

(19)



(11)

EP 2 838 105 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

20.04.2016 Bulletin 2016/16

(51) Int Cl.:

H01J 23/207 ^(2006.01)

(21) Application number: **13180725.7**

(22) Date of filing: **16.08.2013**

(54) **Microwave resonant cavity**

Mikrowellenresonanzhohlraum

Cavité à hyper-fréquences résonnante

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(43) Date of publication of application:

18.02.2015 Bulletin 2015/08

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(56) References cited:

**EP-A2- 0 125 450 US-A- 3 103 609
US-A- 5 422 541**

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a microwave resonant cavity, and more particularly, to a microwave resonant cavity with a screw hole and a screw with threads of different pitches.

DISCUSSION OF THE BACKGROUND

[0002] Microwave and radio frequency (RF) filters are common components of communication devices. Both transmitters and receivers use filters for rejection of signals in the unwanted frequency bands. A major application of such filters is in cellular personal communications services (PCS) phones. The most commonly used filter for cellular PCS applications is the coaxial ceramic type in which several coaxial ceramic resonators with very high relative dielectric constants are coupled to each other. These filters are often installed on top of circuit boards and substantially increase the height of the board thickness. As a result, such filters are one of the components that restrict the implementation of thin cell/PCS phone designs. A resonant cavity is a device having an enclosed volume bounded by electrically conductive surfaces and in which oscillating electromagnetic fields are sustainable. For example, resonant cavities may be used as filters and have excellent power handling capability and low energy losses. Several resonant cavities may be coupled together to achieve sophisticated frequency selective behavior. US 3 103 609 discloses a multicavity klystron amplifier comprising a body portion having a plurality of cavity resonators therein, said body portion being of block construction for conducting heat readily from the resonators there within, waveguides affixed to said body portion and communication with the first and last resonators thereof, said waveguides projecting outwardly in the same direction in spaced relation and having means at their outer ends for coupling to standard waveguides, a block of heat conducting material interconnecting said waveguides intermediate their lengths for conducting heat there from in use and a plurality of heat radiating fins affixed to said block and to said body portion for radiating heat into the atmosphere. EP 0 125 450 discloses that in microwave device, particularly a microwave local oscillator, frequency variations due to temperature changes are reduced by supporting the tuning element, for example a quartz or sapphire crystal, in the end of a tube of INVAR or other material having a low thermal coefficient of expansion. The tube projects into the cavity (12) from a hole in one wall thereof. Preferably the tube is positively located relative to the cavity by means of an external lip (20) on the tube abutting a shoulder (22) formed by a reduced diameter part of the hole adjacent the cavity. The lip (20) may be urged into positive contact with the shoulder (22) by a spring washer (24) acting between the end of the tube and the opposed end of a

bush (26) screwed into the hole.

[0003] In US 5 422 541 a klystron tuning mechanism includes a tuning element support mechanism, a preset section, a driving mechanism, and a pitch changing section. The tuning element support mechanism is arranged in a cavity resonator to be coupled to a tuning element, fixed in the cavity resonator, through bellows, and axially applies a biasing force to the tuning element. The preset section has a plurality of screw members axially positioned in accordance with preset tuning frequencies and selectively movable coaxially with the tuning element, and a preset plate having an internal thread portion meshed with the screw members. The preset section is retractably moved with respect to the tuning element support mechanism. The driving mechanism drives the preset section to retractably move so as to bring a selected one of the screw members into contact with the tuning element support mechanism against the biasing force, thereby positioning the tuning element to a preset position. The pitch changing section changes part of the pitch of the internal thread portion.

[0004] This "Discussion of the Background" section is provided for background information only. The statements in this "Discussion of the Background" are not an admission that the subject matter disclosed in this "Discussion of the Background" section constitutes prior art to the present disclosure, and no part of this "Discussion of the Background" section may be used as an admission that any part of this application, including this "Discussion of the Background" section, constitutes prior art to the present disclosure.

SUMMARY

[0005] One aspect of the present disclosure provides a microwave resonant cavity with a screw hole having a first pitch and a screw having a second pitch different from the first pitch.

[0006] A microwave resonant cavity according to one embodiment of the present disclosure comprises: a conductive shell defining a volume, wherein the conductive shell includes a screw hole having first threads; a screw having second threads configured to engage with the screw hole, wherein the screw extends into the volume, the microwave resonant cavity has a resonant frequency, and the movement of the screw changes the resonant frequency; wherein the first threads have a first pitch, and at least a portion of the second threads has a second pitch different from the first pitch.

[0007] A microwave resonant cavity according to another embodiment of the present disclosure comprises: a conductive shell defining a volume, wherein the conductive shell includes a screw hole having first threads; a screw having second threads configured to engage with the screw hole, wherein the screw extends into the volume; and wherein the microwave resonant cavity has a resonant frequency, and the movement of the screw changes the resonant frequency; wherein the first

threads have a substantially constant pitch, and at least a portion of the second threads has a gradually changed pitch.

[0008] The resonant frequency of the microwave resonant cavity can be adjusted by changing the extending position of the screw into the volume, and the screw can be firmly fixed in the screw hole after the adjustment of the resonant frequency is completed due to the design of different pitches between the screw hole and the screw. As a result, the resonant frequency of the microwave resonant cavity will be maintained at the desired value.

[0009] The foregoing has outlined rather broadly the features and technical advantages of the present disclosure in order that the detailed description of the disclosure that follows may be better understood. Additional features and advantages of the disclosure will be described hereinafter, which form the subject of the claims of the disclosure. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures or processes for carrying out the same purposes of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete understanding of the present disclosure may be derived by referring to the detailed description and claims when considered in connection with the Figures, where like reference numbers refer to similar elements throughout the Figures, and:

FIG. 1 illustrates an assembled view of a microwave resonant cavity according to one embodiment of the present disclosure;

FIG. 2 illustrates a disassembled view of the microwave resonant cavity shown in FIG. 1;

FIG. 3 illustrates an upside-down view of the microwave resonant cavity shown in FIG. 2;

FIG. 4 illustrates a cross-sectional view of the microwave resonant cavity 10 along a section line 1-1 in FIG. 1;

FIG. 5 is a close-up cross-sectional view of the conductive shell and the screw according to one embodiment of the present disclosure;

FIG. 6 is a close-up cross-sectional view of the conductive shell and a screw according to another embodiment of the present disclosure;

FIG. 7 is a close-up cross-sectional view of the conductive shell and a screw according to another embodiment of the present disclosure; and

FIG. 8 is a close-up cross-sectional view of the conductive shell and a screw according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0011] The following description of the disclosure accompanies drawings, which are incorporated in and constitute a part of this specification, and illustrate embodiments of the disclosure, but the disclosure is not limited to the embodiments. In addition, the following embodiments can be properly integrated to complete another embodiment.

