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(54) **Title:** A CAVITY MICROWAVE FILTER ASSEMBLY, AND A METHOD FOR MAKING A CAVITY MICROWAVE FILTER ASSEMBLY

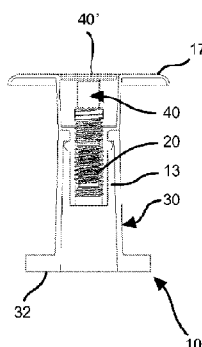


Fig. 2

(57) **Abstract:** The present invention relates to a cavity microwave filter assembly for filtering an electromagnetic wave, including an input connection for receiving input electromagnetic energy, an output connection for providing output filtered electromagnetic energy, and at least one cavity with a base supporting a dielectric resonator, the dielectric resonator comprising i) a dielectric body, commonly known as a "top hat", with a tubular stub portion having an internal thread and ii) a pedestal with a first end, an opposite second end and a hollow, the pedestal being mounted to the base at the second end. The dielectric body is secured to the pedestal, resting on the pedestal with the stub portion received in the hollow of the pedestal. A central passage extends through the dielectric body and the pedestal, and a tuning screw for creating a desired response of the assembly to the input electromagnetic energy extends through the central passage engaging the internal thread. The stub portion includes a radially outwardly bulging annular deformation, the pedestal including a radially inwardly directed flange delimiting the hollow at the first end, a lock for locking the dielectric body to the pedestal comprising a face of the flange facing the base cooperating with the annular deformation of the stub portion.



A cavity microwave filter assembly, and a method for making a cavity microwave filter assembly

Field of the invention

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The invention relates to a cavity microwave filter assembly and to a method of making a cavity microwave filter assembly.

10 **Background of the invention**

The present invention relates to a cavity microwave filter assembly for filtering an electromagnetic wave, including an input connection for receiving input electromagnetic energy, an output connection for providing output filtered electromagnetic energy, and at least one cavity with a base supporting a dielectric resonator, the dielectric resonator comprising i) a dielectric body, commonly known as a 'top hat', with a tubular stub portion having an internal thread and ii) a pedestal with a first end, an opposite second end and a hollow, the pedestal being mounted to the base at the second end. The dielectric body is secured to the pedestal, resting on the pedestal with the stub portion received in the hollow of the pedestal. A central passage extends through the dielectric body and the pedestal, and a tuning screw for creating a desired response of the assembly to the input electromagnetic energy extends through the central passage engaging the internal thread.

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Examples of cavity microwave filter assemblies are disclosed in US patents no. 3 737 816 and 7 764 146.

Prior art dielectric bodies are constructed with the pedestal having an inner thread matching an outer thread

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formed on the outer face of the tubular stub portion of the dielectric body. This requires a machining of the various parts at high costs and also leads to the need for long tuning screws which adds to the dimensions of the assembly.

Summary of the invention

An object of the present is to solve the aforementioned problems. According to an aspect of the invention the stub portion includes a radially outwardly bulging annular deformation, the pedestal including a radially inwardly directed flange delimiting the hollow at the first end, a lock for locking the dielectric body to the pedestal comprising a face of the flange facing the base cooperating with the annular deformation of the stub portion.

According to the invention the filter assembly may be formed by a method involving the steps of providing a dielectric body that has a stub portion with an annular deformation zone adapted for creating an outwardly bulging annular portion by deformation, inserting the stub portion into the hollow of the pedestal, maintaining the dielectric body resting against an inwardly directed flange of the pedestal, applying a compressive force onto the stub portion to deform the deformation zone of the stub portion at a the radially inwardly directed flange of the pedestal, thereby establishing the outwardly bulging annular deformation.

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A kit for making the cavity microwave filter assembly is also proposed, the kit including a housing having said at least one cavity and a base, a resonator body, and a pedestal which includes the radially inwardly directed

flange at a first end thereof, the stub portion of said resonator body being an elongated tubular body having an inner thread, a substantially smooth outer surface and an annular deformation zone adapted to provide for an outwardly bulging annular portion by deformation through a compressive force applied in a longitudinal direction of the stub portion.

The dependent claims are directed to embodiments involving additional advantages, as will appear from the below detailed description.

