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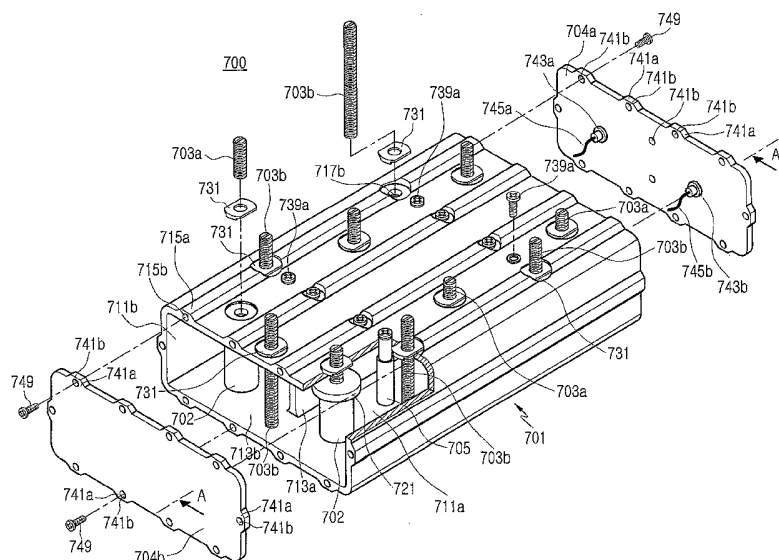
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[Continued on next page]

(54) Title: RADIO FREQUENCY FILTER



(57) Abstract: A radio frequency filter is disclosed. It has a metallic housing, which has a containing space extending along its longitudinal direction, and thus is easy to manufacture with little manufacturing cost. The metallic housing of the disclosed radio frequency filter is manufactured using an extrusion process. Therefore, the precision of products is guaranteed and the manufacturing cost of the radio frequency filter is reduced by decreasing the unit price. In addition, the metallic housing, which is fabricated through the extrusion process, has an initial form of a long frame, which can be cut into appropriate length and used according to the specification needed for the product. This enables active adaptation to the product specification. Furthermore, the metal resonator rods and the window rods are integrally formed in a single fixing frame and thus can be easily installed in the housing.



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RADIO FREQUENCY FILTER

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to a radio frequency filter, and more particularly to a radio frequency filter which is easy to manufacture and has little manufacturing cost.

10 2. Description of the Related Art

Radio frequency filters are commonly used for passing, blocking, and time delaying of service frequency band signals. The resonance frequency of the radio frequency filters is tuned by a tuning means to adjust the characteristics thereof.

15 A conventional radio frequency filter 100 will now be described with reference to FIGs. 1 to 6.

FIG. 1 is a perspective view showing an embodiment of a radio frequency filter 100 having disk-shaped metal resonator rods 120 according to the prior art. As shown in FIG. 1, the radio frequency filter 100 comprises a metallic housing 110, disk-shaped metal resonator rods 120, a cover 160, and tuning screws 170, 20 175.

The metallic housing 110 has an input connector 111 and an output connector 113. The interior of the metallic housing 110 is divided into a number of containing spaces by diaphragms 130. The disk-shaped metal resonator rods 120 are contained in the respective containing spaces. The input connector 111 and the output connector 113 are positioned on the same side of the metallic housing 110 and each of them is connected to a respective containing space. The diaphragms 130 have coupling windows 131, 132, 133, 134, and 135 formed therein for serial connection from a containing space, to which the input connector 111 is connected, to another containing space, to which the output connector 113 is connected. The metallic housing 110 has an open upper surface. After the disk-shaped metal resonator rods 120 are contained in the respective containing spaces, the upper end of the metallic housing 100 is sealed using the 30 cover 160.

35 The disk-shaped metal resonator rods 120 are composed of metal resonator rods 121, which extend from the bottom surface of the metallic housing 110, and disks 122, which extend along the upper outer peripheral surfaces of the metal resonator rods 121 in the diametric direction thereof.

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The radio frequency filter 100, wherein disks 122 are positioned on the metal resonator rods 120 which is assembled in the metallic housing 110, is characterized in that it is operated for low resonance frequency.

5 The interrelationship between the resonance frequency and the metallic housing 110, the disk-shaped metal resonator rods 120, the diaphragms 130, as well as the cover 160 will now be explained.

10 In general, the resonance frequency is determined by values of capacitance and inductance, which are formed among capacitive components 17 and inductive components 19 constituting a resonance circuit, particularly among a metallic housing 110, disk-shaped metal resonator rods 120, diaphragms 130, and a cover 160, as is clear from the circuit diagram shown in FIG. 6.

15 Meanwhile, referring to FIGs. 4 and 5, the input and output connectors 111, 113 are connected the disk-shaped metal resonator rods 120 via an input terminal coupling copper wire 115 and an output terminal coupling copper wire 117, respectively.

The resonance frequency of the radio frequency filter 100, constructed as described above, is affected by the length, outer diameter, and the like of the disk-shaped metal resonator rods 120 and is tuned more precisely with separate tuning screws 170, 175.

20 Referring to FIG. 1, the tuning screws 170, 175 are fastened on the cover 160 in locations corresponding to those of the disk-shaped metal resonator rods 120, which are contained in the metallic housing 110, as well as in locations corresponding to those of the coupling windows 131-135, which are formed in the diaphragms 130. The tuning screws 170, 175 are used to tune the resonance and coupling characteristics of the radio frequency filter 100 and are fixed using nuts 171, after the tuning, to prevent them from playing. The cover 160 is provided with fastening holes 169 for screws 179 and the metallic housing 110 is provided with, on its upper end, fastening tabs 180 to fix the cover 160 on the metallic housing 110.

30 The tuning screws 170, 175 are fastened into screw holes (not shown), which are formed on the cover 160, and are used to tune the resonance frequency, inductance, or capacitance. In other words, the radio frequency filter 100 is tuned by tightening or loosening the tuning screws 170, 175 to obtain desired resonance and coupling characteristics. After the radio frequency filter 100 is tuned, the tuning screws 170, 175 are fixed on the cover 160, for example, using nuts 171, lest the resonance frequency, as well as the resonance and coupling characteristics should be changed due to playing of tuning screws 170, 175.

35 Meanwhile, the tuning screws 170, 175 are classified into first tuning

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screws 170, which are fixed in locations corresponding to those of the disk-shaped metal resonator rods 120 and are used to tune the resonance characteristics, and second tuning screws 175, which are fixed in locations corresponding to those of the coupling windows 131-135 and are used to tune the coupling characteristics. The second tuning screws 175 may also be referred to as coupling screws. As such, the first and second tuning screws 170, 175 have different roles according to their locations.

The operations of the radio frequency filter 100 will now be described with reference to FIGs. 1 and 6.

The input terminal coupling copper wire 115 and the output terminal coupling copper wire 117 provide inductive couplings 52, 58. The metallic housing 110, the disk-shaped metal resonator rods 120, and the cover 160 constitute parallel LC resonance circuits 10, 11, 12, 13, 14, 15. Each of the resonance circuits 10-15 is provided with a capacitive coupling 17 or an inductive coupling 19 by means of the interrelationship between each of the adjacent disk-shaped metal resonator rods 120, between the disk-shaped metal resonator rods 120 and the metallic housing 110, or between each of the coupling windows 131-135.

If a radio frequency signal is applied to the input connector 111, a current flows through the input terminal coupling copper wire 115 and electromagnetic energy is formed. The electromagnetic energy is transmitted to the parallel LC resonance circuit 10, which is composed of the metallic housing 110, the disk-shaped metal resonator rods 120, and the cover 160. Only an energy component of the electromagnetic energy, the frequency of which corresponds to the resonance frequency F_0 of the parallel LC resonance circuit 10, is transmitted to the next adjacent parallel LC resonance circuit 11 and remaining components are grounded G. An inductive coupling 53 is provided between the parallel LC resonance circuit 10 and the next adjacent parallel LC resonance circuit 11 and an energy component, the frequency of which corresponds to the resonance frequency thereof, is transmitted. As such, the radio frequency filter 100 has a configuration wherein parallel LC resonance circuits 10-15 and an inductive or capacitive coupling are alternated in series between the input and output connectors 111, 113.