[0012] References to "one embodiment," "an embodiment," "exemplary embodiment," "other embodiments," "another embodiment," etc. indicate that the embodiment(s) of the disclosure so described may include a particular feature, structure, or characteristic, but not every embodiment necessarily includes the particular feature, structure, or characteristic. Further, repeated use of the phrase "in the embodiment" does not necessarily refer to the same embodiment, although it may.

[0013] The present disclosure is directed to a microwave resonant cavity with a screw hole and a screw with threads of different pitches. In order to make the present disclosure completely comprehensible, detailed steps and structures are provided in the following description. Obviously, implementation of the present disclosure does not limit special details known by persons skilled in the art. In addition, known structures and steps are not described in detail, so as not to limit the present disclosure unnecessarily. Preferred embodiments of the present disclosure will be described below in detail. However, in addition to the detailed description, the present disclosure may also be widely implemented in other embodiments. The scope of the present disclosure is not limited to the detailed description, and is defined by the claims.

[0014] FIG. 1 illustrates an assembled view of a microwave resonant cavity 10 according to one embodiment of the present disclosure, FIG. 2 illustrates a disassembled view of the microwave resonant cavity 10 shown in FIG. 1, and FIG. 3 illustrates an upside-down view of the microwave resonant cavity 10 shown in FIG. 2. In one embodiment of the present disclosure, the microwave resonant cavity 10 comprises a conductive shell 20 with a screw hole 21 having first threads 23 and a screw 30 having second threads 33 configured to engage with the screw hole 21.

[0015] FIG. 4 illustrates a cross-sectional view of the microwave resonant cavity 10 along a section line 1-1 in FIG. 1. Referring to FIG. 1, FIG. 3 and FIG. 4, in one embodiment of the present disclosure, the conductive shell 20 defines a volume 25, the screw 30 extends into the volume 25, and the microwave resonant cavity 10 has a resonant frequency depending on the position of the screw 30. In other words, the movement of the screw 30 changes the resonant frequency. In one embodiment

of the present disclosure, the conductive shell 20 includes a notch 26 configured to couple microwave energy into or out of the volume 25, as shown in FIG. 3.

[0016] In one embodiment of the present disclosure, the screw 30 includes a depression 31 on one end to accommodate a tool such as a screw driver for driving the screw 30 into the volume 25 to adjust the resonant frequency of the microwave resonant cavity 10. In one embodiment of the present disclosure, the conductive shell 20 has a first hardness, and the screw 30 has a second hardness greater than the first hardness, such that the first threads 23 of the conductive shell 20 will be deformed by the second threads 33 of the screw 20. As a result, the deformed first threads 23 of the conductive shell 20 will lock up the screw 20 at a desired position, i.e., the screw 20 can be firmly fixed in the screw hole 21, and the resonant frequency of the microwave resonant cavity 10 will be kept at a desired frequency.

[0017] In one embodiment of the present disclosure, the microwave resonant cavity 10 further comprises a printed circuit board 40 having a transmission line 41, wherein the conductive shell 20 is mounted on the printed circuit board 40. The electromagnetic properties of the resonant, air-filled resonant cavity 10 are dependent on the exact dimensions of the effective length of the screw 30 and its distance from the external wall of the cavity, and the capacitive gap between the screw 30 and the external metalized surface of the printed circuit board 40 that forms a part of the resonant cavity 10.

[0018] The microwave signal is considered to be guided to the resonant cavity 10 through the embedded waveguide/transmission line 41, which can be implemented, for example, in either microstrip or stripline technology. When the microwave signal reaches the end of the feeding transmission line 41, it is guided through a vertical via post (or an array of via posts) 43 to a metalized feeding pad 45 located inside the volume 25.

[0019] FIG. 5. is a close-up cross-sectional view of the conductive shell 20 and the screw 30 according to one embodiment of the present disclosure. In one embodiment of the present disclosure, the first threads 23 have a first pitch P1, and at least a portion of the second threads 33 has a second pitch P2 different from the first pitch P1. In a preferred embodiment of the present disclosure, the second pitch P2 is substantially larger than the first pitch P1.

[0020] FIG. 6. is a close-up cross-sectional view of the conductive shell 20 and a screw 50 according to another embodiment of the present disclosure. In one embodiment of the present disclosure, the screw 50 has a front portion 50A having third threads 53A and a back portion 50B having second threads 53B, wherein the second threads 53B have a second pitch P2 and the third threads 53A have a third pitch P3 different from the second pitch P2. In one embodiment of the present disclosure, the third pitch P3 can be either larger than or equal to the second pitch P2.

[0021] In one preferred embodiment of the present dis-

closure, the third pitch P3 of the third threads 53A in the front portion 50A is substantially the same as the first pitch P1 of the first threads 23 in the conductive shell 20, such that the screw 50 can be easily moved into the screw hole 21 of the conductive shell 20 when the front portion 50A begins to engage with the screw hole 21. After the front portion 50A is moved into the screw hole 21, the back portion 30B of the screw 50 starts to engage with the screw hole 21, and the screw 50 can be firmly fixed in the screw hole 21 by using the different pitch design between the first threads 23 and second threads 53B.

