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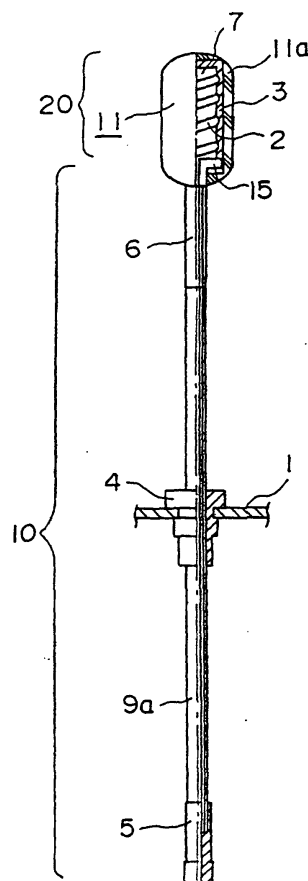
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(54) **DIRECTIONAL ANTENNA WITH ELECTROMAGNETIC INTERFERENCE SUPPRESSOR**

(57) An antenna has an electromagnetic interference suppressor (3) which comprises a composite magnetic member containing soft magnetic powder having an oxide film layer and which covers a part of the periphery of the antenna. It is preferable that the electromagnetic interference suppressor covers one side or a half of the periphery of the antenna. The antenna may comprise a first antenna portion (10) slidably held by a housing of a radio apparatus, and a second antenna portion (20) connected to one end of the first antenna portion. In this case, the electromagnetic interference suppressor is arranged in at least one of the first and the second antenna portions. The first antenna portion is slidably held by a holder portion (4) fixedly attached to the housing of the radio apparatus. A stopper portion (5) is fixedly attached to one end of the first antenna portion to serve as a feeding portion for the first antenna portion when the antenna is pulled out. The second antenna portion is connected to the other end of the first antenna portion through a sleeve portion (6).

FIG.3



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Description

TECHNICAL FIELD

[0001] This invention relates to an antenna adapted for use in a mobile radio apparatus.

BACKGROUND ART

[0002] In recent years, various kinds of mobile radio apparatuses such as mobile telephone sets are more and more increasingly used. Each of these mobile radio apparatuses is assigned with a specific frequency for transmission and reception of a radio wave. The above-mentioned specific frequency tends to be a high frequency. The radio wave having a high frequency may possibly give an adverse influence upon a body of a user of the mobile radio apparatus. Despite such possibility, a typical mobile telephone set makes use of an antenna of the type that a part of the antenna protrudes outside of a housing. This is because a primary object is to improve the sensitivity in transmission and reception.

[0003] Fig. 1 shows a conventional whip antenna of a top-loading type. This antenna is disclosed in Japanese Unexamined Patent Publication (JP-A) No. 8-84017 (84017/1996) and comprises a first antenna portion 30 as a whip element, a stopper portion 35 connected to a bottom end of the first antenna portion 30, a sleeve portion 36 formed at a top end of the first antenna portion 30, and a second antenna portion 40 connected to a top end of the sleeve portion 36. The second antenna portion 40 comprises a bobbin portion 47, a helical coil 42 wound around the bobbin portion 47, and a resin coating portion 41a covering the bobbin portion 47 and the helical coil 42. The resin coating portion 41a serves to improve the radiation efficiency and the appearance of the second antenna portion 40.

[0004] Therefore, the resin coating portion 41a is formed by a material which can minimize the adverse influence upon antenna characteristics. Generally, the antenna characteristics include the directivity and the gain. It is desired for the mobile telephone sets that the antenna is nondirectional or omnidirectional and has a high gain.

[0005] Fig. 2 shows another conventional whip antenna of a bottom-loading type. The antenna is disclosed in Japanese Unexamined Patent Publication (JP-A) No. 8-503830 (503830/1996) and comprises a first antenna portion 50 as a whip element held by a housing 51 of a telephone set, a second antenna portion 60 as a bottom-loading element covering a bottom end of the first antenna portion 50, and a stopper portion 65 formed at a bottom end of the second antenna portion 60. The second antenna portion 60 is provided with a helical coil 52.