Brief description of the drawings and detailed description of the invention

An embodiment of the invention will now be explained in details with reference to the drawings where

Fig. 1a is a perspective view seen from below of a telecommunications device with a cavity microwave filter assembly,

Fig. 1b is an exploded view of the device of fig. 1a, showing the filter assembly,

Fig. 1c is a perspective view of the bottom part of the filter assembly, and

Fig. 2 - 5 show steps performed in the making of a dielectric resonator used in the assembly.

Fig. 1a is a perspective view of a telecommunications device 300 used i.a. for filtering an electromagnetic wave and including a microwave filter assembly 1 as well as a heat sink 150. The device 300 is shown in an exploded perspective view in fig. 1b, showing a top part 1' and a

bottom part 1" of the filter assembly 1. An input probe or connection 2 is configured for receiving input electromagnetic energy and an output probe or connection 3 is configured for providing output filtered electromagnetic energy.

Fig. 1c shows the bottom part 1" in a perspective view. The bottom part has a base 5 supporting walls 4', 4" defining a plurality of cavities 4. Dielectric resonators 10 often referred to as 'top hats' and comprising a dielectric body 15 on a pedestal 30 are mounted on the base 5 in the cavities 4. A tuning screw 40, which may eg. be of aluminium or PEI (Polyether Imide) extends through each resonator 10.

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The base 5 has several through-going apertures 6, as shown in fig. 1a, at the location of each pedestal 30. The apertures 6 provide access openings for insertion into the filter assembly 1 of a tool, such as a screw driver mounted on a robot arm (not shown), for adjusting the position of the tuning screws 40 by engaging the lower end (not shown) of the tuning screws 40. By turning the screws 40 the position of a head portion 40' of each screw 40 relative to the top part 1' can be varied in order to tune the filter assembly 1.

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Fig. 2 is a cross-sectional view through the dielectric resonator 10 which includes the dielectric body 15 and the pedestal 30. The dielectric body 15, which may eg. be of low carbon steel, has a head portion 17 and a tubular stub portion 20 with an internal thread 21 (not shown). The tubular stub portion 20 extends from the head portion 17 of the dielectric body 15 into the pedestal 30 to which it is secured. The pedestal 30 has a first end 31

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and an opposite second end 32 with a flange. The pedestal 30 is mounted to the base 5 at the second end 32, and has a hollow 35. As shown, an annular space 13 is formed between the stub portion 20 and the pedestal 30.

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As seen also in fig. 5, an abutment face 16 of the dielectric body 15 rests directly or indirectly against the pedestal 30 with the stub portion 20 received in the hollow, and the stub portion 20 includes a radially outwardly bulging annular deformation 22. The pedestal 30 on the other hand includes a radially inwardly directed flange 33 that delimits the hollow 35 at the first end 31. A central passage 12 extends through the dielectric body 15 and the pedestal 30 and has the tuning screw 40 used for creating the desired response of the assembly 1 to the input electromagnetic energy. The screw 40 extends through the central passage 12, engaging the internal thread 21 of the stub portion 20. As shown, a lock holds the dielectric body 15 securely to the pedestal 30 in that a face 34 of the pedestal flange 33 facing the base 5 cooperates with the annular deformation 22 of the stub portion 20.

Figs. 3, 4 and 5 show method steps followed in establishing the aforementioned lock. A dielectric body 15 with an internally threaded stub portion 20 formed with an easily deformed annular deformation zone 22' is first provided. The internal thread 21 may be formed only on the part of the stub portion 20 below the deformation zone 22'. The stub portion 20 is inserted into the hollow 35, and the dielectric body 15 is maintained resting against the flange 33 of the pedestal 30 using a suitable fixture (not shown). Then, a compressive force is applied onto the stub portion 20 to deform the stub portion 20 in the

deformation zone 22' at the flange 33, thereby establishing the outwardly bulging annular deformation 22 which effectively clamps the pedestal flange 33 between the deformation 22 and the abutment face 16 of the head portion
5 17 that rests against the pedestal 30.

Preferably the deformation of the deformation zone 22' is provided as shown in fig. 4 by inserting into the head portion 17 a tool 100, placing a threaded rotatable head
10 portion 105 of the tool 100 into engagement with the thread 21 of the stub portion 20, as shown in fig. 4, and rotating the rotatable head portion 105 of the tool 100 further to provide the compressive force that draws the tip of the stub portion 20 towards the abutment face 16,
15 as shown in fig. 4.

