the length of the slip ring assembly 15.

[0017] More specifically, upper and lower sets of axially sets 12a and 12b of axially spaced identical brush wires 12 are mounted to respective upper and lower brush blocks 32 and 34 that provide for proper wire positioning in sliding or rotating contact with the slip ring assembly grooves 30. As best depicted in Fig. 1, each brush block assembly 32 and 34 extends the length of the slip ring assembly 15 and has opposite ends in respective contact with bearings 22 and 24 to properly position the bearings within the assembly 10. The brush blocks 32 and 34 are also used for positioning and locating the lead wires 36, and provide lead exits as known in the art. The lead wires 36 are retained in position in relation to the brush block assemblies 32, 34 by utilizing a potting material 38 disposed between the outer surface of each brush block and the inner surface wall of the housing 20. A retainer ring 40 disposed in a recessed proximal end of the housing 20 is used to axially fix the brush block assemblies 32, 34 relative to the rotating shaft 28 while an end cap 42 closes off the distal end of the assembly 10 through which the lead wires 36 extend.

[0018] The foregoing construction of assembly 10 is conventional with the exception of the composition of brush wires 12. As best depicted in Fig. 2, each brush wire 12 in the preferred embodiment includes a surface layer 16 in the form of a cladding layer 16a that is metallurgically bonded to an underlying conductive core 16b preferably through a diffusion layer 16c. The cladding layer 16a is preferably made of a noble material, such as gold. The feature of metallurgically bonding the outer layer 16a either to the underlying core 16b or diffusion layer 16c provides much better attachment conditions than previously achieved with gold or noble metal plating due to the tendency of plated materials to wear faster as a result of the inferior attachment conditions between the plated layer and substrate inherent in plating technology. This inherent disadvantage of plating is particularly noticeable and disadvantageous in products relying upon one or more brush wires in sliding or rotating contact with an associated slip ring assembly.

[0019] Brush wires 12 constructed in accordance with the unique features of the present invention tend to offer similar performance (i.e. in terms of wear rates and longevity) provided by high gold content and therefore higher priced gold alloy brush wires but without the concomitant costs. The noble metal clad brush wire 12 of the invention also offers the ability to provide better conductivity than gold alloy wire of similar dimension by being bonded to a center core material 16b selected to have better conductivity then a pure gold alloy. The ability to bond the cladding layer 16a to a center core 16b of a different material enables the resulting brush wire 12 to have superior mechanical properties in relation to gold alloy wires depending on the selection of the center core material.

[0020] The feature of using noble metal clad wires also offer better formability as compared to plated wires as a result of superior bonding attachment provided by metallurgical bonding relative to plating. This improved formability is evidenced by fewer incidences of cracking or peeling of the surface layer 16a which is particularly useful when the brush wire is bent on a tight radius. The noble metal clad wires of the invention have particularly advantageous benefits when used in brush wires having, for example, a horse shoe shape of the type depicted in Fig. 3 as is used in the assembly 10 of the preferred embodiment.

[0021] The invention is not limited to the use of gold but is intended to cover other noble metals. The invention is also applicable to brush wires used with sliding or rotating contacts in which a surface material forming an outer layer is metallurgically bonded to a core material, with or without an intermediate cladding layer, so

that the benefits of metallurgical bonding as described above may be realized that would otherwise not be realized by attachment of such surface material with plating techniques.

[0022] The invention is applicable to the use of both monofilament and multifilament materials forming the individual brush wires and brush wire assemblies.

[0023] In the preferred embodiment, each wire 12 is formed with a gold outer layer 16a that is metallurgically bonded to the diffusion layer 16c (e.g. Nickel) in turn metallurgically bonded to the core 16b (e.g. Beryllium copper). Under certain circumstances, depending on the selection of materials forming the outer cladding layer 16a and core 16b, a diffusion layer 16c is unnecessary in which case the outer layer is metallurgically bonded to the core.

[0024] Figure 4 is a detailed side view of a multifilament brush assembly 100 that may comprise a plurality of filaments 102 which made be in the 1 to 25 mil size and which are held in a unitary relationship by means of a collar 104. The collar 104 may comprise the end portion of a wire insulation, or maybe a separate tube element specifically designed to hold the fibers 102 in a selectively shaped bundle. As shown, the fibers 102 extend from the collar 104 a sufficient distance to enable them to be in tangential contact with the slip ring surface, as well know (see e.g. U.S. Patent No. 4,398,113).