Accordingly, if a frequency signal is applied to the input connector 111, only a component of the signal, the frequency of which corresponds to the resonance frequency of the parallel LC resonance circuits 10-15, are outputted via the output connector 113.

However, conventional radio frequency filters have a restriction in that,

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since they have a number of diaphragms in their metallic housing, the metallic housing should be fabricated through a high precision casting process, such as die casting, or should be subject to milling processing. This results in a problem of increased manufacturing cost. In particular, the casting process costs a lot for mold fabricating and is not suitable for small-scale production, while the milling processing is suitable for small-scale production, not for mass production.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the prior art, and an object of the present invention is to provide a radio frequency filter which is easy to manufacture and has little manufacturing cost.

Another object of the present invention is to provide a radio frequency filter which is easy to assemble.

In order to accomplish this object, there is provided a radio frequency filter comprising: a metallic housing having a containing space which extends along its longitudinal direction and the opposite ends of which are open; at least two metal resonator rods which extend upward from the bottom surface of the containing space and are arranged along the longitudinal direction of the housing; tuning screws which are fastened on the upper surface of the metallic housing and the ends of which face the upper end of the metal resonator rods in the containing space; and coupling screws which are positioned between the metal resonator rods and are fastened on the upper surface of the housing in locations corresponding to those of window rods.

In accordance with another aspect of the present invention, there is provided a radio frequency filter comprising: a housing having a containing space which extends along its longitudinal direction and the opposite ends of which are open; a fixing frame which is fixed on the bottom surface of the containing space of the housing and extends along the longitudinal direction of the housing; at least one metal resonator rod extending up to a predetermined height from the fixing frame; tuning screws which are fastened on the upper surface of the metallic housing and the ends of which face the upper end of the metal resonator rods in the containing space; and front and rear covers coupled to each of the opposite ends of the containing space to seal it.

The metal resonator rod and the window rod are alternated along the longitudinal direction of the fixing frame.

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BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view showing an embodiment of a radio frequency filter according to the prior art;

FIG. 2 is a perspective view, partially broken, illustrating the construction of the radio frequency filter shown in FIG. 1;

FIG. 3 is a side sectional view, partially broken, illustrating the construction of the radio frequency filter shown in FIG. 2;

FIG. 4 is a perspective view showing the inside of an input terminal of the radio frequency filter of FIG. 1, taken along line B;

FIG. 5 is a perspective view showing the inside of an output terminal of the radio frequency filter of FIG. 1, taken along line C;

FIG. 6 is an equivalent circuit diagram illustrating the operations of the radio frequency filter shown FIG. 1;

FIG. 7 is a perspective view, partially broken, of a radio frequency filter according to a preferred embodiment of the present invention;

FIG. 8 is a side sectional view of the radio frequency filter shown in FIG. 7;

FIG. 9 is perspective view illustrating a window rod of the radio frequency filter shown in FIG. 7;

FIG. 10 is a perspective view illustrating another type of window rod of the radio frequency filter shown in FIG. 7; and

FIG. 11 is an exploded perspective view showing a radio frequency filter according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

FIG. 7 is a perspective view, partially broken, of a radio frequency filter 700 according to a preferred embodiment of the present invention and FIG. 8 is a side sectional view of the radio frequency filter 700 shown in FIG. 7. As shown

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in FIGs. 7 and 8, a radio frequency filter 700 according to a preferred embodiment of the present invention comprises a metallic housing 701, metal resonator rods 702, window rods 705, tuning screws 703a, coupling screws 703b, a front cover 704a, and a rear cover 704b.

5 The metallic housing 701 has a containing space 711a, 711b, which extends along its longitudinal direction and the opposite ends of which are open. The containing space 711a, 711b is divided into two spaces by a diaphragm 713a, which extends along the longitudinal direction of the metallic housing 701. One end of the diaphragm 713a contacts an end of the metallic housing 701, while the
10 other end of the diaphragm 713a is spaced a predetermined distance from the other end of the metallic housing 701. Accordingly, a space is defined between the other end of the metallic housing 701 and the other end of the diaphragm 713a to provide a coupling window 713b. The two divided containing spaces 711a, 711b communicate with each other through the coupling window 713b.

15 The metallic housing 701 is provided with, on its outer peripheral surface, a number of protrusions 715a extending along its longitudinal direction. The protrusions 715 have fastening holes 715b formed on their opposite ends, which extend along the longitudinal direction of the metallic housing 701. The diaphragm 713 also has a fastening hole (not shown) formed on its end. The
20 metallic housing 701 is generally made of metallic material, but may also be made of synthetic resin, if necessary. When the housing is made of synthetic resin, it may be coated with metallic coating material, on its surface, according to the characteristics of the radio frequency filter.

 The metallic housing 701 is provided with a number of screw holes 717a, 717b, 717c, on its upper surface, which communicate with the containing spaces
25 711a, 711b. The screw holes 717a, 717b, 717c are selectively coupled with the tuning screws 703a, the coupling screws 703b, or screws 739a for fixing the window rods 705.

 The metallic housing 701, constructed as described above, can be
30 manufactured using extrusion, since it is composed of the containing spaces 711a, 711b, which extend along its longitudinal direction, and the diaphragm 713a. The extrusion process is advantageous in that it can manufacture products with less cost, regardless of production quantity, compared with a high precision casting process, such as die casting, or a fabrication process, such as milling.
35 The metallic housing is initially fabricated as a kind of frame, through extrusion. The frame is then cut into a metallic housing having a length corresponding to a final specification, and is provided with the fastening holes 715b, the screw holes 717a, 717b, 717c, and the like. If necessary, the containing spaces 711a, 711b of

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the metallic housing 701 may be formed as a single space, instead of being divided by the diaphragm 713a. In other words, although the metal resonator rods 702 are arranged in two rows in the present embodiment, they may be arranged in one row, if necessary.

5 At least two of the metal resonator rods 702 are positioned in the metallic housing 701, extend upward from the bottom surfaces of the containing spaces 711a, 711b, and have disks 721, which extend along their diametric direction from their upper outer peripheral surfaces. In the drawing, three pairs of metal resonator rods 702 are arranged in two rows. The metal resonator rods 702 are
10 fixed on the bottom surfaces of the containing spaces 711a, 711b by means of screws 723, which are fastened from the bottom surface of the metallic housing 701. The metal resonator rods 702 have tuning holes 725 extending downward from their upper surfaces. It should be noted that, when the metal resonator rods 702 are fixed on the bottom surfaces of the containing spaces 711a, 711b, the
15 screw hole 717a, which is formed in a selected location among the screw holes 717a, 717b, 717c formed on the upper surface of the metallic housing 702, should be aligned in a line with the tuning hole 725.

Meanwhile, the metal resonator rods 702 may be formed as coaxial-type metal resonator rods (not shown) without the disks 721, if necessary. In that
20 case, the metal resonator rods 702 may be provided with threads on their lower ends to be directly fastened on the lower end of the metallic housing 701. This is similar to how the window rods 705 are fastened with the metallic housing 701, as will be described below.

The window rods 705 play the same role as the diaphragm 130 (shown in
25 FIG. 1), which has conventional coupling windows 131-135 (shown in FIG. 1) formed therein. Each of the window rods 705 is positioned between two adjacent metal resonator rods 702 and affects the coupling characteristics thereof. The window rods 705 extend from the bottom surfaces of the containing spaces 711a, 711b to the top surfaces thereof. Referring to FIGs. 8 and 9, the window
30 rods 705 have threaded portions 751 on their lower ends, which are fastened on the lower portion of the metallic housing 701 for fixation. In order to secure firm fixation between the window rods 705 and the metallic housing 701, the window rods 705 have fastening holes 753 formed on their top surfaces, into which certain screws 739a are fastened from the upper portion of the metallic
35 housing 701. The screws 739a may be fastened together with washers 739b. At least one window rod 705 is fastened between two adjacent metal resonator rods 702. In other words, according to the size of the containing spaces 711a, 711b and the coupling characteristics between the adjacent metal resonator rods

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702, one, two, or larger number of window rods 705 may be provided. When a pair of window rods 705 are provided, the pair of window rods 705 and coupling screws 703b are arranged in turn between two adjacent metal resonator rods 702 along a direction, which is perpendicular to the longitudinal direction of the metallic housing 701.