[0022] FIG. 7. is a close-up cross-sectional view of the conductive shell 20 and the screw 60 according to another embodiment of the present disclosure. In one embodiment of the present disclosure, the screw 60 has second threads 63 with a gradually changed pitch, and the first threads 23 of the conductive shell 20 have a substantially constant pitch. In a preferred embodiment of the present disclosure, the pitch of the second threads 60 at a front portion of the screw 60 is substantially the same as the pitch of the first threads 23 in the conductive shell 20, such that the screw 60 can be easily moved into the screw hole 21 of the conductive shell 20 when the front portion begins to engage with the screw hole 21. After the front portion is moved into the screw hole 21, the threads 63 with increasing pitch start to engage with the screw hole 21 and the screw 60 can be firmly fixed in the screw hole 21 by using the increasing pitch design of second threads 63.

[0023] FIG. 8. is a close-up cross-sectional view of the conductive shell 20 and a screw 70 according to another embodiment of the present disclosure. In one embodiment of the present disclosure, the screw 70 has a front portion 70A having third threads 73A and a back portion 70B having second threads 73B, wherein the third threads 73A have a third pitch P3 substantially the same as the first pitch P1 of the first threads 23 of the conductive shell 20. In one embodiment of the present disclosure, the second threads 73B have a gradually changed pitch.

[0024] When the front portion 70A begins to engage with the screw hole 21, the screw 70 can be easily moved into the screw hole 21 of the conductive shell 20 because the third pitch P3 of the third thread 73A in the front portion 70A is substantially the same as the first pitch P1 of the first threads 23 of the conductive shell 20. After the front portion 70A is moved into the screw hole 21, the back portion 70B of the screw 70 starts to engage with the screw hole 21, and the screw 70 can be firmly fixed in the screw hole 21 by using the increasing pitch design of second threads 73B.

[0025] The resonant frequency of the microwave resonant cavity 10 can be adjusted by changing the extending position of the screw 30 into the volume 25, and the screw 30 can be firmly fixed in the screw hole 21 after the adjustment of the resonant frequency is completed due to the design of different pitches between the screw hole 21 and the screw 30. As a result, the resonant frequency of the microwave resonant cavity will be main-

tained at the desired value.

[0026] Although the present disclosure and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the scope of the disclosure as defined by the appended claims. For example, many of the processes discussed above can be implemented in different methodologies and replaced by other processes, or a combination thereof.

[0027] Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present disclosure, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed, that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present disclosure.

Claims

1. A microwave resonant cavity (10), comprising:

a conductive shell (20) defining a volume, and the conductive shell including a screw hole (21) having first threads (23);
a screw (30) having second threads (33) configured to engage with the screw hole, wherein the screw extends into the volume; and
wherein the microwave resonant cavity has a resonant frequency, and the movement of the screw changes the resonant frequency;
wherein the first threads have a first pitch, and at least a portion of the second threads has a second pitch different from the first pitch, wherein the conductive shell (20) has a first hardness and the screw (30) has a second hardness greater than the first hardness,
characterized in that the first threads (23) of the conductive shell are deformed by the second threads (33) of the screw.

2. A microwave resonant cavity, (10) comprising:

a conductive shell (20) defining a volume, and the conductive shell including a screw hole (21) having first threads (23) a screw (60) having second threads (63) configured to engage with the screw hole, wherein the screw extends into the volume; and
wherein the microwave resonant cavity has a resonant frequency, and the movement of the screw changes the resonant frequency;
wherein the conductive shell (20) has a first

hardness and the screw (30) has a second hardness greater than the first hardness, **characterized in that**

the first threads (23) have a substantially constant pitch, and at least a portion of the second threads has a gradually changed pitch. and **in that** the first threads (23) of the conductive shell are deformed by the second threads (63) of the screw.

3. The microwave resonant cavity of claim 1, wherein the second pitch is substantially larger than the first pitch.

4. The microwave resonant cavity of claim 1, wherein the screw has a front portion having third threads and a back portion having the second threads, and the third threads have a third pitch different from the second pitch.

5. The microwave resonant cavity of claim 4, wherein the third pitch is substantially the same as the first pitch.

6. The microwave resonant cavity of claim 4, wherein the third pitch is substantially larger than the second pitch.

7. The microwave resonant cavity of claim 4, wherein the third pitch is substantially smaller than the second pitch.

8. The microwave resonant cavity of claim 1 or 2, wherein the screw includes a depression on one end to accommodate a tool for driving the screw.

9. The microwave resonant cavity of claim 1 or 2, further comprising a printed circuit board having a transmission line, wherein the conductive shell is mounted on the printed circuit board.

10. The microwave resonant cavity of claim 9, wherein the conductive shell includes a notch configured to couple microwave energy from the transmission line into the volume.

11. The microwave resonant cavity of claim 2, wherein the screw has a front portion having third threads and a back portion having the second threads, the second threads have a second pitch, and the third threads have a third pitch different from the second pitch.

12. The microwave resonant cavity of claim 11, wherein the first threads have a first pitch, and the third pitch is substantially the same as the first pitch.

Patentansprüche

1. Ein Mikrowellenresonanzhohlraum (10), umfassend:

ein leitendes Gehäuse (20) das ein Volumen definiert, und das leitende Gehäuse beinhaltet eine Gewindebohrung (21) mit einem ersten Gewinde (23); eine Schraube (30) mit einem zweiten Gewinden (33), konfiguriert zum Verschrauben mit der Gewindebohrung, wobei die Schraube sich in das Volumen erstreckt; und wobei der Mikrowellenresonanzhohlraum eine Resonanzfrequenz aufweist, und die Bewegung der Schraube ändert die Resonanzfrequenz; wobei das erste Gewinde eine erste Steigung aufweisen, und mindestens ein Abschnitt des zweiten Gewindes eine zweite Steigung unterschiedlich von der ersten Steigung aufweist, wobei das leitende Gehäuse (20) eine erste Härte aufweist und die Schraube (30) eine zweite Härte aufweist, die größer ist als die erste Härte, **dadurch gekennzeichnet, dass** das erste Gewinde (23) des leitenden Gehäuses durch das zweite Gewinde (33) der Schraube verformt wird.