CLAIMS:

1. A cavity microwave filter assembly (1) for filtering an electromagnetic wave, including:
- 5 an input connection (2) for receiving input electromagnetic energy,
- an output connection (3) for providing output filtered electromagnetic energy, and
- at least one cavity (4) with a base (5) supporting a dielectric resonator (10),
- 10 said dielectric resonator (10) comprising:
- i) a dielectric body (15) with a tubular stub portion (20) having an internal thread (21), and
- ii) a pedestal (30) with a first end (31), an opposite
- 15 second end (32) and a hollow (35),
- said pedestal (30) being mounted to said base (5) at said second end (32),
- said dielectric body (15) resting against said pedestal (30) with said stub portion (20) received in said hollow
- 20 (35),
- said stub portion (20) including an outwardly bulging annular deformation (22),
- said pedestal (30) including an inwardly directed flange (33) delimiting said hollow (35) at said first end
- 25 (31),
- a central passage (12) extending through said dielectric body (15) and said pedestal (30),
- a tuning screw (40) for creating a desired response of said assembly (1) to said input electromagnetic energy,
- 30 said screw (40) extending through said central passage (12) engaging said internal thread (21), and
- a lock for locking said dielectric body (15) to said pedestal (30), said lock comprising a face (34) of said

flange (33) facing said base (5) cooperating with said annular deformation (22) of said stub portion (20).

2. The assembly of claim 1, said screw (40) engaging only
5 said dielectric body (15).

3. The assembly of claim 1 or 2, said screw (40) being accessible through said base (5), for varying the position of said screw in said passage (12).

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4. The assembly according to any of the preceding claims, an annular space (13) being provided between said stub portion (20) and said pedestal (30).

15 5. The assembly according to any of the preceding claims, said flange (33) and said peripheral deformation (22) extending perpendicular to said central passage (12).

6. The assembly according to any of the preceding claims,
20 said dielectric body (15) having an abutment face (16) resting on said flange (33) of said pedestal (30).

7. A kit for making a cavity microwave filter assembly (1) according to any of the preceding claims, said assembly including i) a housing bottom part (1'') having said
25 at least one cavity (4) and said base (5), ii) a resonator body (15), and iii) said pedestal (30) including said radially inwardly directed flange (33) at said first end (31), said stub portion (20) of said resonator body (15)
30 being an elongated tubular body having an inner thread (21) and an annular deformation zone (22') adapted to provide for an outwardly bulging annular portion (22) by deformation through a compressive force being applied in a longitudinal direction of said stub portion (20).

8. A method of making the assembly according to any of claims 1-6, said stub portion (20) having an annular deformation zone (22') adapted to provide for an outwardly bulging annular portion (22) by deformation, comprising
5 the steps of:

- i) inserting said stub portion (20) into said hollow (35),
- ii) maintaining said dielectric body (15) resting against
10 said pedestal (30),
- iii) applying a compressive force onto said stub portion (20) to deform said deformation zone (22') at said flange (33), thereby establishing said outwardly bulging annular deformation (22).

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9. The method according to the preceding claim, wherein said step iii) is performed by inserting a tool (100) into a head portion (17) of said dielectric body (15) opposite said stub portion (20), rotating a threaded rotatable head portion (105) of said tool (100) into engagement with said thread (21) of said stub portion (20),
20 and rotating said rotatable head portion (105) of said tool (100) further to provide said compressive force, and wherein said tool (100) is then removed.