Meanwhile, the distance between the metal resonator rods 702 of the radio frequency filter 700 may be reduced according to the characteristics thereof, such as the resonance frequency. In that case, it may be somewhat difficult to fasten the window rods 705 and the diameter of the upper portion 755b of the window rods 705 may be smaller than that of the middle portion 755a thereof, as shown in FIG. 10.

The tuning screws 703a are fastened on the upper end of the metallic housing 701 and their ends may face the upper surfaces of the metal resonator rods 702 or be positioned in the tuning holes 725 of the metal resonator rods 702. The tuning screws 703a are used to tune the resonance characteristics of the radio frequency filter 700. In other words, the resonance frequency of the radio frequency filter 700 is tuned according to the distance between the tuning screws 703a and the metal resonator rods 702.

Spring nuts 731 may be fastened on the tuning screws 703a. The spring nuts 731 are supported on the upper surface of the metallic housing 701 and provide elastic force in the longitudinal direction of the tuning screws 703a. After the resonance characteristics of the radio frequency filter 700 are tuned, the elastic force provided by the spring nuts 731 prevents the tuning screws 703a from playing.

Each of the coupling screws 703b is positioned between two adjacent metal resonator rods 702. Accordingly, the coupling screws 703b are preferably disposed adjacently to the window rods 705. The coupling screws 703b are also fastened on the coupling window 713b, which is formed between the other end of the metallic housing 701 and the other end of the diaphragm 713a. The coupling screws 703b are used to tune the coupling characteristics between two adjacent metal resonator rods 702. The coupling screws 703b have the same configuration as that of the tuning screws 703a, except that they are longer than the latter.

Spring nuts 731 may be fastened on the coupling screws 703b. The spring nuts 731 are supported on the upper surface of the metallic housing 701 and provide elastic force in the longitudinal direction of the coupling screws 703b. After the coupling characteristics of adjacent metal resonator rods 702 are tuned, the elastic force provided by the spring nuts 731 prevents the coupling screws

703a from playing.

The front cover 704a seals an end of the metallic housing 701. The front cover 704a may have an input connector 743a and an output connector 743b. The input and output connectors 743a, 743b are connected to adjacent metal resonator rods 702 via an input terminal coupling copper wire 745a and an output terminal coupling copper wire 745b, respectively. The front cover 704a has fastening pieces 741a, which extend from the outer peripheral surface thereof and have a shape corresponding to that of the protrusions 715a of the metallic housing 701. The fastening holes 741a have through-holes 741b formed thereon, through which screws 749 are fastened into the fastening holes 715b of the protrusions 715a to fix the front cover 704a. The fastening holes may also be formed on an end of the diaphragm 713a. The front cover 704 may then have corresponding through-holes.

The rear cover 704b seals the other end of the metallic housing 701. The rear cover 704b has fastening pieces 741a, which extend from the outer peripheral surface thereof and have a shape corresponding to that of the protrusions 715a of the metallic housing 701. The fastening holes 741a have through-holes 741b formed thereon, through which screws 749 are fastened into the fastening holes 715b of the protrusions 715a to fix the rear cover 704b.

Meanwhile, the input and output connectors 743a, 743b may be formed in a somewhat different manner according to the configuration of the radio frequency filter 700. The radio frequency filter 700 shown in FIG. 7 has a configuration wherein three pairs of metal resonator rods 702 are arranged in two rows and its metallic housing 701 has input and output connectors 743a, 743b positioned on its end. However, the number of the metal resonator rods 702 may be larger or smaller than the above configuration, according to the characteristics (for example, frequency band) needed for the system to which the product is applied. For example, if three metal resonator rods 702 are arranged in a row, the containing spaces 711a, 711b of the metallic housing 701 may be formed as a single space. Then, the input connector 743a is positioned on the front cover 704a and the output connector 743b on the rear cover 704b. Such modification in design of the radio frequency filter 700 will be easily understood by those skilled in the art.

The radio frequency filter 700 according to a preferred embodiment of the present invention, shown in FIG. 7, has the same equivalent circuit as that of the radio frequency filter 100 shown in FIG. 1. The operations of the radio frequency filter 700, constructed as described above, will now be described with reference to FIG. 6.

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In the radio frequency filter 700, the input terminal coupling copper wire 745a and the output terminal coupling copper wire 745b provide inductive couplings 52, 58. The metal resonator rods 702 and the metallic housing 701 constitute parallel LC resonance circuits 10-15, the resonance characteristics (for example, resonance frequency) of which are tuned by the tuning screws 703a. Between each of the resonance circuits 10-15, variously formed inductive or capacitive couplings 53-57 are provided as follows: an inductive or capacitive coupling between each of the adjacent metal resonator rods 702; an inductive or capacitive coupling between the metal resonator rods 702 and the metallic housing 701; and an inductive or capacitive coupling between the window rods 705 and adjoining metal resonators 702 or metallic housing 701. The coupling characteristics of the inductive or capacitive couplings 53-57 are tuned by the coupling screws 703b. In particular, the resonance frequency of each of the parallel LC resonance circuits 10-15 is tuned by the tuning screws 703a and the coupling characteristics between each of the parallel LC resonance circuits 10-15 are tuned by the coupling screws 703b.

If a radio frequency signal is applied to the input connector 743a of the radio frequency filter 700, a current flows through the input terminal coupling copper wire 745a and electromagnetic energy is formed. The electromagnetic energy is transmitted to the parallel LC resonance circuit 10, which is composed of the metal resonator rods 702, the metallic housing 701, and the like. An energy component of the electromagnetic energy, the frequency of which corresponds to the resonance frequency of the parallel LC resonance circuit 10, is transmitted to the next adjacent parallel LC resonance circuit 11 and remaining components are grounded G. An inductive or capacitive coupling 53 is formed between the parallel LC resonance circuit 10 and the next adjacent parallel LC resonance circuit 11, according to the constructional relationship among the metal resonator rods 702, the metallic housing 701, and the window rod 705 to transmit frequency energy. In other words, the frequency energy, which is filtered by the parallel LC resonance circuit 10, is transmitted to the next adjacent parallel LC resonance circuit 11 via the inductive or capacitive coupling 53 between the resonance circuit 10 and the resonance circuit 11.

Through above procedure, the frequency energy, the resonance frequency of which corresponds to that of the resonance circuits 10-15, is transmitted to the resonance circuit 15, which is connected to the output terminal coupling copper wire 745b. The transmitted frequency energy then generates a current by means of the inductive coupling 58 of the output terminal coupling copper wire 745b. Accordingly, only a signal, the resonance frequency of which corresponds to that

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of the resonance circuits 10-15, is outputted to the output connector 743b.

FIG. 11 is an exploded perspective view showing a radio frequency filter 800 according to another preferred embodiment of the present invention, wherein its housing is partially broken for illustration.

5 As shown in FIG. 11, the radio frequency filter 800 comprises a housing 801; a fixing frame 802 having metal resonator rods 821 and window rods 825 extending in series; a front cover 804a; and a rear cover 804b.

10 The housing 801 has a containing space 811a, 811b, which extends along its longitudinal direction and the opposite ends of which are open. The containing space 811a, 811b is divided into two spaces by a diaphragm 813a, which extends along the longitudinal direction of the housing 801. One end of the diaphragm 813a contacts an end of the housing 801, while the other end of the diaphragm 813a is spaced a predetermined distance from the other end of the housing 801. Accordingly, a space is defined between the other end of the housing 801 and the other end of the diaphragm 813a to enable the two divided
15 containing spaces 811a, 811b communicate with each other. Meanwhile, a coupling screw 803b may be fastened in the space between the other ends of diaphragm 813a and the housing 801 to tune the coupling characteristics between the two divided containing spaces 811a, 811b. The coupling screw 803b may be
20 fastened adjacently to the bottom surfaces of the containing spaces 811a, 811b from the upper end of the housing 801.