2. Ein Mikrowellenresonanzhohlraum (10) umfassend:

ein leitendes Gehäuse (20) das ein Volumen definiert, und das leitende Gehäuse beinhaltet eine Gewindebohrung (21) mit ersten Gewinden (23), eine Schraube (60) mit einem zweiten Gewinden (63), konfiguriert zum Einschrauben in die Gewindebohrung, wobei die Schraube sich in das Volumen erstreckt; und wobei der Mikrowellenresonanzhohlraum eine Resonanzfrequenz aufweist, und die Bewegung der Schraube ändert die Resonanzfrequenz; wobei das leitende Gehäuse (20) eine erste Härte aufweist und die Schraube (30) eine zweite Härte aufweist, die größer ist als die erste Härte, **dadurch gekennzeichnet, dass** das erste Gewinde (23) eine substantiell konstante Steigung aufweisen, und mindestens ein Abschnitt des zweiten Gewindes hat eine graduell geänderte Steigung und dass das erste Gewinde (23) des leitenden Gehäuses durch das zweite Gewinde (33) der Schraube verformt wird.

3. Der Mikrowellenresonanzhohlraum nach Anspruch 1, wobei die zweite Steigung substantiell größer ist als die erste Steigung.

4. Der Mikrowellenresonanzhohlraum nach Anspruch 1 wobei die Schraube einen vorderen Abschnitt aufweist mit einem dritten Gewinde und einen hinteren Abschnitt mit dem zweiten Gewinde, und das dritte

Gewinde eine dritte Steigung unterschiedlich zu der zweiten Steigung aufweist.

5. Der Mikrowellenresonanzhohlraum nach Anspruch 4, wobei die dritte Steigung substantiell gleich der ersten Steigung ist.

6. Der Mikrowellenresonanzhohlraum nach Anspruch 4, wobei die dritte Steigung substantiell größer als die zweite Steigung ist.

7. Der Mikrowellenresonanzhohlraum nach Anspruch 4, wobei die dritte Steigung substantiell kleiner als die zweite Steigung ist.

8. Der Mikrowellenresonanzhohlraum nach Anspruch 1 oder 2, wobei die Schraube eine Vertiefung an einem Ende beinhaltet, um ein Werkzeug zum Drehen der Schraube unterzubringen.

9. Der Mikrowellenresonanzhohlraum nach Anspruch 1 oder 2, ferner umfassend eine Leiterplatte mit einer Übertragungsleitung, wobei das leitende Gehäuse auf der Leiterplatte montiert ist.

10. Der Mikrowellenresonanzhohlraum nach Anspruch 9, wobei das leitende Gehäuse eine Kerbe konfiguriert zum Einleiten von Mikrowellen-Energie von der Übertragungsleitung in das Volumen beinhaltet.

11. Der Mikrowellenresonanzhohlraum nach Anspruch 2, wobei die Schraube einen vorderen Abschnitt mit einem dritten Gewinde aufweist und einen hinteren Abschnitt mit einem zweiten Gewinden, das zweite Gewinde weist eine zweite Steigung auf und das dritte Gewinde weist eine dritten Steigung auf, die unterschiedlich zu der zweiten Steigung ist.

12. Der Mikrowellenresonanzhohlraum nach Anspruch 11, wobei das erste Gewinde eine erste Steigung aufweist und die dritte Steigung ist substantiell gleich der ersten Steigung.

Revendications

1. Une cavité micro-ondes résonante (10), comprenant:

une enveloppe conductrice (20) définissant un volume, et l'enveloppe conductrice comprenant un trou de vis (21) ayant des premiers filets (23); une vis (30) ayant des seconds filets (33) configurés pour venir en prise avec le trou de vis, dans lequel la vis pénètre dans le volume; et dans laquelle la cavité résonante à micro-ondes présente une fréquence de résonance, et le mouvement de la vis modifie la fréquence de

- résonance;
 dans laquelle les premiers filets présentent un premier pas, et au moins une partie des second filets présentent un second pas différents du second pas,
 dans laquelle l'enveloppe conductrice (20) présente une première dureté et la vis (30) présente une seconde dureté supérieure à la première dureté,
caractérisée en ce que les premiers filets (23) de l'enveloppe conductrice sont déformés par les seconds filets (33) de la vis.
2. Une cavité micro-ondes résonante (10) comprenant :
- une enveloppe conductrice (20) définissant un volume, et l'enveloppe conductrice comprenant un trou de vis (21) ayant des premiers filets (23); une vis (60) ayant des seconds filets (63) configurés pour venir en prise avec le trou de vis, dans lequel la vis s'étend au sein du volume; et dans laquelle la cavité micro-ondes résonante présente une fréquence de résonance, et le mouvement de la vis modifie la fréquence de résonance;
 dans laquelle l'enveloppe conductrice (20) présente une première dureté et la vis (30) présente une seconde dureté supérieure à la première dureté,
caractérisée en ce que les premiers filets (23) de l'enveloppe conductrice sont déformés par les seconds filets (63) de la vis.
3. La cavité micro-ondes résonante de la revendication 1, dans laquelle le second pas est sensiblement plus grand que le premier pas.
4. La cavité micro-ondes résonante de la revendication 1, dans laquelle la vis présente une partie avant des troisièmes filets et une partie arrière ayant les seconds filets, et les troisièmes filets ayant un troisième pas distinct du second pas.
5. La cavité micro-ondes résonante de la revendication 4, dans laquelle le troisième pas est sensiblement identique au premier pas.
6. La cavité micro-ondes résonante de la revendication 4, dans laquelle le troisième pas est sensiblement plus grand que le second pas.
7. La cavité micro-ondes résonante de la revendication 4, dans laquelle le troisième pas est sensiblement plus petit que le second pas.
8. La cavité résonante micro-ondes selon la revendication 1 ou 2, dans laquelle la vis comporte un creux sur une extrémité pour recevoir un outil d'entraînement de la vis.
9. La cavité micro-ondes résonante de la revendication 1 ou 2, comprenant en outre une carte de circuit imprimé ayant une ligne de transmission, dans laquelle l'enveloppe conductrice est montée sur la carte de circuit imprimé.
10. La cavité micro-ondes résonante de la revendication 9, dans laquelle l'enveloppe conductrice comprend une encoche configurée pour le couplage au volume de l'énergie micro-ondes de la ligne de transmission.
11. La cavité micro-ondes résonante de la revendication 2, dans laquelle la vis présente une partie avant ayant des troisièmes filets et une partie arrière ayant les seconds filets, les seconds filets ayant un second pas, et les troisièmes filets présentant un troisième pas distinct du second pas.
12. La cavité micro-ondes résonante de la revendication 11, dans laquelle les premiers filets présentent un premier pas, et le troisième pas est sensiblement identique au premier pas.

