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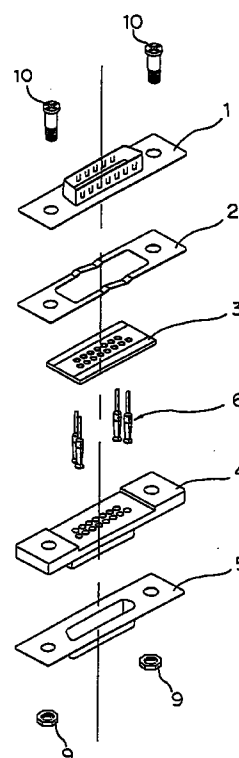
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(54) **ELECTRIC FILTER ADAPTER**

(57) An electrical adapter with a filter comprises a contact element, a filter unit, a front frame and a back frame. The filter unit is made of a filter comprising at least one member selected from the group consisting of a condenser, a ferrite and a resistor. The contact element is electrically connected to the filter unit. The contact element and the filter unit are held between the front frame and the back frame. The front frame, the contact element, the filter unit and the back frame are fixedly assembled.



**Fig. 1**

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## Description

### Technical Field

The present invention relates to an electrical adapter with a filter having a filter unit for removing electrical noise.

### Background Art

Recently, with the progress of electronic devices of higher function and higher speed, there was a demand for an anti-noise measure for reducing or attenuating interfering signal and noise signal. Various types of electrical connectors with a filter have heretofore been proposed in order to fulfill the demand.

The proposals so far made are of the type that a filter element is disposed to the electrical connector itself. Therefore, the electrical connector attached to a conventional electronic device must be replaced with a new one when a further anti-noise measure is applied to.

### Disclosure of the Invention

However, replacement of the electrical connector attached to a conventional electronic device involves many problems and much time, and labor is required and many difficulties are encountered.

Therefore, the present invention proposes an electrical adapter with a filter capable of reducing or attenuating noise without replacement of an electrical connector and a cable attached to a conventional electronic device.

That is, the present invention provides an electrical adapter with a filter comprising a contact element, a filter unit, a front frame and a back frame,

the filter unit being made of a filter comprising at least one member selected from the group consisting of a condenser, a ferrite and a resistor,

the contact element being electrically connected to the filter unit,

the contact element and the filter unit being held between the front frame and the back frame, and

the front frame, the contact element, the filter unit and the back frame being fixedly assembled.

The electrical adapter with a filter thus constructed is disposed between a female type electrical connector and a male type electrical connector of a conventional electronic device. The electrical adapter with a filter of the present invention exhibits high electromagnetic shielding effect, excellent noise attenuation effect and high reliability.

### Brief Description of the Drawings

Fig. 1 is an exploded perspective view showing one embodiment of the electrical adapter with a filter according to the present invention.

Fig. 2 is an enlarged sectional view of an assem-

bled state showing one embodiment of the electrical adapter with a filter according to the present invention.

Fig. 3 is a chart showing attenuation characteristics of the electrical adapter with a filter according to the present invention.

### Detailed Description of the Invention

An assembly of components of the electrical adapter with a filter according to the present invention will be described hereinafter in detail.

Fig. 1 is an exploded perspective view showing one embodiment of the electrical adapter with a filter according to the present invention; Fig. 2 is a sectional view of an assembled state showing one embodiment of the electrical adapter with a filter according to the present invention; and Fig. 3 is a chart showing attenuation characteristics of the electrical adapter with a filter according to the present invention. It should be noted that the electrical adapter with a filter according to the present invention is not limited to the assembly shown in Figs. 1 and 2, and the attenuation characteristics shown in Fig. 3.

The electrical adapter with a filter comprises a filter unit 3 which is located at the central portion of the electrical adapter and into which contact elements 6 are inserted. The filter unit 3 is fixedly assembled into a sandwiched structure by being sandwiched between a front frame 1 and a back frame 5. A leaf spring 2 is disposed between the front frame 1 and the filter unit 3. A body 4 is disposed between the back frame 5 and the filter unit 3.

The contact elements 6 are not particularly limited in material. Each contact element 6 has a male portion 6a and a female portion 6b which are similar in shape and dimension to the contact elements used as a conventional female type electrical connector and a male type electrical connector. The male portion 6a and the female portion 6b preferably form an integral body. It is also preferred that the contact elements 6 are in contact with a filter 8 of the filter unit 3 by soldering 7 or other means (for example, pressure contact, conductive adhesive, etc.). The contact elements 6 may be inserted into the filter unit 3 or they may be attached to a top surface or a side surface of the filter unit 3. The female portion 6b of the contact elements 6 are preferably inserted into hole portions formed in the body 4.