The housing 801 is generally made of metallic material, but may also be made of synthetic resin, if necessary. When the housing is made of synthetic resin, it may be coated with metallic coating material, on its surface, according to
25 the characteristics of the radio frequency filter 800.

The housing 801, constructed as described above, can be manufactured using extrusion, since it is composed of the containing spaces 811a, 811b, which extend along its longitudinal direction, and the diaphragm 813a. The extrusion process is advantageous in that it can manufacture products with less cost, regardless of production quantity, compared with a high precision casting process, such as die casting, or a fabrication process, such as milling. The housing is initially fabricated as a kind of frame, through extrusion. The frame is then cut
30 into a housing having a length corresponding to a final specification, and is provided with fastening holes, screw holes, and the like. If necessary, the containing spaces 811a, 811b of the housing 801 may be divided into two spaces by the diaphragm 813a. Alternatively, they may be formed as a single space, instead of being divided.
35

The fixing frame 802 extends along the longitudinal direction of the

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housing 801 and is fixed on the bottom surfaces of the containing spaces 811a, 811b. The fixing frame 802 shown in FIG. 11 is fastened on the bottom surfaces of the containing spaces 811a, 811b by means of fastening means, such as screws. However, if necessary, a predetermined shape of slot may be formed on the bottom surfaces of the containing spaces 811a, 811b and extend along their longitudinal direction, as well as a rail may be formed on the lower end of the fixing frame 802 with a corresponding shape to be inserted into the slot. Alternatively, the slot may be formed on the lower surface of the fixing frame 802 and the rail may be formed on the bottom surfaces of the containing spaces 811a, 811b.

The metal resonator rods 821 extend along a direction from the fixing frame 802 and have screw holes 823 formed on their upper ends. The number of the metal resonator rods 821 may be modified according to the specification needed for the radio frequency filter 800. Disks 805 are fastened on the upper ends of the metal resonator rods 821. To this end, the disks 805 have threaded rods 851 corresponding to the screw holes 823, which are formed on the upper ends of the metal resonator rods 821. The disks 805 also have tuning holes 853, which are recessed a predetermined depth from their other surfaces. The disks 805 are preferably spaced a predetermined distance from the upper surfaces of the containing spaces 811a, 811b.

The window rods 825 extend in the same direction as that of the metal resonator rods 821 from the fixing frame 802 and have screw holes 827 formed on their upper ends. The height of the upper ends of the window rods 825 measured from the lower end of the fixing frame 802 corresponds to that of the containing spaces 811a, 811b. If necessary, the height of the window rods 825 may be smaller than that of the containing spaces 811a, 811b and then the screw holes 827 may be omitted.

The metal resonator rods 821 and the window rods 825 are alternated along the longitudinal direction of the fixing frame 802.

The metal resonator rods 821 and the window rods 825 are integrally formed on the fixing frame 802, respectively, and may be manufactured using processing, molding, or extrusion. If an extrusion process is used, a piece is first fabricated in the shape of a frame, in which a rectangular space is formed, and cut into appropriate width to form the fixing frame 802, the metal resonator rods 821, and the window rods 825 at the same time.

When the fixing frame 802 is positioned on the bottom surfaces of the containing spaces 811a, 811b, screws are fastened from the lower surface of the housing 802 to fix the housing 802 on the bottom surfaces of the containing

spaces 811a, 811b. In addition, screws 839 may be coupled on the upper ends of the window rods 825 from the upper surface of the housing 801.

Meanwhile, tuning screws 803a are coupled on the upper surface of the housing 801 in locations corresponding to those of the tuning holes 853 of the disks 805. By adjusting their fastening depth, the tuning screws 803a are used to tune the resonance characteristics of the radio frequency filter 800. The tuning screws 803a face the tuning holes 853 in the containing spaces 811a, 811b and, if necessary, their ends may be positioned in the tuning holes 853.

The front cover 804a seals an end of the housing 801. The front cover 804a has a pair of coupling copper wires 845. The coupling copper wires 845 are adapted to electrically connect an input or output connector (not shown) with adjoining metal resonator rod 802. The front cover 804a is fastened on an end of the housing 801 by means of a fastening means, such as a screw. The rear cover 804b is fastened on the other end of the housing 801 to seal the containing spaces.

Meanwhile, although the pair of coupling copper wires 845 are positioned on the front cover 804a, they may be positioned differently according to the configuration of the radio frequency filter 800. For example, if three metal resonator rods 802 are arranged in a row, the containing spaces 811a, 811b of the housing 800 may be formed as a single space. The coupling copper wires 845 are then separately positioned on the front and rear cover 804a, 804b. Such modification in design of the radio frequency filter 800 will be easily understood by those skilled in the art.

The radio frequency filter 800 according to another embodiment of the present invention, shown in FIG. 11, has the same equivalent circuit as that of the radio frequency filter 100 shown in FIG. 1. The operations of the radio frequency filter 800, constructed as described above, will now be described with reference to FIG. 6.

In the radio frequency filter 800, the coupling copper wires 845 provide inductive couplings 52, 58. The metal resonator rods 821 and the housing 801 constitute parallel LC resonance circuits 10-15, the resonance characteristics (for example, resonance frequency) of which are tuned by the tuning screws 803a. Between each of the resonance circuits 10-15, variously formed inductive or capacitive couplings 53-57 are provided as follows: an inductive or capacitive coupling between each of the adjacent metal resonator rods 821; an inductive or capacitive coupling between the metal resonator rods 821 and the housing 801; and an inductive or capacitive coupling between the window rods 825 and adjoining metal resonators 821 or housing 801. The coupling characteristics of

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the inductive or capacitive couplings 53-57 are changed according to the shape, size, and the like of the window rods 825. The size of the window rods 825 may be easily adjusted by those skilled in the art according to the characteristics of the radio frequency filter 800.

5 If a radio frequency signal is applied to a side of the coupling copper wires 845 of the radio frequency filter 800, a current flows and electromagnetic energy is formed. The electromagnetic energy is transmitted to the parallel LC resonance circuit 10, which is composed of the metal resonator rods 821, the housing 801, and the like. An energy component of the electromagnetic energy,
10 the frequency of which corresponds to the resonance frequency of the parallel LC resonance circuit 10, is transmitted to the next adjacent parallel LC resonance circuit 11 and remaining components are grounded G. An inductive or capacitive coupling 53 is formed between the parallel LC resonance circuit 10 and the next adjacent parallel LC resonance circuit 11, according to the
15 constructional relationship among the metal resonator rods 821, the housing 801, and the window rods 825 to transmit frequency energy. In other words, the frequency energy, which is filtered by the parallel LC resonance circuit 10, is transmitted to the next adjacent parallel LC resonance circuit 11 via the inductive or capacitive coupling 53 between the resonance circuit 10 and the resonance
20 circuit 11.

Through above procedure, the frequency energy, the resonance frequency of which corresponds to that of the resonance circuits 10-15, is transmitted to the resonance circuit 15, which is connected to the other side of the coupling copper wires 845. The transmitted frequency energy then generates a current by means
25 of the inductive coupling 58 of the coupling copper wires 845. Accordingly, only a signal, the resonance frequency of which corresponds to that of the resonance circuits 10-15, is outputted to the coupling copper wires.