[0006] However, each of the conventional whip antennas illustrated in Figs. 1 and 2 simply aims to improve the reception sensitivity without considering the influence upon the human body by the radio wave radiated

from the antenna.

[0007] Thus, in the conventional mobile radio apparatuses, no effective countermeasure is taken against the radio wave having a high frequency.

[0008] Other techniques related to the antenna will be briefly mentioned below.

[0009] Japanese Unexamined Patent Publication (JP-A) No. 9-46756 (46756/1997) describes an antenna having an antenna cover made of a radio absorbing material and attached via a shaft to a fixing member formed at a base of the antenna.

[0010] Japanese Unexamined Patent Publication (JP-A) No. 9-223888 (223888/1997) discloses a technique of shielding an electromagnetic wave radiated from an antenna by the use of an electromagnetic wave shielding plate having a hook to engage an antenna of a mobile telephone set.

[0011] Japanese Utility Model Application No. 59-22598 (22598/1984) discloses an antenna comprising at least two linear radiation elements arranged in close proximity of each other and a radio absorber interposed between the linear radiation elements.

[0012] Japanese Unexamined Patent Publication (JP-A) No. 64-37106 (37106/1989) discloses an antenna comprising an antenna body covered with a radio absorber matching a radar frequency.

[0013] Japanese Unexamined Patent Publication (JP-A) No. 50-20 (20/1975) discloses that a radio wave is absorbed by a structure coated with a paint containing ferrite.

[0014] Japanese Unexamined Patent Publication (JP-A) No. 5-228873 (228873/1993) discloses a radio absorber comprising at least one unit film which is a heat-treated composite layer formed by oxidizing a composite layer composed of a resin layer and a metal layer.

[0015] In view of the above, it is an object of this invention to provide a directional antenna capable of controlling the directivity of an antenna portion to reduce the influence upon a human body by a radio wave radiated from the antenna.

SUMMARY OF THE INVENTION

[0016] According to this invention, there is provided an antenna having an electromagnetic interference suppressor which comprises a composite magnetic member containing soft magnetic powder having an oxide film layer and which covers a part of the periphery of the antenna.

[0017] The electromagnetic interference suppressor may cover one side or a half of the periphery.

[0018] The antenna may comprise a first antenna portion slidably held by a housing of a radio apparatus, and a second antenna portion connected to one end of the first antenna portion. The electromagnetic interference suppressor may be arranged in at least one of the first and the second antenna portions.

[0019] The antenna may further comprise a holder

portion slidably holding the first antenna portion and fixedly attached to the housing of the radio apparatus, a stopper portion fixedly attached to one end of the first antenna portion to serve as a feeding portion for the first antenna portion when the antenna is pulled out, and a sleeve portion formed at the other end of the first antenna portion and connected to the second antenna portion.

[0020] The orientation of the electromagnetic interference suppressor may be preliminarily determined by coupling of the holder portion and the stopper portion.

[0021] The orientation of the electromagnetic interference suppressor may be preliminarily determined by coupling of the holder portion and the sleeve portion.

[0022] The second antenna portion may be one of a stick type, a helical type, and a dielectric-resonance type.

[0023] The electromagnetic interference suppressor may be covered with an insulating coating portion.

[0024] The electromagnetic interference suppressor may have an electromagnetic absorber.

[0025] The electromagnetic interference suppressor may be provided by adhesion, fitting, or painting.

BRIEF DESCRIPTION OF THE DRAWING

[0026]

Fig. 1 shows a conventional whip antenna of a top-loading type;

Fig. 2 shows another conventional whip antenna of a bottom-loading type;

Fig. 3 is a half sectional view of a directional antenna according to one embodiment of this invention;

Fig. 4 is an enlarged half sectional view of an intermediate portion of the directional antenna illustrated in Fig. 3;

Fig. 5 is an enlarged half sectional view of a lower portion of the directional antenna illustrated in Fig. 3; and

Fig. 6 is an enlarged half sectional view of an upper portion of the directional antenna illustrated in Fig. 3.

BEST MODE FOR EMBODYING THE INVENTION

[0027] Description will be made about a directional antenna according to one embodiment of this invention with reference to the annexed drawing.