The filter unit 3 is predominantly made of the filter 8 which comprises at least one member selected from the group consisting of a condenser, a ferrite and a resistor. More specifically, the filter unit 3 comprises a substrate, the filter 8, a grounding electrode and a signal electrode. The filter unit 3 is attached with an array of the contact element 6. It should be noted that the filter unit 3 thus constructed is not particularly limited in material, shape, structure and method of manufacture.

Although the filter 8 is not particularly limited in method of manufacture, it is preferred to be formed by a printing method. It is more preferred that the filter 8 is

formed by a thick-film printing method. Although the material of the condenser which forms the filter 8 is not particularly limited, it is preferred to be made of a dielectric substance having a composition of a perovskite structure. It is more preferred that the condenser is made of a dielectric substance containing at least one member selected from the group consisting of  $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ ,  $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})\text{O}_3$ ,  $\text{PbTiO}_3$ , and  $\text{Bi}_2\text{O}_3$ . The ferrite which forms the filter 8 may be formed on the surface of the substrate. Preferably, it is formed on an inner wall of the holes of the substrate. On the other hand, the grounding electrode formed at the filter unit 3 is preferably formed in the area as wide as possible so that the electromagnetic shielding effect is enhanced.

The leaf spring 2 may or may not be used. In view of strength reinforcement of the adapter, however, it is preferred that the leaf spring 2 is used. The leaf spring 2 is not particularly limited in shape, material, structure, etc. However, the use of the leaf spring for fixedly assembling each members into a sandwiched structure is advantageous for electrical connection between the grounding electrode of the filter unit 3 and the front frame 1 and/or the back frame 5, and for reinforcing the strength and holding the whole structure of the electrical adapter.

The number of the leaf springs 2 can be decided as desired. The leaf spring 2 may preferably be used in such a way to sandwich the filter unit 3. In case where no leaf spring 2 is used, the grounding electrode of the filter unit 3 may simply be electrically connected to the front frame 1 and/or the back frame 5 by soldering, conductive adhesive, or the like. Electrical connection between the front frame 1 and the back frame 5 is preferably secured by a fixing jig, for example, nut, bolt, caulking.

The body 4 is not particularly limited in shape, material, structure, etc. The use of the body 4 is not always necessary but preferable for the purposes of reinforcement of the contact elements 6 and attachment/detachment of the electrical connector.

The method for fixedly assembling the front frame 1, the leaf spring 2, the filter unit 3, the body 4 and the back frame 5 is not particularly limited. It is preferred, however, that they are assembled into a sandwiched structure as previously mentioned. They are preferably assembled with the use of nuts 9 and bolts 10, and more preferably with the use of eyelet. Particularly preferably, the front frame 1 and the back frame 5 are caulked each other.

According to the present invention, the electrical adapter with a filter which exhibits high electromagnetic shielding effect and excellent noise attenuation effect can be provided. The electrical adapter of the present invention is disposed between the conventional male and female electrical connector for the purpose of reducing or attenuating the noise in the conventional electric device. Thus, the electronic device adapted with the electrical adapter of the present invention exhibits

high reliability.

Also, according to the present invention, the electrical adapter with a filter can be disposed between the male and female electrical connector of a novel electronic device, and it exhibits high electromagnetic shielding effect, excellent noise attenuation effect and high reliability. Further, the electrical adapter can be manufactured at a lower cost.

The electrical adapter with a filter according to the present invention can be applied to a wide range of electronic devices. For example, the electrical adapter can be applied to communication equipment, imaging equipment, electronic devices for automobiles, peripheral equipment for computers, vending machines, ticket venders, "Pachinko(Japanese pin ball machines), amusement game machines, electronic amusement machines.

### Embodiments

Embodiments of the electrical adapter with a filter according to the present invention will be described hereinafter. It should be noted, however, that the present invention is not limited to the following embodiments.

#### (Embodiment 1)

First, in order to manufacture the filter unit 3, a ferrite layer is formed on an inner wall of a through-hole formed in an alumina ceramics substrate by screen printing a ferrite paste, followed by drying and calcining the paste. Then, a signal electrode is formed by screen printing an Ag-Pd conductive paste at a prescribed position, followed by drying and calcining the paste. Further, a dielectric layer is formed by screen printing a dielectric paste predominantly composed of  $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$  and  $\text{PbTiO}_3$  at a prescribed position, followed by drying and calcining the paste.

Then, a grounding electrode is formed by screen printing an Ag-Pd conductive paste at a prescribed position, followed by drying and calcining the paste. Further, a protective layer is formed by screen printing a glass paste at a prescribed position, followed by drying and calcining the paste.