As mentioned above, the radio frequency filter according to the present invention has a metallic housing, which has containing spaces extending along its
30 longitudinal direction, and is advantageous in that it is easy to manufacture and it can be manufactured with less cost. Specifically, conventional radio frequency filters use a high precision die casting process or a milling process to manufacture a metallic housing, which has a number of diaphragm therein. Accordingly, they have a problem of high fabrication cost of molds or increased unit price of
35 individual products due to the fabrication process. However, according to the present invention, the metallic housing is manufactured using a extrusion process. Therefore, the precision of products is guaranteed and the manufacturing cost of the radio frequency filter is reduced by decreasing the unit price. In addition,

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the metallic housing, which is fabricated through the extrusion process, has an initial form of a long frame, which can be cut into appropriate length and used according to the specification needed for the product. This enables active adaptation to the product specification. Furthermore, the metal resonator rods and the window rods are integrally formed in a single fixing frame and thus can be easily installed in the housing. According to the prior art, on the other hand, a distance error may occur between the window rods and the metal resonator rods, when respective metal resonator rods are fastened on the housing, and affect the resonance characteristics, such as the resonance frequency, of the radio frequency filter. However, according to the radio frequency filter of the present invention, the metal resonator rods and the window rods are integrally fabricated and the distance between them or between each of the metal resonator rods is fixed. This stabilizes the resonance characteristics of the radio frequency filter.

While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

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WHAT IS CLAIMED IS:

1. A radio frequency filter comprising:
a housing having a containing space which extends along its longitudinal
5 direction and the opposite ends of which are open;
at least two metal resonator rods arranged along the longitudinal direction
of the housing;

tuning screws which are fastened on the upper surface of the housing and
the ends of which face the upper end of the metal resonator rods in the containing
10 space;

coupling screws which are positioned between the metal resonator rods
and are fastened on the upper surface of the housing; and

front and rear covers coupled to each of the opposite ends of the
containing space to seal it.

2. A radio frequency filter as claimed in claim 1, wherein the containing
space of the housing is divided into two spaces by means of a diaphragm, which
extends along the longitudinal direction from an end of the housing.

3. A radio frequency filter as claimed in claim 2, wherein at least two
metal resonator rods are positioned in each of the two divided containing spaces.

4. A radio frequency filter as claimed in claim 2, wherein the diaphragm
provides a coupling window, which extends to a location that is spaced a
25 predetermined distance from the other end of the housing, and the coupling
window makes the two divided containing spaces communicate with each other.

5. A radio frequency filter as claimed in claim 2, wherein the diaphragm
extends to a location that is spaced a predetermined distance from the other end of
30 the housing, the two divided containing spaces communicate with each other, and
the coupling screws are fastened in a space between the other end of the housing
and an end of the diaphragm.

6. A radio frequency filter as claimed in claim 1, wherein the housing is
35 made of metallic material.

7. A radio frequency filter as claimed in claim 1 further comprising a
number of protrusions which protrude from an outer peripheral surface of the

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metallic housing, extend along its longitudinal direction, and have fastening holes on their ends; as well as fastening pieces which extend from outer peripheral surfaces of the front and rear covers, respectively, and have through-holes corresponding to the fastening holes.

5

8. A radio frequency filter as claimed in claim 1 further comprising at least one through-hole formed in the center of the front cover and a fastening hole, which is formed on an end of the diaphragm and corresponds to the through-hole.

10

9. A radio frequency filter as claimed in claim 1 further comprising disks extending from outer peripheral surfaces of the ends of the metal resonator rods along the diametric direction thereof.

15

10. A radio frequency filter as claimed in claim 1 further comprising tuning holes extending from the ends of the metal resonator rods in the longitudinal direction thereof, in which the ends of the tuning screws are positioned.

20

11. A radio frequency filter as claimed in claim 1 further comprising screws which is fastened on the lower ends of the metal resonator rods from the lower surface of the metallic housing to fix the metallic resonator rods on the bottom surface of the containing space.

25

12. A radio frequency filter as claimed in claim 1 further comprising at least one window rod, which is positioned between the metal resonator rods, extends from the bottom surface of the containing space to the top surface thereof, and faces the coupling screws.

30

13. A radio frequency filter as claimed in claim 12, wherein the window rod has a threaded portion, which is formed on the outer peripheral surface of its lower end, and is fastened on the lower surface of the metallic housing and wherein said filter further comprises a screw, which is fastened on the upper end of the window rod from the upper surface of the metallic housing to fix the window rod in the containing space.

35

14. A radio frequency filter as claimed in claim 12, wherein the window rod has an upper portion, which extends a predetermined length and the diameter of which is smaller than the middle portion thereof.

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15. A radio frequency filter comprising:

a housing having a containing space which extends along its longitudinal direction and the opposite ends of which are open;

5 a fixing frame which is fixed on the bottom surface of the containing space of the housing and extends along the longitudinal direction of the housing;

at least one metal resonator rod extending up to a predetermined height from the fixing frame; and

10 front and rear covers coupled to each of the opposite ends of the containing space to seal it.

16. A radio frequency filter as claimed in claim 15 further comprising a fastening hole extending downward from the upper surface of the metal resonator rod and a disk having a threaded rod on its surface, which is fastened into the
15 fastening hole.

17. A radio frequency filter as claimed in claim 15, wherein the containing space is divided into at least two spaces by means of a diaphragm, which extends along its longitudinal direction.
20

18. A radio frequency filter as claimed in claim 17, wherein the fixing frame is fixed in each of the at least two divided containing spaces.

19. A radio frequency filter as claimed in claim 17, wherein the
25 diaphragm extends to a location which is spaced a predetermined distance from the other end of the housing, so that the at least two divided containing spaces communicate with each other, and wherein said filter further comprises a coupling screw which is fastened from the upper surface of the housing and is positioned in a space between the other end of the housing and an end of the
30 diaphragm.

20. A radio frequency filter as claimed in claim 15, wherein the housing is made of metallic material.

35 21. A radio frequency filter as claimed in claim 15 further comprising a tuning screw which is fastened on the upper surface of the housing and the end of which faces the upper end of the metal resonator rod in the containing space.

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22. A radio frequency filter as claimed in claim 15, wherein said filter further comprises at least one window rod extending up to a predetermined height from the fixing frame and wherein the metal resonator rod and the window rod are alternated along the longitudinal direction of the fixing frame.

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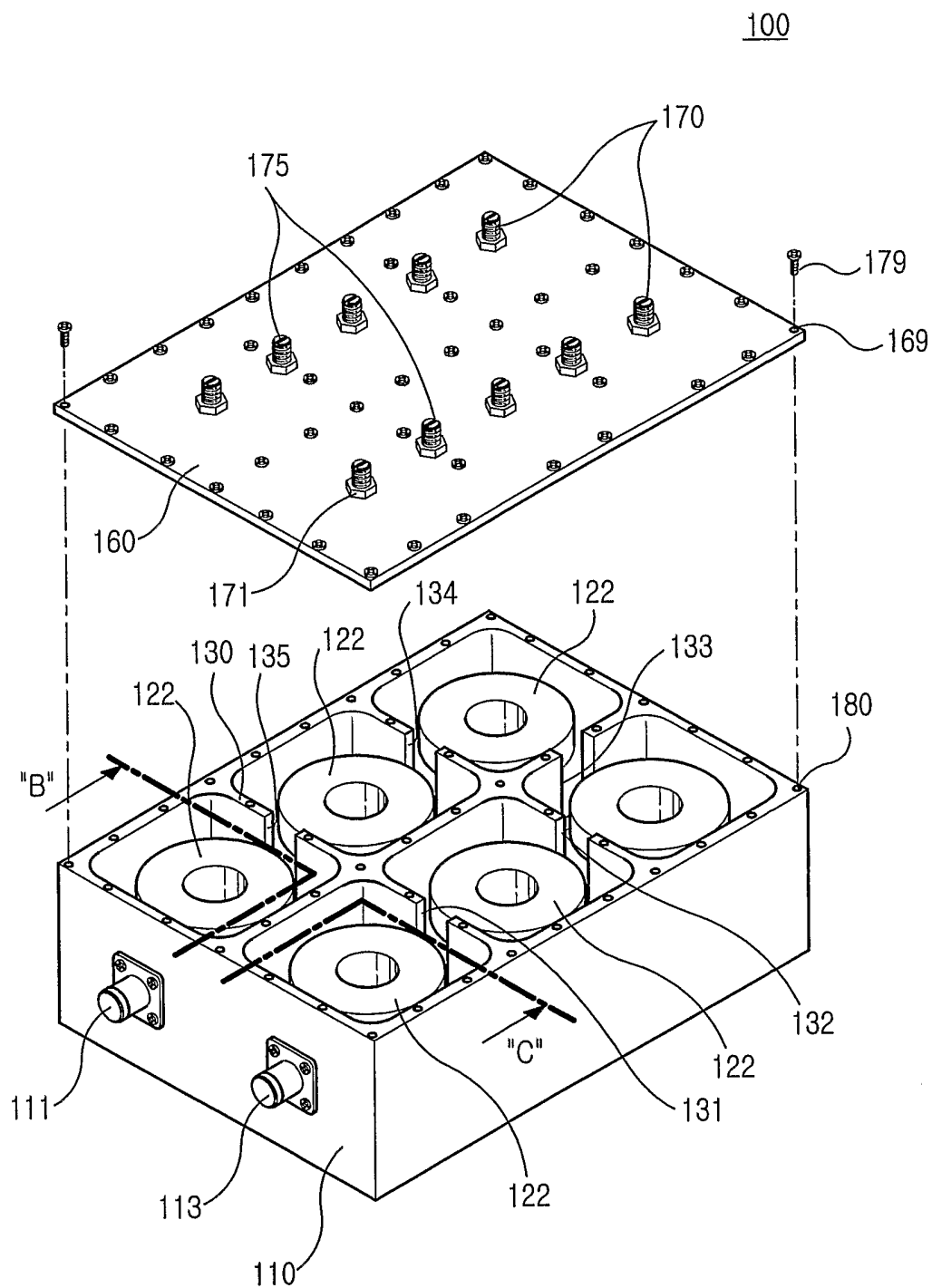