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Fig. 1b

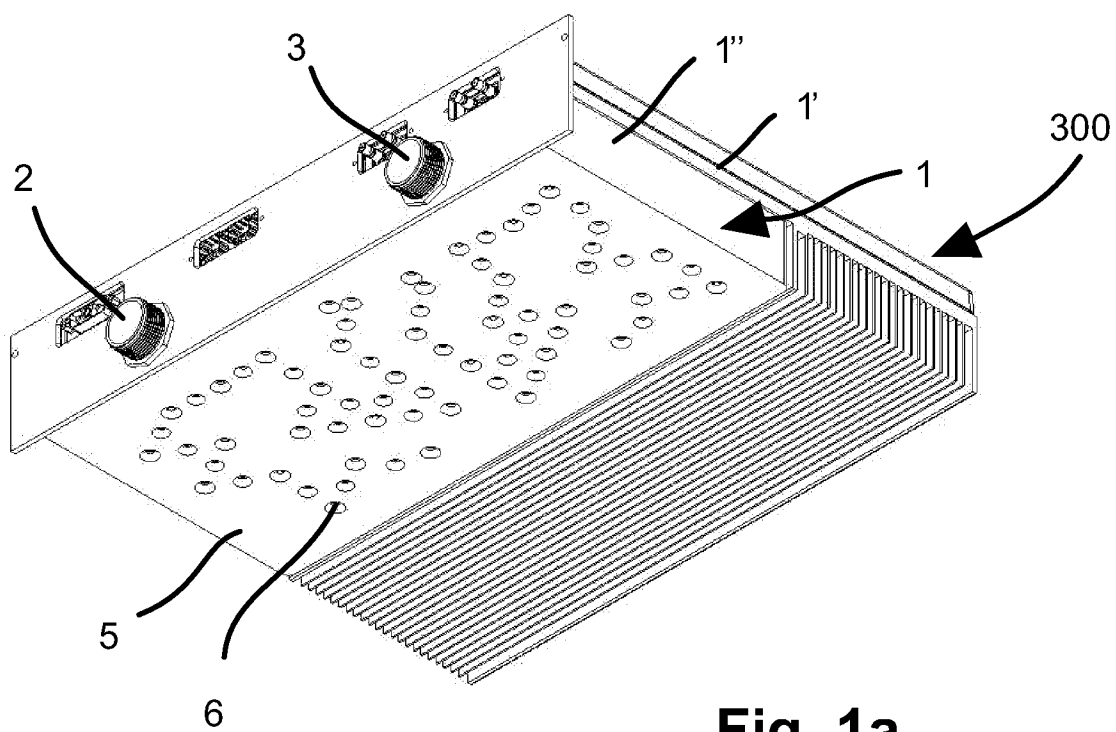