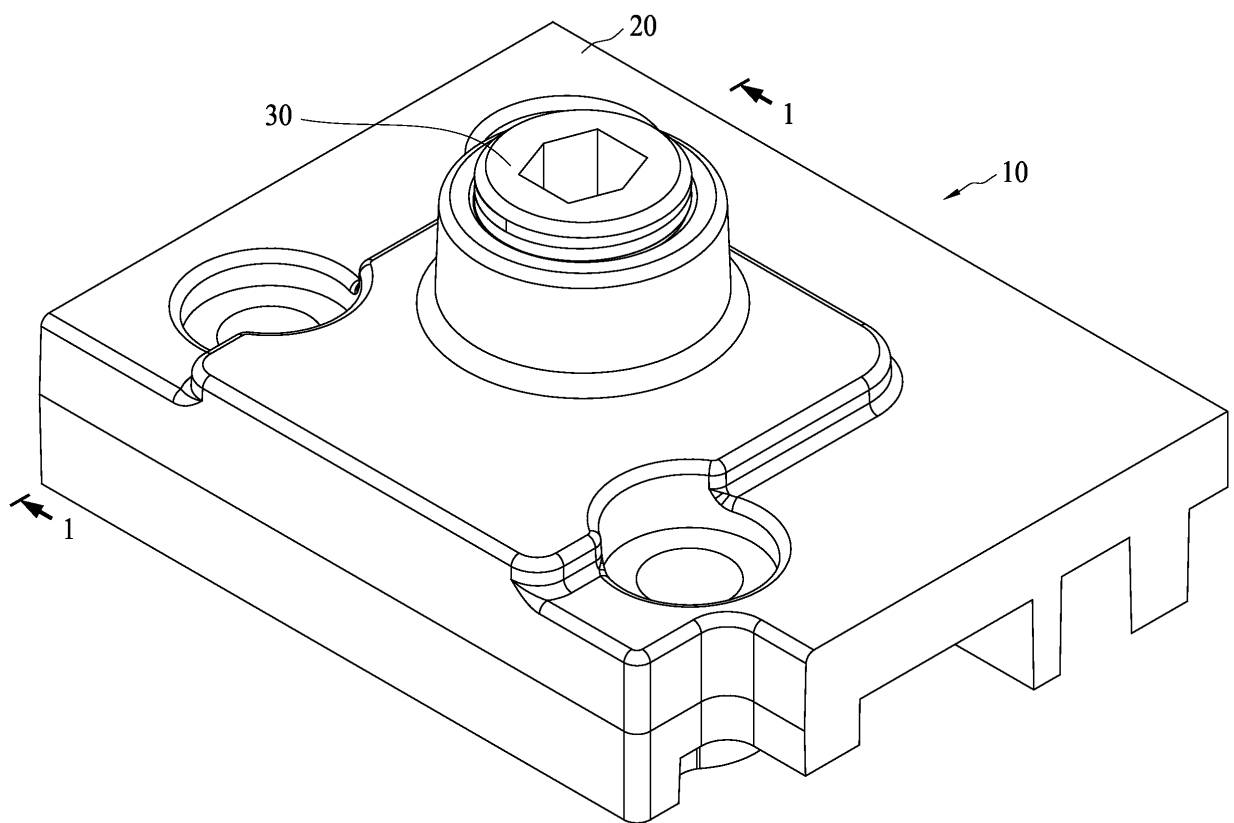


FIG. 1

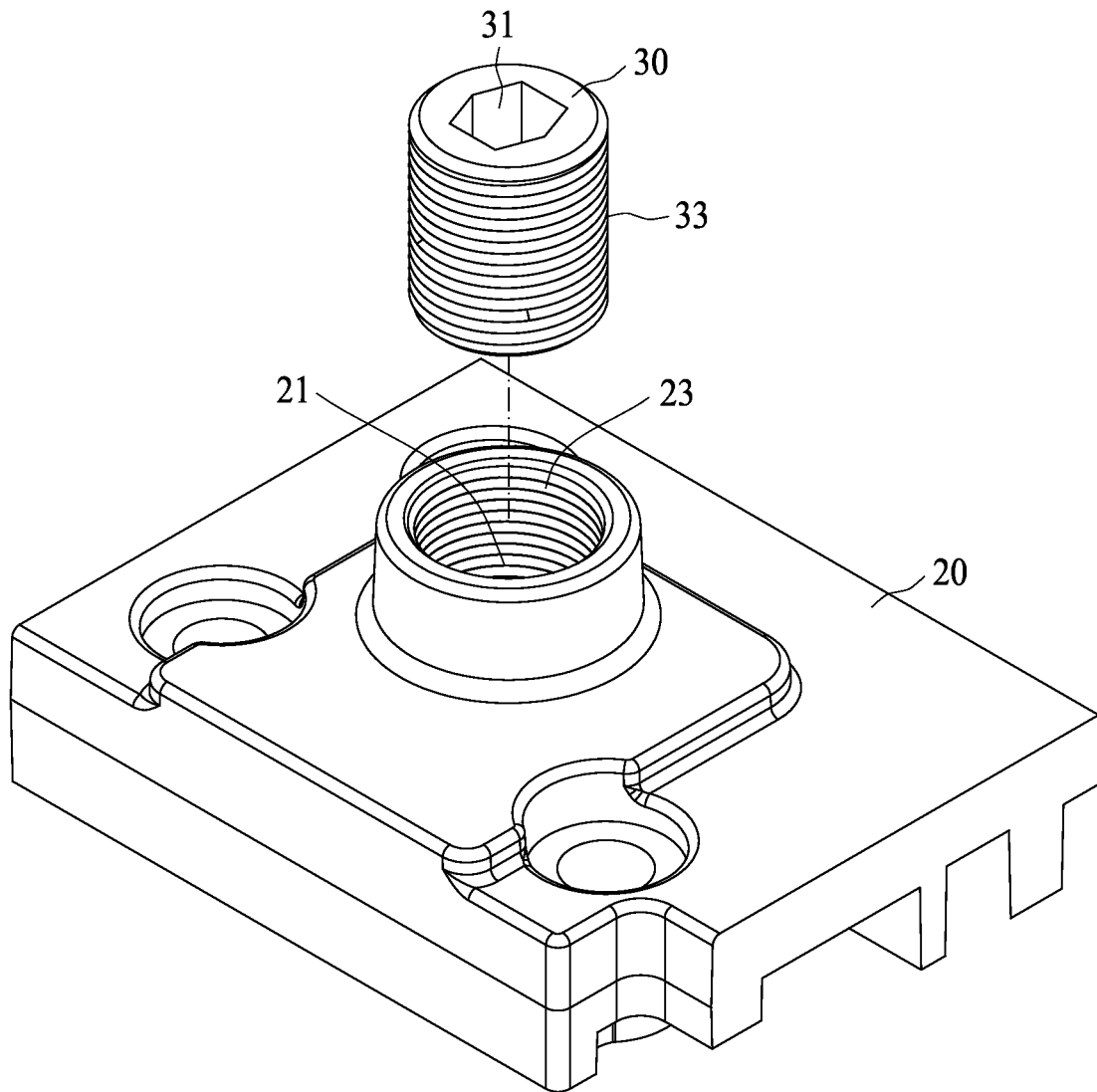


FIG. 2

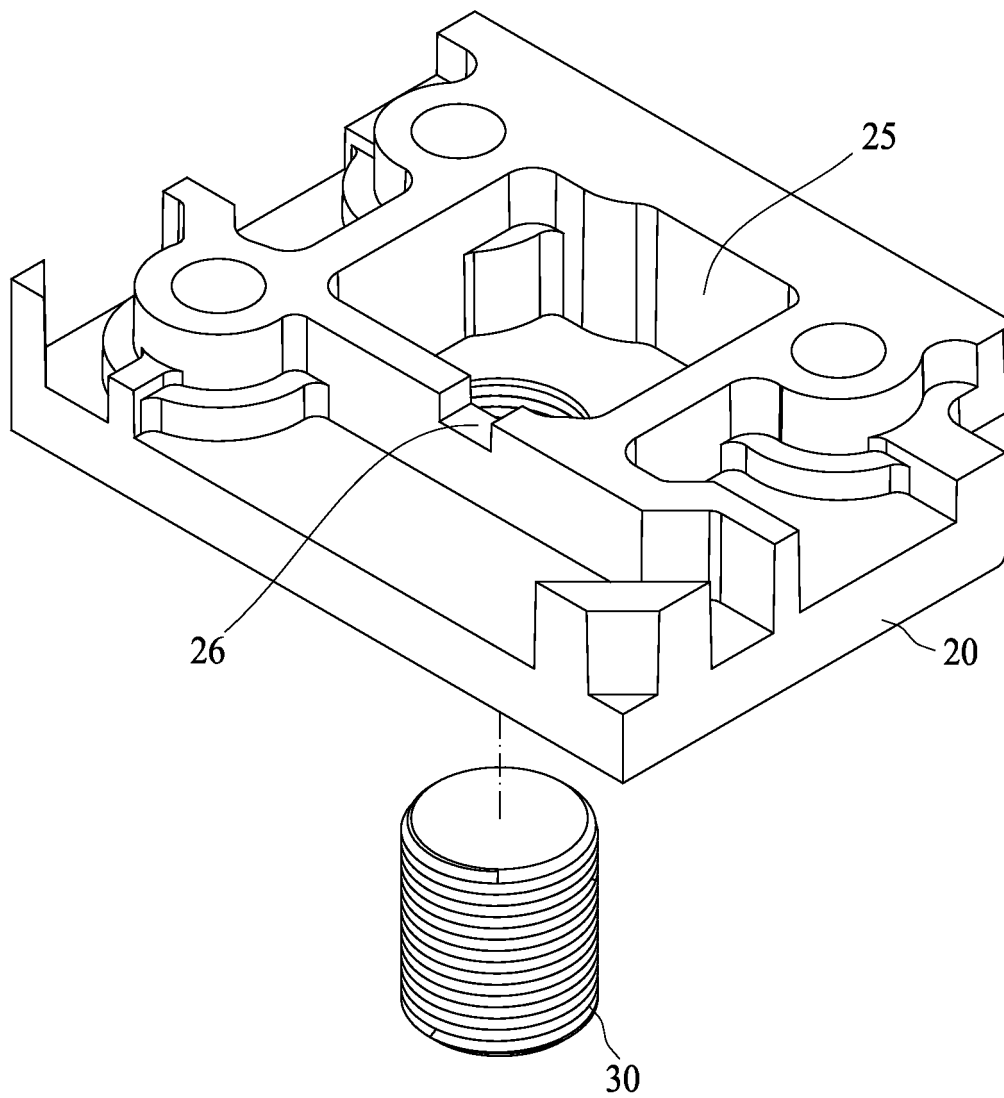