FIG.1

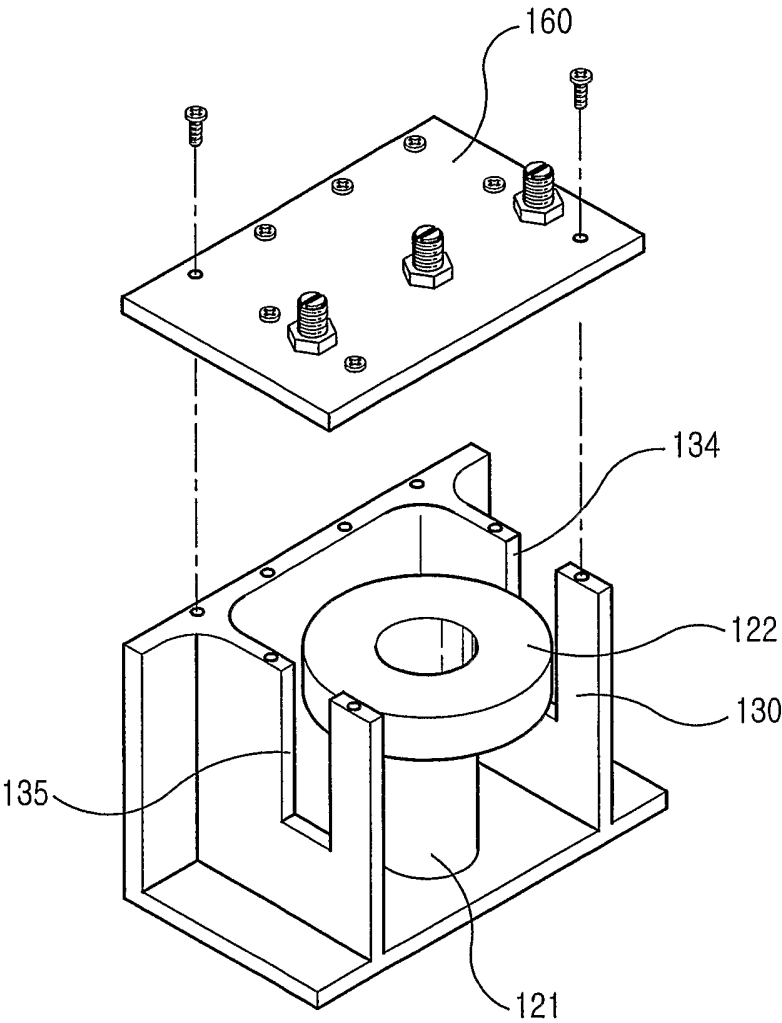


FIG.2

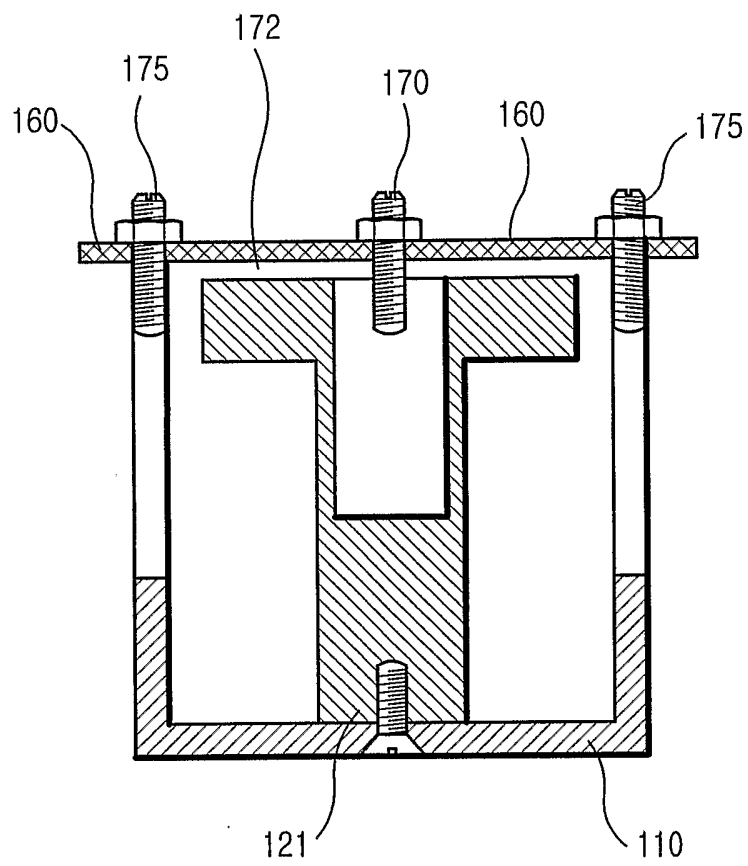


FIG.3

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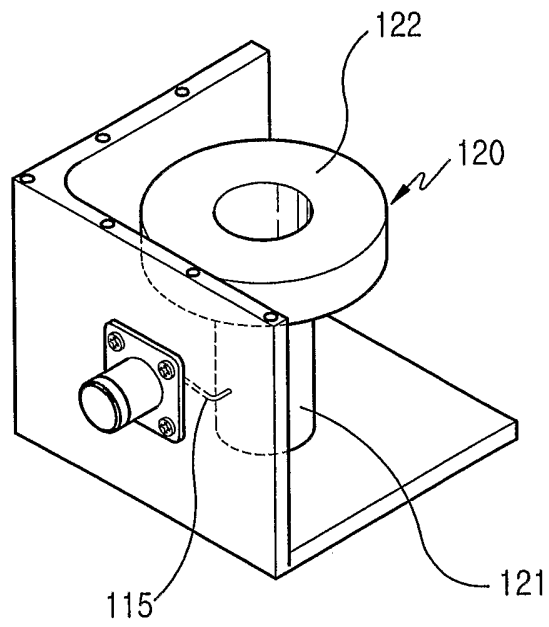