[0028] Referring to Fig. 3, the directional antenna comprises a holder portion (antenna-holding fixture) 4 fixedly attached to a housing 1 of a mobile radio apparatus, a first antenna portion 10 held by the holder portion 4 to be slidable in the vertical direction, a stopper portion 5 fixedly attached to a bottom end of the first antenna portion 10 to be coupled to the holder portion 4 and serve as a feeding portion for the first antenna portion 10 when the antenna is pulled out, a sleeve por-

tion 6 attached to a top end of the first antenna portion 10 to be coupled to the holder portion 4 when the first antenna portion 10 is retreated, a second antenna portion 20 formed at a top end of the sleeve portion 6, and an electromagnetic interference suppressor 3 formed at a desired part of a circumference of each of the first and the second antenna portions 10 and 20 so as to shield an electromagnetic wave. In the illustrated example, the electromagnetic interference suppressor 3 is formed at one side or a half of the circumference of each of the first and the second antenna portions 10 and 20. The electromagnetic interference suppressor 3 may be provided by adhesion, fitting, or painting. Although not shown in the figure, the housing 1 is also provided with an electromagnetic interference suppressor similar to the electromagnetic interference suppressor 3 provided in each of the first and the second antenna portions 10 and 20.

[0029] As illustrated in detail in Figs. 4 and 5, the first antenna portion 10 comprises a whip element 8, the electromagnetic interference suppressor 3 formed at the outer periphery of the whip element 8, and a first coating portion 9a formed on the outer periphery of the electromagnetic interference suppressor 3. The whip element 8 may be made of a Ti-Ni alloy or an ordinary wire such as a stainless steel wire and a piano wire. The first coating portion 9a may be formed by fitting an insulating tube or molding an insulating resin material.

[0030] The second antenna portion 20 is connected to a top end of the whip element 8. As shown in Fig. 6 also, the second antenna portion 20 has the sleeve portion 6 to serve as the feeding portion and a helical coil 2 to perform an antenna function when the antenna is retreated. The helical coil 2 is wound around a helical guide portion 7. The electromagnetic interference suppressor 3 is formed outside of the helical coil 2 and the helical guide portion 7. Thus, the helical coil 2 and the helical guide portion 7 are covered by the electromagnetic interference suppressor 3 to shield the electromagnetic wave.

[0031] Furthermore, the electromagnetic interference suppressor 3 is covered with a second coating portion 11a having an insulating nature. The second coating portion 11a may be formed by molding an insulating resin material to enclose the electromagnetic interference suppressor 3. Alternatively, the second coating portion 11a may be formed by fitting an insulating resin cap to the electromagnetic interference suppressor 3. Thus, an antenna top portion 11 protected by the second coating portion 11a is formed.

[0032] The above-mentioned directional antenna is arranged so that the electromagnetic interference suppressor 3 is always faced to a human body when the mobile radio apparatus is used. This arrangement is implemented by a positioning structure formed at a coupling portion of the holder portion 4 and the stopper portion 5 or a coupling portion of the holder portion 4 and the sleeve portion 6 to uniquely determine the orienta-

tion of the electromagnetic interference suppressor 3 with respect to the holder portion 4. Specifically, it is assumed that the electromagnetic interference suppressor 3 is oriented in a same direction at the first and the second antenna portions 10 and 20. Then, the orientation when the antenna is pulled out can be determined by a coupling state of the holder portion 4 and the stopper portion 5. On the other hand, the orientation when the antenna is retreated can be determined by a coupling state of the holder portion 4 and the sleeve portion 6. Specifically, by coupling these portions as a combination of irregular shapes like a jigsaw puzzle, the electromagnetic interference suppressor 3 can be oriented in a predetermined direction.

[0033] As the electromagnetic interference suppressor 3, use may be made of a product manufactured and sold by Tokin Corporation, Sendai, Japan under the trade name of "BUSTERAID". The technique related to "BUSTERAID" is described in detail in Japanese Unexamined Patent Publication (JP-A) No. 9-93034 (93034/1997). The electromagnetic interference suppressor described in the above-mentioned publication is made of soft magnetic powder having a magnetostrictive constant not equal to zero and shaped into a flattened configuration. After shaping, the soft magnetic powder has an average thickness smaller than a skin depth of a desired composite magnetic member at a used frequency. The soft magnetic powder has as a dielectric layer an oxide film layer formed at least on a surface thereof. A combination of annealing treatment and the above-mentioned soft magnetic powder provides the composite magnetic member having a high-frequency magnetic permeability controllably varied within a wide range. By the use of a plurality of composite magnetic members different in residual strain, it is possible to effectively suppress the electromagnetic interference.