[0025] In accordance with the invention, each fiber 102 is constructed in a manner similar to that described above in connection with brush wire 12. That is, each fiber 102 is preferably in the form of a cladding layer that is metallurgically bonded to an underlying conductive core preferably through a diffusion layer. The cladding layer is preferably made of a noble material, such as gold. As in the case of brush wire 12, the feature of metallurgically bonding the outer layer either to the underlying core or to a diffusion layer (in turn metallurgically bonded to the core) provides much better attachment conditions than previously achieved with gold or noble metal plating as described above.

[0026] It will be readily seen by one of ordinary skill in the art that the present invention fulfills all of the objects set forth above. After reading the foregoing specification, one of ordinary skill will be able to effect various changes, substitutions of equivalents and various other aspects of the invention as broadly disclosed herein. It is therefore intended that the protection granted hereon be limited only by the definition contained in the appended claims and equivalents thereof.

Claims

1. A slip ring and brush assembly for transmitting electrical energy between a conductor and a shaft, one of said conductor and shaft being stationary and the other of said conductor and shaft being a rotating structure, the assembly comprising:

   a noble metal covered slip ring surface formed on the shaft and at least one brush wire in contact with said noble metal covered slip ring surface and coupled to the stationary conductor, wherein said at least one brush wire includes a conductive core, an optional metal barrier layer covering the core, and a noble metal surface layer metallurgically bonded to one of said barrier layer and core.

2. The slip ring and brush assembly of claim 1, further comprising said metal barrier layer being formed of a material preventing diffusion between said conductive core and said noble surface layer.

3. The slip ring and brush assembly of claim 2, wherein said metal barrier layer is metallurgically bonded to said conductor core.

4. The slip ring and brush assembly of claim 2, wherein said conductive core is copper, said barrier layer is nickel and said noble metal surface layer is gold.

5. The slip ring and brush assembly of claim 1, wherein said brush wire is smoothly curved along at least a portion of the length thereof.

6. The slip ring and brush assembly of claim 1, wherein said brush wire is drawn to a predetermined size.

7. The slip ring and brush assembly of claim 6, wherein said brush wire is formed without any heat treatment after drawing.

8. The slip ring and brush assembly of claim 1, wherein said brush wire is a single monofilament wire.

9. The slip ring and brush assembly of claim 1, wherein said brush wire includes a bundle of filaments each having said conductive core, said optional metal barrier layer covering the core, and said noble metal surface layer metallurgically bonded to one of said barrier layer and core.

10. The slip ring and brush assembly of claim 1, wherein said slip ring surface is plated.

11. The slip ring and brush assembly of claim 1, wherein said slip ring surface is metallurgically bonded or plated to an underlying surface.

12. The slip ring and brush assembly of claim 1, wherein said conductive core is a beryllium copper center core, said barrier layer is a nickel clad barrier layer, and said noble metal surface layer is a gold cladding layer.

13. The slip ring and brush wire assembly of claim 12, wherein the diameter of the beryllium copper center

core approximately is 0.007 inch with a nickel clad barrier of about 75-150 micro inch and a gold cladding of approximately 100-500 micro inch on the outer surface of said nickel barrier.

14. In a slip ring and brush assembly including a slip ring in sliding contact with a brush wire, the improvement wherein said brush wire includes a first material forming at least part of a core and a second material forming an outer layer metallurgically bonded to said first material.