FIG. 3

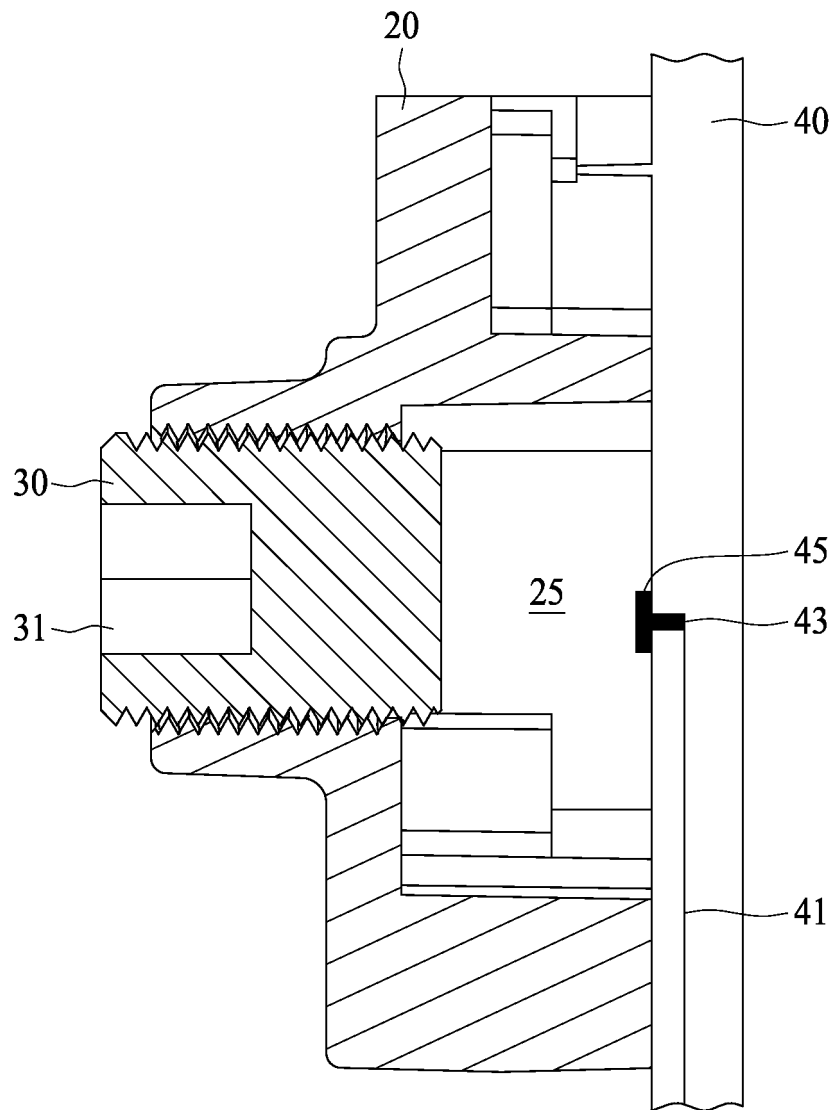


FIG. 4

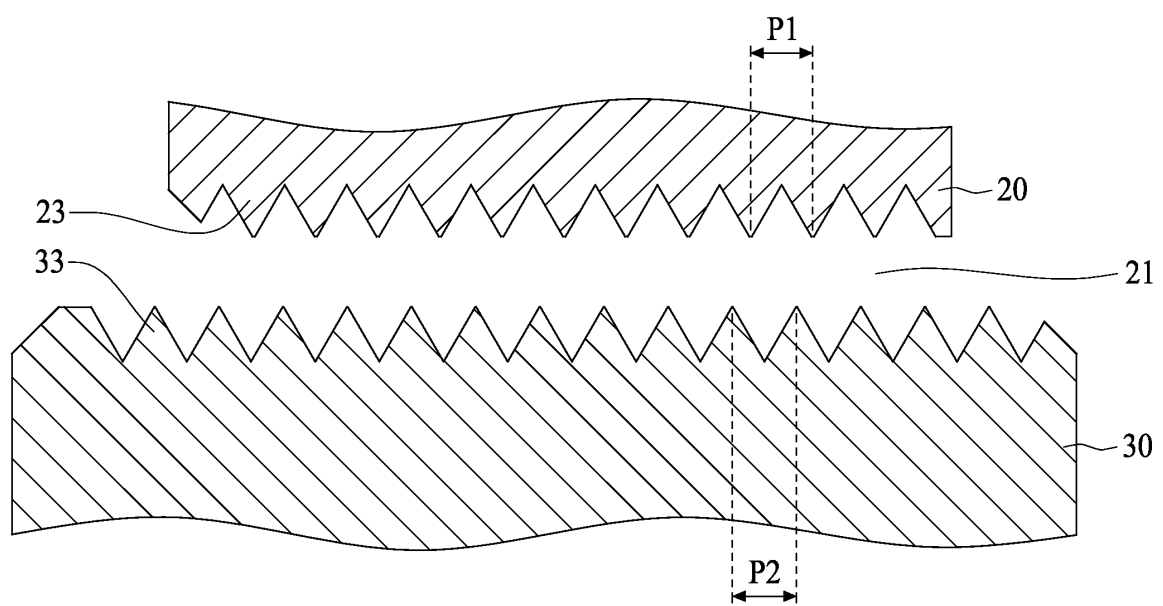


FIG. 5