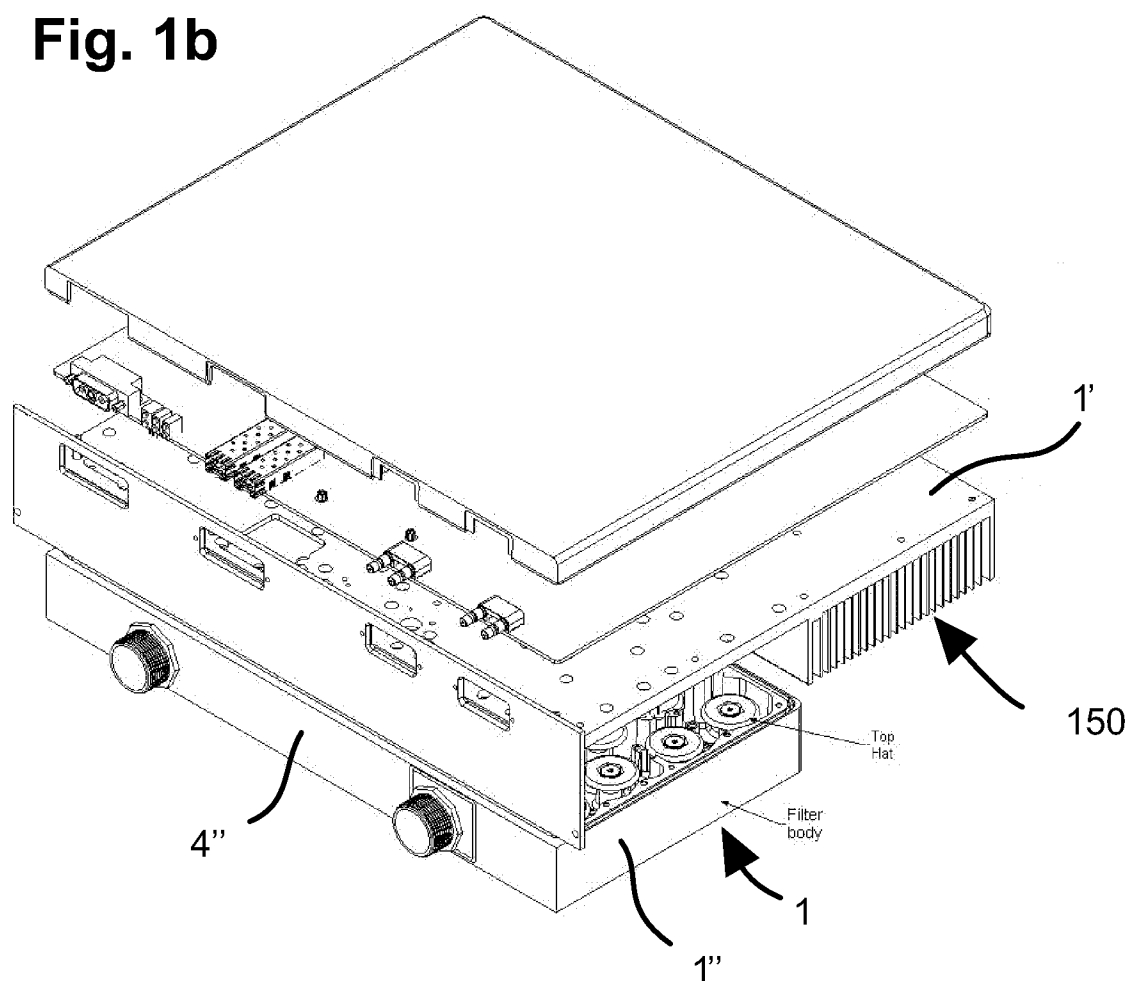
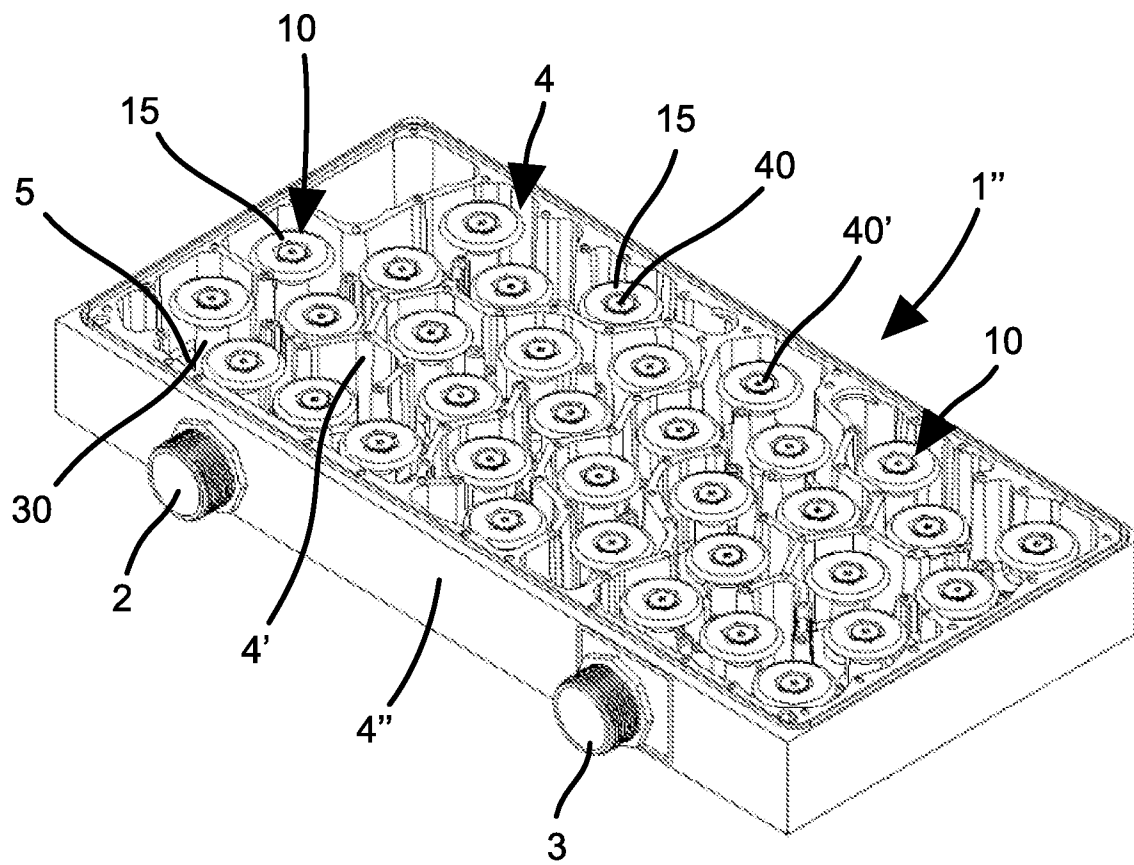