FIG. 4

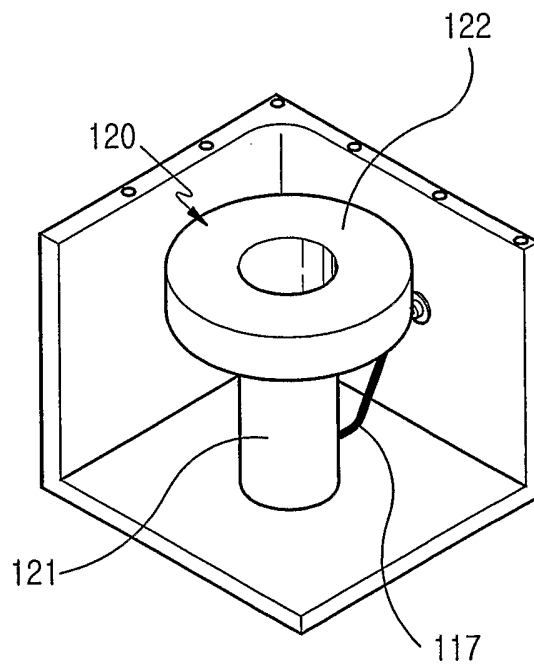


FIG. 5

200

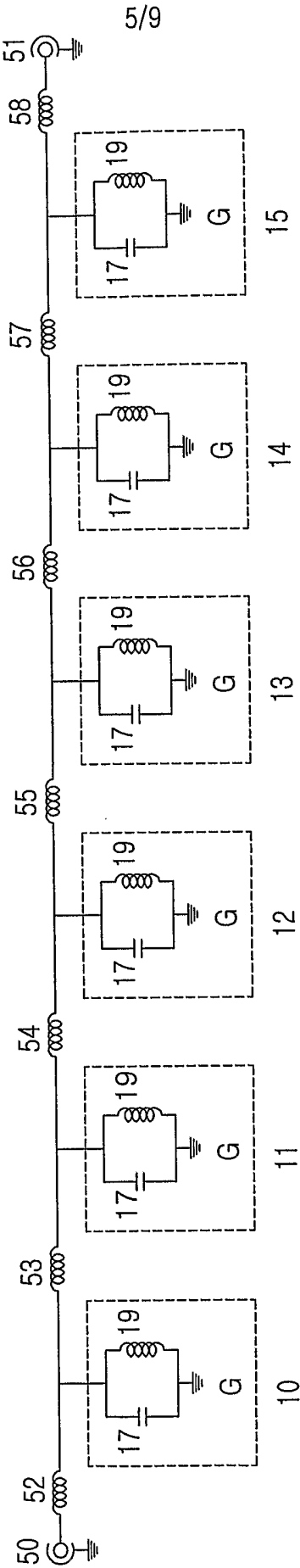


FIG.6

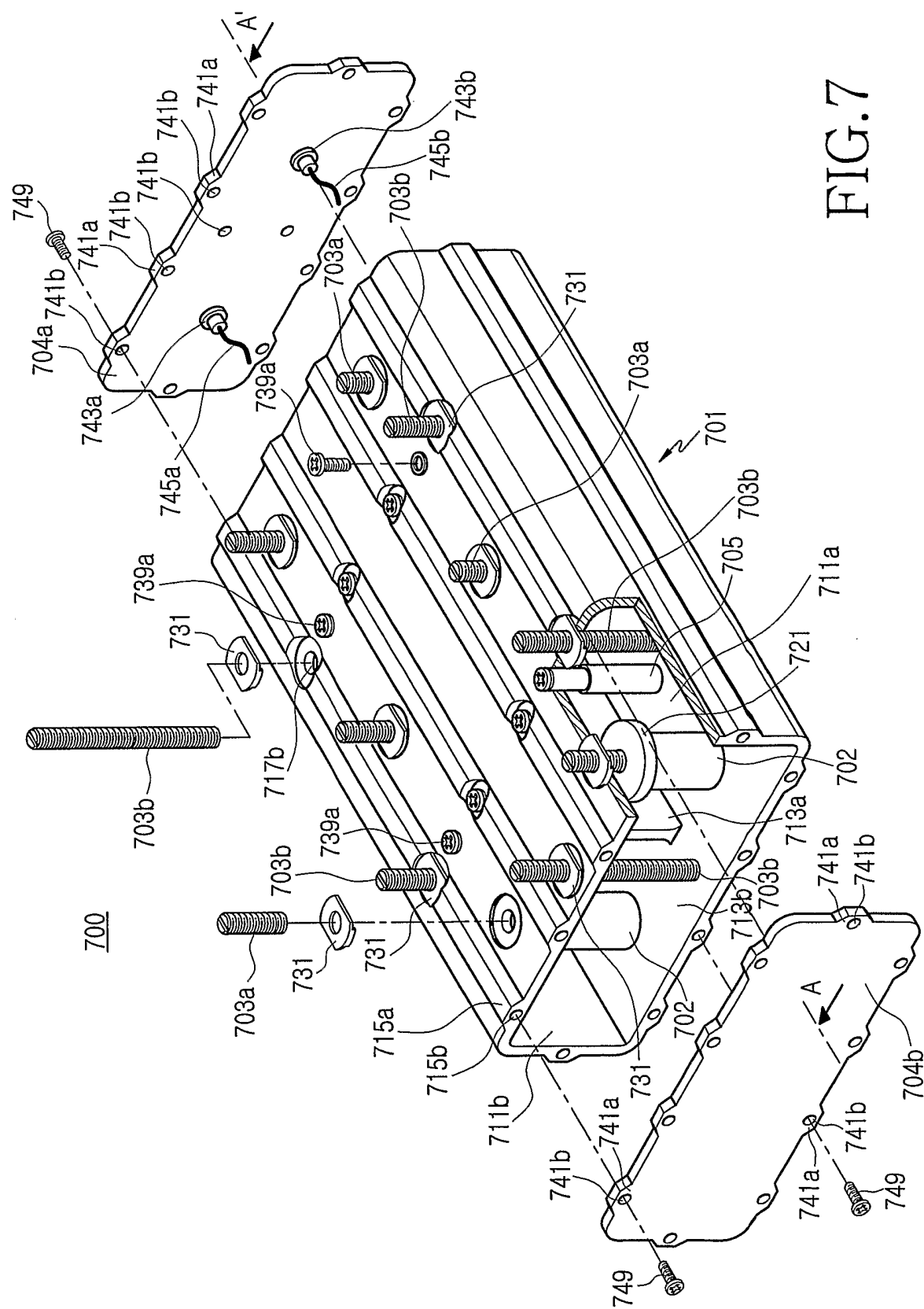


FIG. 7

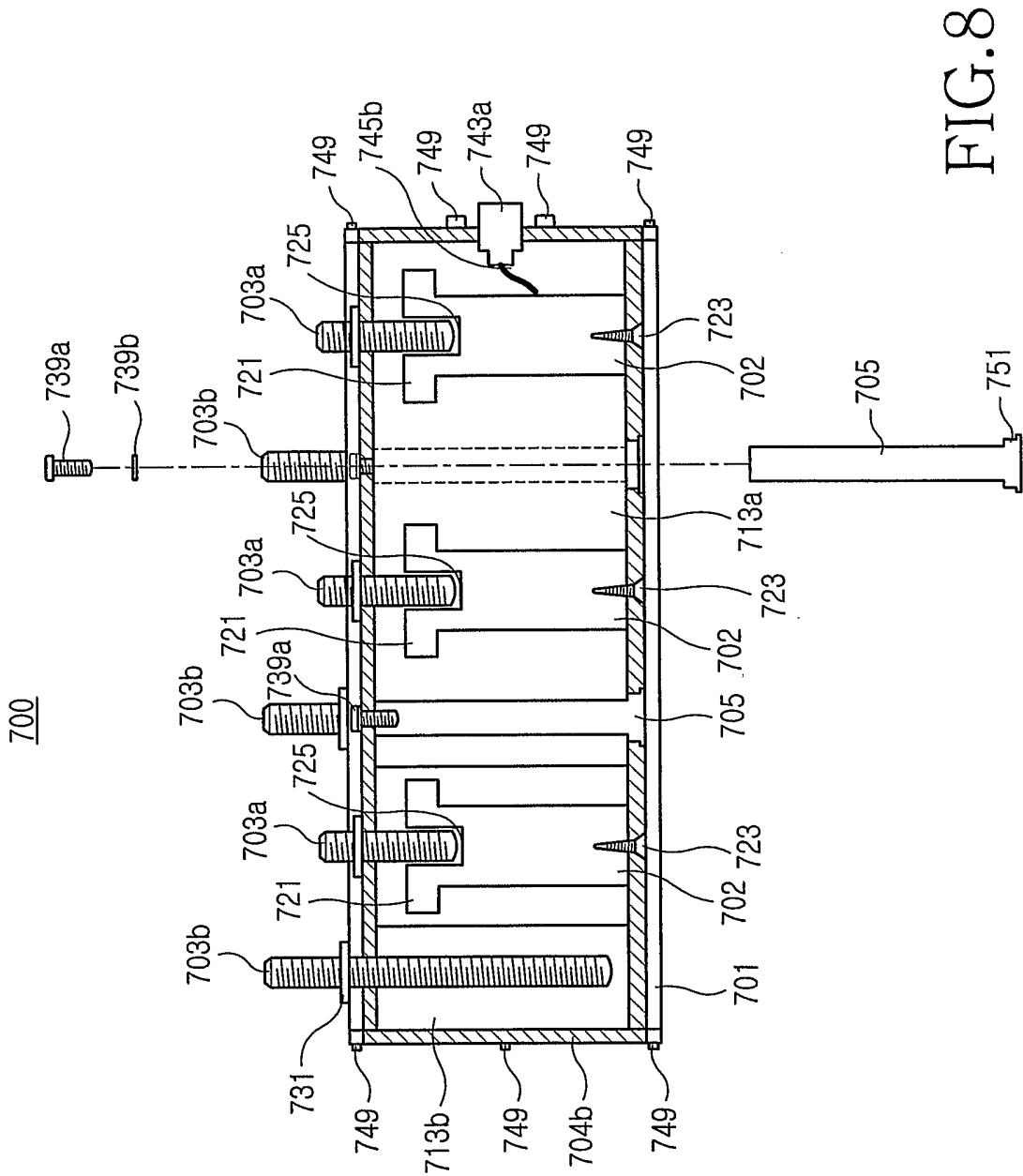


FIG. 8

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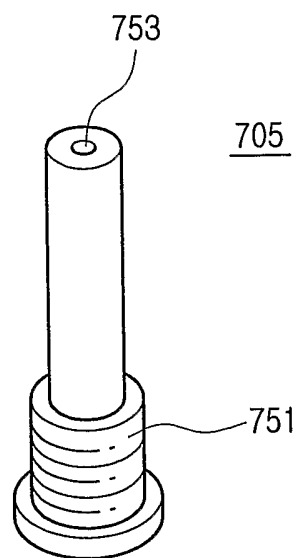


FIG. 9

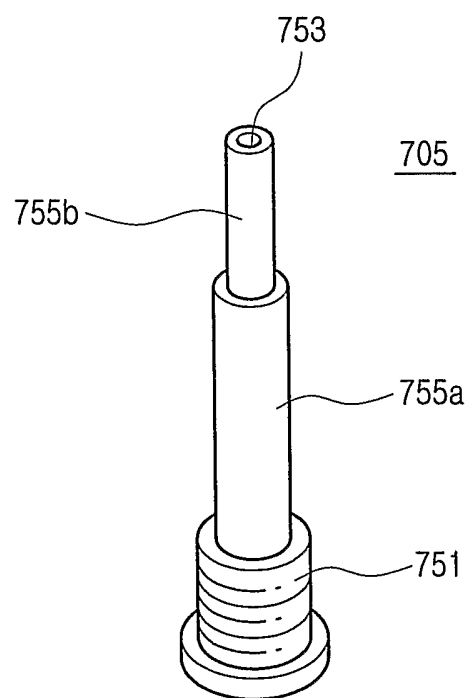
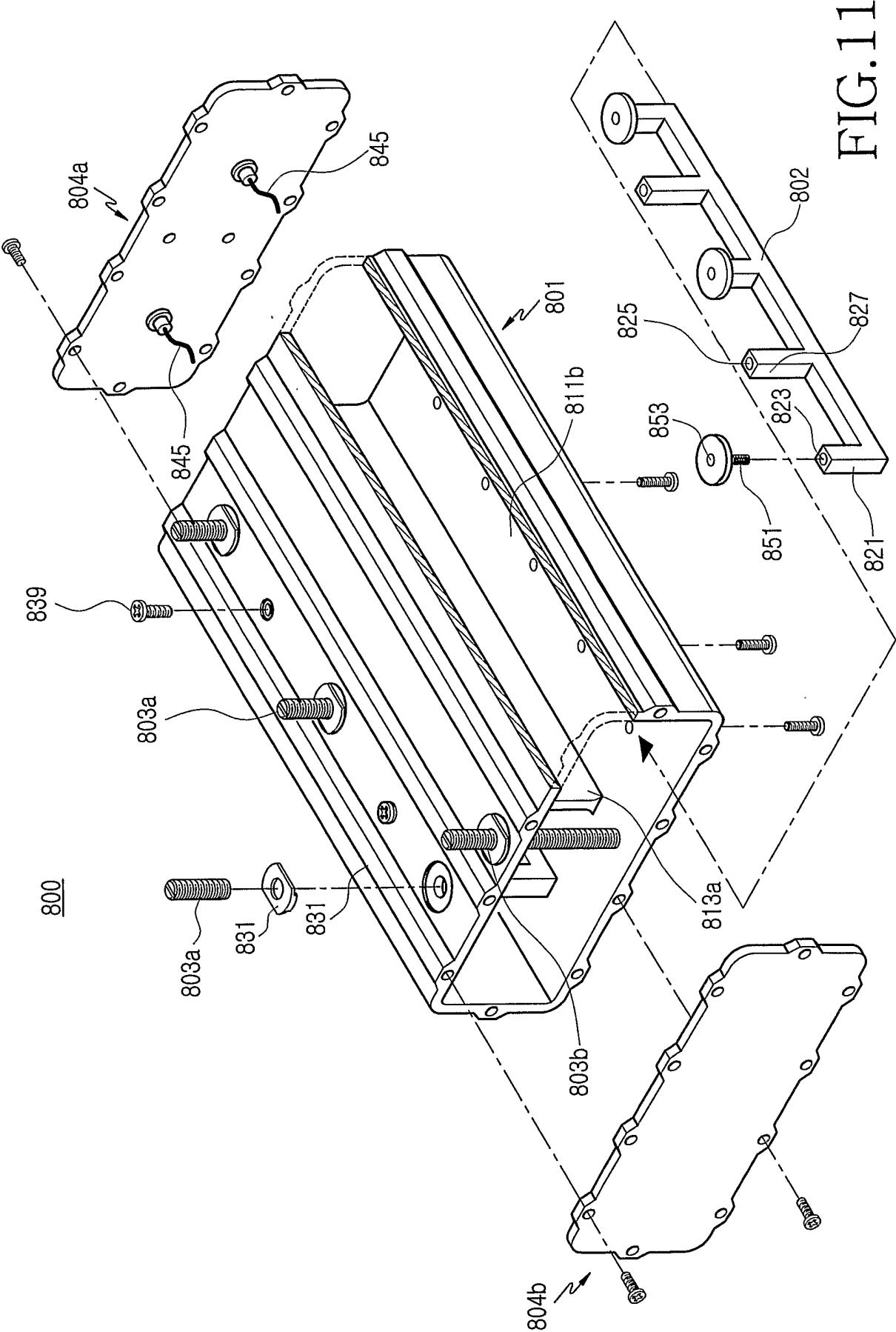


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2004/001120

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H01P 1/20

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 7 H01P 7/00 ; 7/04 ; 7/06 ; 1/205

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
KR, JP : IPC as above

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

PAJ, FPD, USPAT, KIPONET

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5023579 (Bentivenga) 11 Jun 1991 See the whole document and figures	1-22
A	US 5990763 (Sipila) 23 Nov 1999 See the whole document and figures	1-22
A	US 6366184 (Ohtonen) 2 Apr 2002 See the whole document and figures	1-22



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

"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

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"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

"&" document member of the same patent family

Date of the actual completion of the international search

27 JULY 2004 (27.07.2004)

Date of mailing of the international search report

27 JULY 2004 (27.07.2004)



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JEON, Ki Eock

Telephone No. 82-42-481-5169



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2004/001120

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