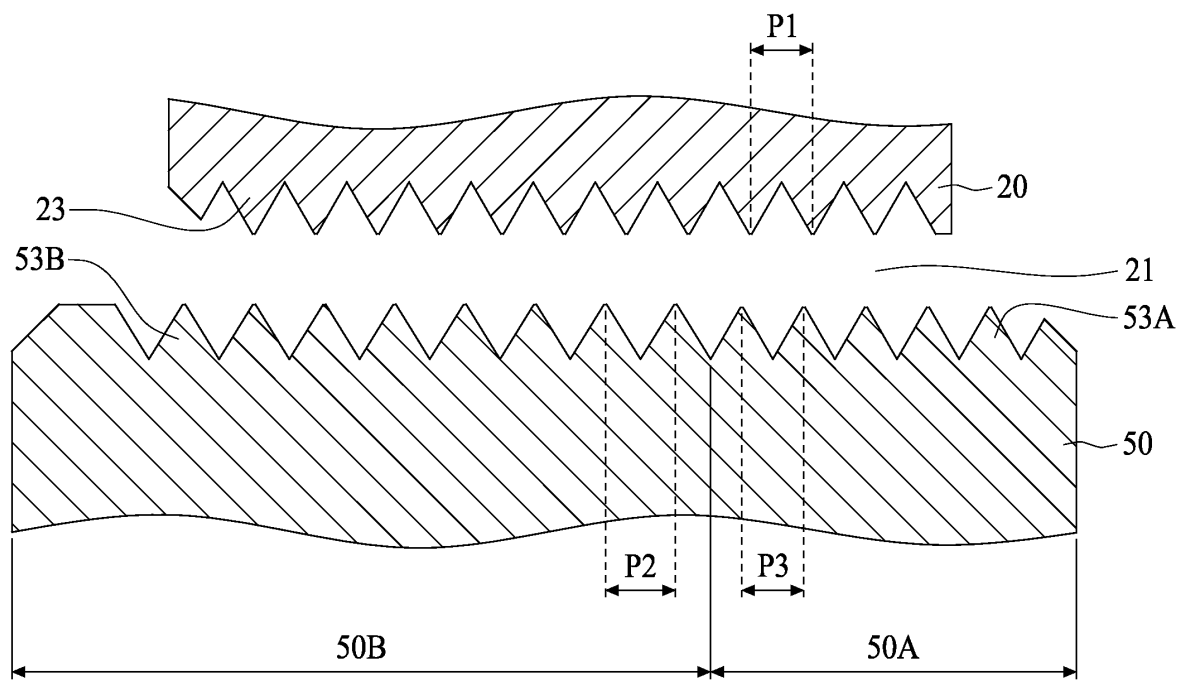


FIG. 6

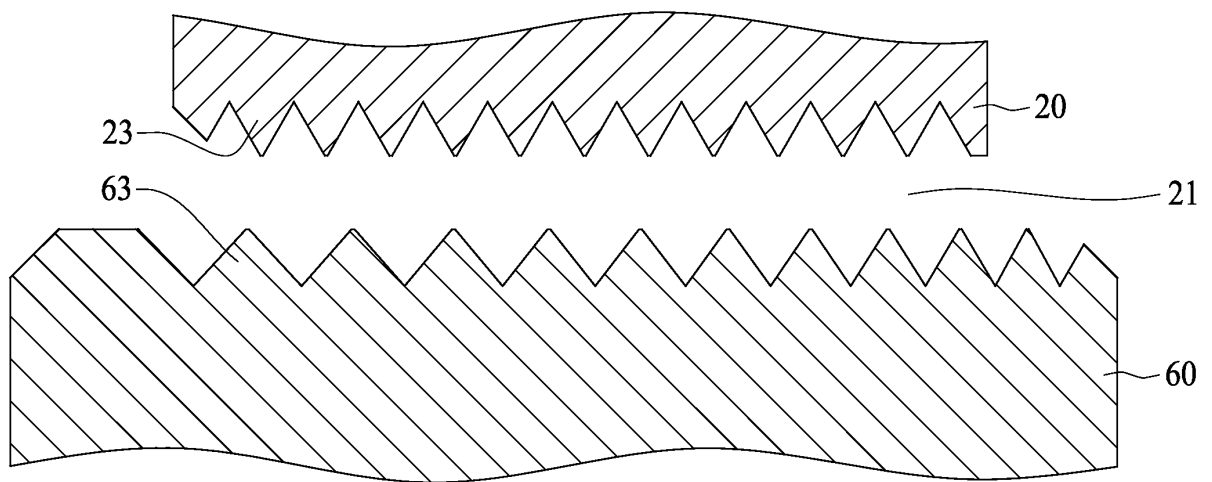


FIG. 7

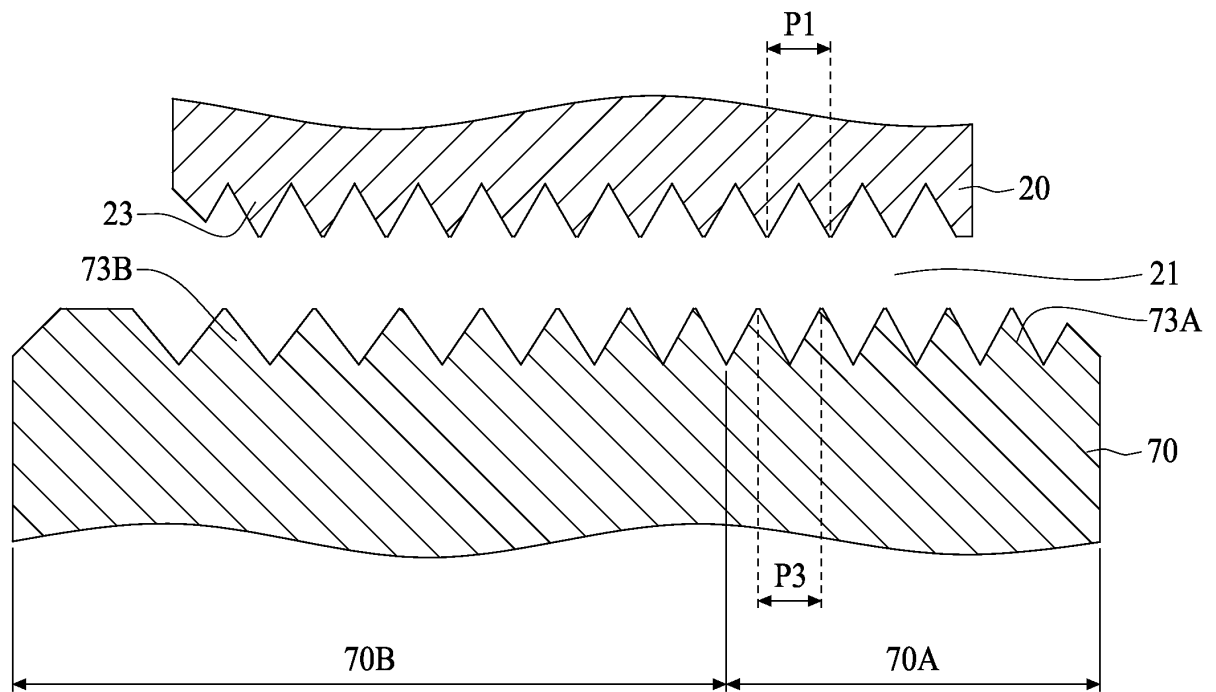


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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