Fig. 1a

Fig. 1c

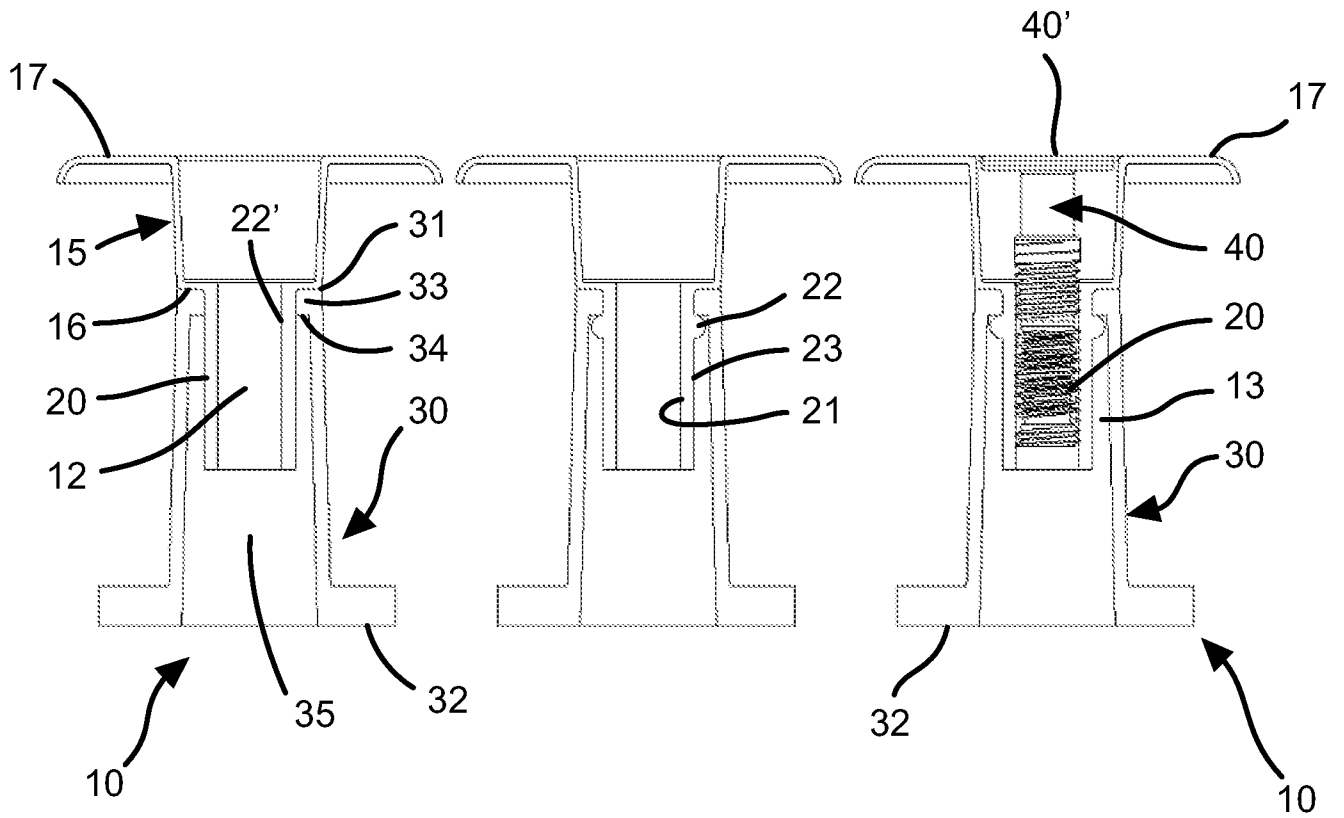
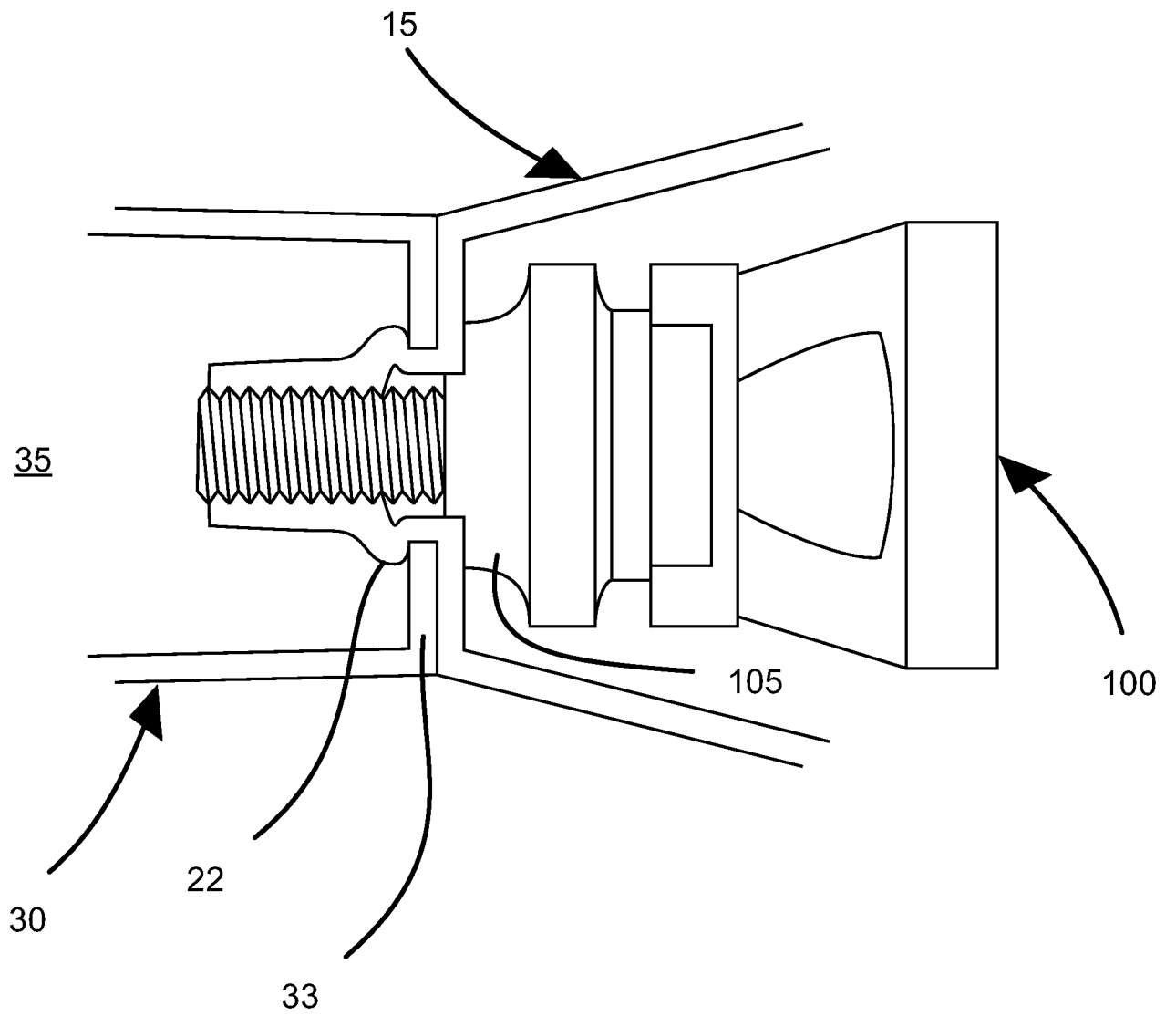


Fig. 3

Fig. 5

Fig. 2

Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/078486

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNKI, VEN: cavity, filter?, resonator?, flange, thread, lock+, screw?, tubal, tubular

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN1330801A (ERICSSON TELEFON AB. L. M.) 09 Jan. 2002(09.01.2002) the whole document	1-9
A	CN101546853A (SHANGHAI HUAWEI TECHNOLOGIES CO., LTD.) 30 Sep. 2009 (30.09.2009) the whole document	1-9
A	CN201181730Y (UNIV. SOUTH CHINA TECH.) 14 Jan. 2009(14.01.2009) the whole document	1-9
A	JP2005223665A (TAMAGAWA ELECTRONICS CO., LTD.) 18 Aug. 2005(18.08.2005) the whole document	1-9

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 28 April 2012(28.04.2012)	Date of mailing of the international search report 24 May 2012 (24.05.2012)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer GU, Yingying Telephone No. (86-10)62411527

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2011/078486

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1330801A	09.01.2002	SE9804425A	19.06.2000
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		IN200100676P3	17.06.2005
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CN201181730Y	14.01.2009	None	
JP2005223665A	18.08.2005	None	

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER

H01P1/208 (2006.01) i

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