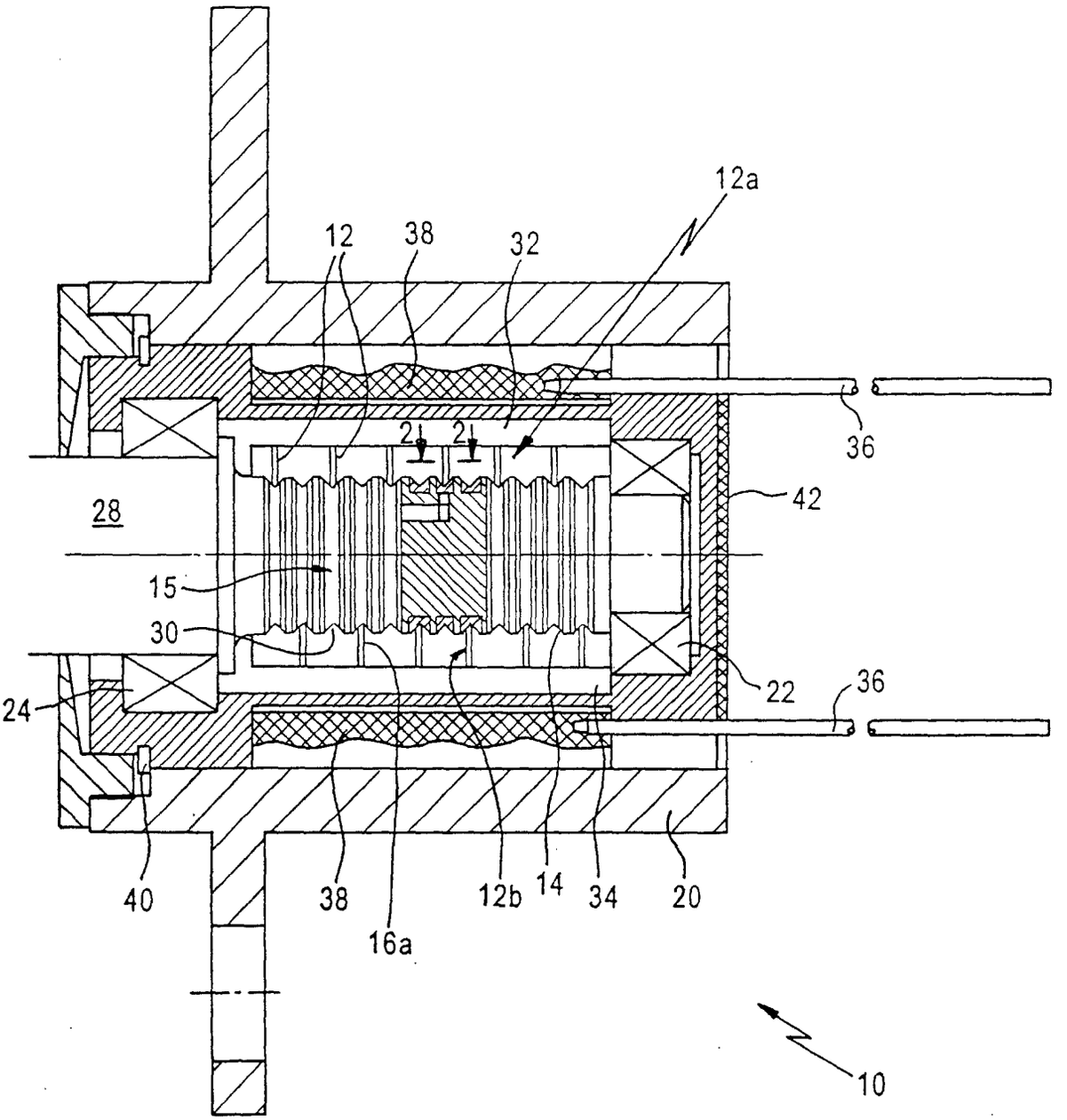

FIG. 1

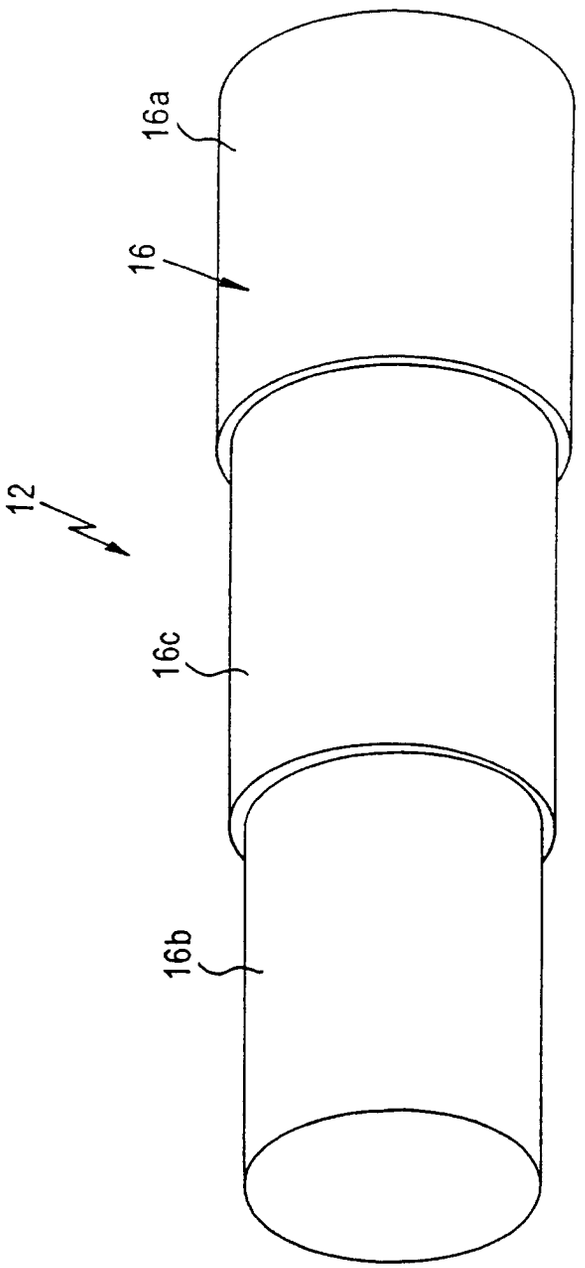

FIG. 2

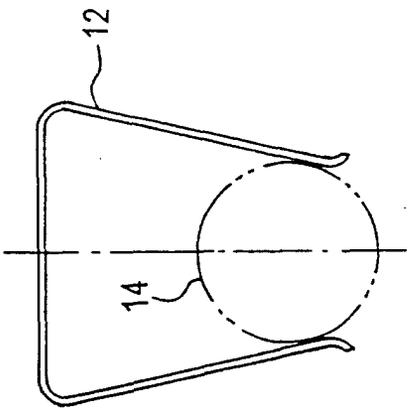

FIG. 3

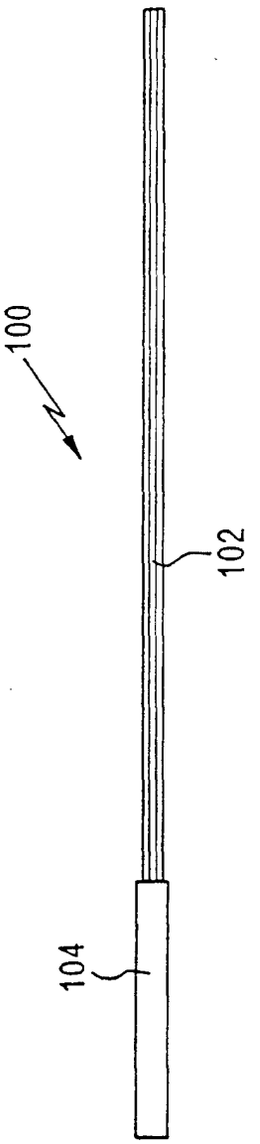

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 10 2994

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,Y	US 4 398 113 A (N.E.LEWIS ET AL) 9 August 1983 (1983-08-09) * column 3, line 26 - line 46 * * column 4, line 66 - column 5, line 12; figures 2-6 *	1,2,4, 8-12,14	H01R13/03 H01R39/20 H01R39/24
Y	EP 0 318 831 A (INCO) 7 June 1989 (1989-06-07) * column 1, line 7 - line 40 * * column 2, line 4 - line 20 * * column 3, line 7 - line 26 * * column 4, line 57 - column 5, line 13 *	1,2,4, 8-12,14	
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 05, 30 June 1995 (1995-06-30) & JP 07 046797 A (MITSUMI), 14 February 1995 (1995-02-14) * abstract *	1,10,11	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	11 May 2001	Alexatos, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 10 2994

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-05-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4398113 A	09-08-1983	CA 1164035 A	20-03-1984
		DE 3170344 D	05-06-1985
		EP 0054380 A	23-06-1982
		JP 1641272 C	18-02-1992
		JP 2034155 B	01-08-1990
		JP 57113570 A	15-07-1982
EP 318831 A	07-06-1989	CA 1331325 A	09-08-1994
		AT 80501 T	15-09-1992
		DE 3874492 A	15-10-1992
		DE 3874492 T	25-02-1993
		ES 2034127 T	01-04-1993
		GR 3005728 T	07-06-1993
		JP 1194218 A	04-08-1989
		JP 1888762 C	07-12-1994
		JP 6007452 B	26-01-1994
JP 07046797 A	14-02-1995	JP 3097408 B	10-10-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82