The signal electrode, dielectric layer and grounding electrode thus formed form a condenser and are protected by the protective layer. The condenser and the ferrite layer serve as the filter 8. In the manner as mentioned above, the filter unit 3 was manufactured.

Thereafter, the contact elements 6 in which the male portion 6a and the female portion 6b form an integral body were inserted into the through-holes of the filter unit 3, and securely fixed to the signal electrode or the grounding electrode by soldering 7.

Then, the front frame 1, the back frame 5 and the leaf spring 2 were manufactured by pressing. On the other hand, the body 4 was made from a resin.

Subsequently, the front frame 1, the leaf spring 2,

the filter mechanism 3, the body 4 and the back frame 5 thus manufactured were superimposed in this order to form a sandwiched structure, and fixed by the fixing bolts 10 and nuts 9.

The electrical adapter with a filter thus manufactured was disposed between electrical connectors. The electrical adapter exhibited excellent productivity, high shielding effect, excellent noise attenuation effect and high reliability. Attenuation characteristics of the electrical adapter with a filter thus manufactured was measured by a spectrum analyzer (manufactured by Hewlett Packard Co., Ltd.; type: 4396A). The result is shown by a broken line A in Fig. 3.

#### (Embodiment 2)

The electrical adapter with a filter was manufactured by almost the same manner as in Embodiment 1 except that no ferrite layer was formed on the filter unit 3 of Embodiment 1.

The electrical adapter with a filter thus manufactured was found to exhibit excellent effect as in Embodiment 1. Attenuation characteristics of the electrical adapter with a filter thus manufactured was measured by a spectrum analyzer (manufactured by Hewlett Packard Co., Ltd.; type: 4396A). The result is shown by a solid line B in Fig. 3.

#### (Embodiment 3)

The electrical adapter with a filter was manufactured by almost the same manner as in Embodiment 1 except that the body 4 of Embodiment 1 was not used.

The electrical adapter with a filter thus manufactured exhibited excellent effect as in Embodiment 1 at a lower cost.

#### Industrial Applicability

The electrical adapter with a filter according to the present invention exhibits high productivity since it can be manufactured merely by fixedly assembling a front frame, a contact element, a filter unit and a back frame. The electrical adapter with a filter also exhibits high shielding effect, excellent noise attenuation effect and high reliability at a lower cost.

#### Claims

1. An electrical adapter with a filter comprising a contact element, a filter unit, a front frame and a back frame,  
     said filter unit being made of a filter comprising at least one member selected from the group consisting of a condenser, a ferrite and a resistor,  
     said contact element being electrically connected to said filter unit,  
     said contact element and said filter unit being held between said front frame and said back

frame, and

    said front frame, said contact element, said filter unit and said back frame being fixedly assembled.

2. The electrical adapter with a filter according to claim 1, wherein said front frame, said filter unit and said back frame are fixedly assembled into a sandwiched structure with said filter unit sandwiched between said front frame and said back frame.
3. The electrical adapter with a filter according to claim 2, further comprising a body, a female portion of said contact element being inserted into a hole portion formed in said body, a leaf spring being disposed between said front frame and said filter unit, and said body being disposed between said back frame and said filter unit.
4. The electrical adapter with a filter according to any one of claims 1 to 3, wherein said filter unit comprises a filter formed by a printing method.
5. The electrical adapter with a filter according to claim 4, wherein said filter of said filter unit comprises a condenser made of a dielectric substance containing at least one member selected from the group consisting of  $\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})\text{O}_3$ ,  $\text{Pb}(\text{Zn}_{1/3}\text{Nb}_{2/3})\text{O}_3$ ,  $\text{PbTiO}_3$ , and  $\text{Bi}_2\text{O}_3$ .
6. The electrical adapter with a filter according to any one of claims 1 to 5, wherein a male portion and the female portion of said contact element form an integral body.

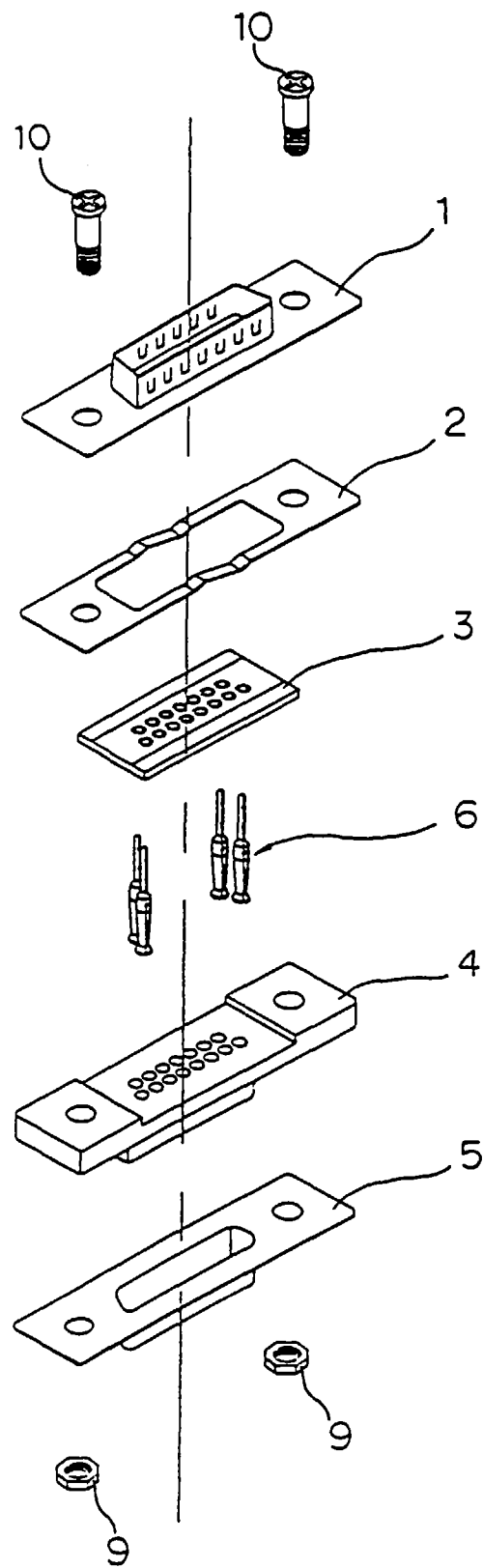


Fig. 1

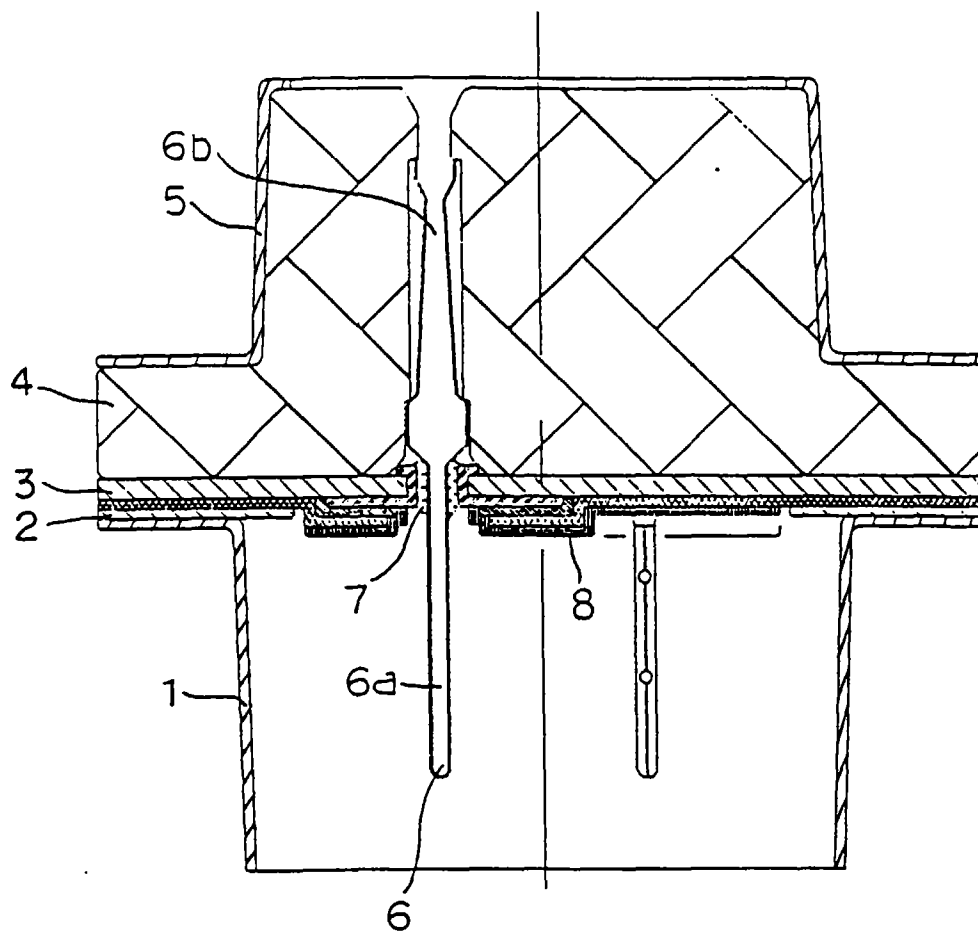


Fig. 2

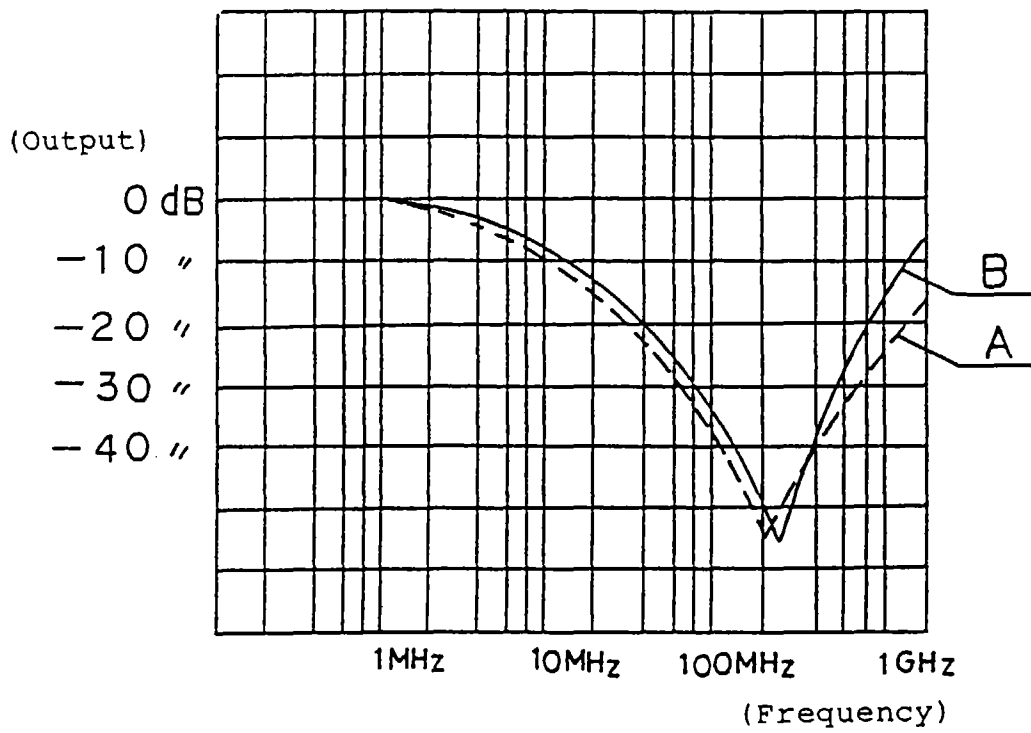


Fig.3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP95/01773

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int. Cl <sup>6</sup> H01R13/719		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
Int. Cl <sup>6</sup> H01R13/66-13/719, 31/06, H01G4/12		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Jitsuyo Shinan Koho 1926 - 1995		
Kokai Jitsuyo Shinan Koho 1971 - 1995		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP, 63-37581, A (AMP Inc.), February 18, 1988 (18. 02. 88), Lines 5 to 19, upper right column, page 4 & EP, 211508, A & US, 4726638, A & US, 4729743, A & US, 4729752, A	1 - 6
Y	JP, 59-184478, A (E. I. Du Pont de Nemours and Co.), October 19, 1984 (19. 10. 84), Line 9, upper right column to line 16, lower left column, page 4 (Family: none)	4
Y	JP, 59-184479, A (E. I. Du Pont de Nemours and Co.), October 19, 1984 (19. 10. 84), Line 15, upper right column to line 10, lower right column, page 5 (Family: none)	4
Y	JP, 59-54666, A (Matsushita Electric Ind. Co., Ltd.), March 29, 1984 (29. 03. 84),	5
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&amp;" document member of the same patent family</p>		
Date of the actual completion of the international search		Date of mailing of the international search report
November 2, 1995 (02. 11. 95)		November 21, 1995 (21. 11. 95)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP95/01773

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Claim & US, 4555494, A	
Y	JP, 2-225363, A (Matsushita Electric Ind. Co., Ltd.), September 7, 1990 (07. 09. 90), Claim & US, 5004715, A	5
Y	JP, 2-44609, A (Kyocera Corp.), February 14, 1990 (14. 02. 90), Claim (Family: none)	5
Y	JP, 4-262382, A (Kitagawa Kogyo K.K.), September 17, 1992 (17. 09. 92), Claim (Family: none)	6

Form PCT/ISA/210 (continuation of second sheet) (July 1992)