[0034] Next, description will be made about a method of producing the above-mentioned directional antenna.

[0035] In the sleeve portion 6, an element 15 is provided by molding or press-fitting. To the element 15, the helical guide portion 7 formed by molding or the like is fitted by press-fitting or screwing. The helical coil 2 is wound around the helical guide portion 7. The helical coil 2 is further wound around the sleeve portion 6 and connected by one of press-fitting, soldering, and screwing. The electromagnetic interference suppressor 3 is provided on a half of the circumference of the helical coil 2 wound around the helical guide portion 7. In order to protect the internal components and to improve external appearance, the second coating portion 11a is formed. Thus, the second antenna portion 20 is formed.

[0036] On the other hand, the electromagnetic interference suppressor 3 is provided around the whip element 8. Then, the first coating portion 9a is formed to protect the whip element 8 and the electromagnetic interference suppressor 3. Thus, the first antenna portion 10 is formed. The top end of the first antenna portion 10

is fitted and fixed to the bottom end of the sleeve portion 6.

[0037] Subsequently, the holder 4 is fitted to the first antenna portion 10. Thereafter, the stopper portion 5 is fitted. The bottom end of the whip element 8 is deformed to provide an enlarged portion which is press-fitted into the stopper portion 5 to secure the whip element 8 and the stopper portion 5 to each other.

[0038] In the above-mentioned directional antenna, the directivity on the one side is broken by a simple structure. Therefore, by facing the one side toward the human body, it is possible to suppress the influence upon the human body.

[0039] The electromagnetic interference suppressor 3 may be provided in only one of the first and the second antenna portions 10 and 20. The second antenna portion 20 may be implemented by a stick type or a dielectric resonance type.

INDUSTRIAL APPLICABILITY

[0040] As described above, the directional antenna according to this invention is useful as an antenna of a radio apparatus such as a mobile telephone set.

Claims

1. An antenna having an electromagnetic interference suppressor which comprises a composite magnetic member containing soft magnetic powder having an oxide film layer and which covers a part of the periphery of said antenna.
2. An antenna as claimed in claim 1, wherein said electromagnetic interference suppressor covers one side or a half of the periphery.
3. An antenna as claimed in claim 1 or 2, comprising a first antenna portion slidably held by a housing of a radio apparatus, and a second antenna portion connected to one end of said first antenna portion, said electromagnetic interference suppressor being arranged in at least one of said first and said second antenna portions.
4. An antenna as claimed in claim 3, further comprising a holder portion slidably holding said first antenna portion and fixedly attached to said housing of the radio apparatus, a stopper portion fixedly attached to one end of said first antenna portion to serve as a feeding portion for said first antenna portion when said antenna is pulled out, and a sleeve portion formed at the other end of said first antenna portion and connected to said second antenna portion.
5. An antenna as claimed in claim 4, wherein the ori-

entation of said electromagnetic interference suppressor is preliminarily determined by coupling of said holder portion and said stopper portion.

6. An antenna as claimed in claim 4, wherein the orientation of said electromagnetic interference suppressor is preliminarily determined by coupling of said holder portion and said sleeve portion. 5
7. An antenna as claimed in any one of claims 3 through 6, wherein said second antenna portion is one of a stick type, a helical type, and a dielectric-resonance type. 10
8. An antenna as claimed in any one of claims 1 through 7, wherein said electromagnetic interference suppressor is covered with an insulating coating portion. 15
9. An antenna as claimed in any one of claims 1 through 8, wherein said electromagnetic interference suppressor has an electromagnetic absorber. 20
10. An antenna as claimed in any one of claims 1 through 9, wherein said electromagnetic interference suppressor is provided by adhesion, fitting, or painting. 25

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FIG.1

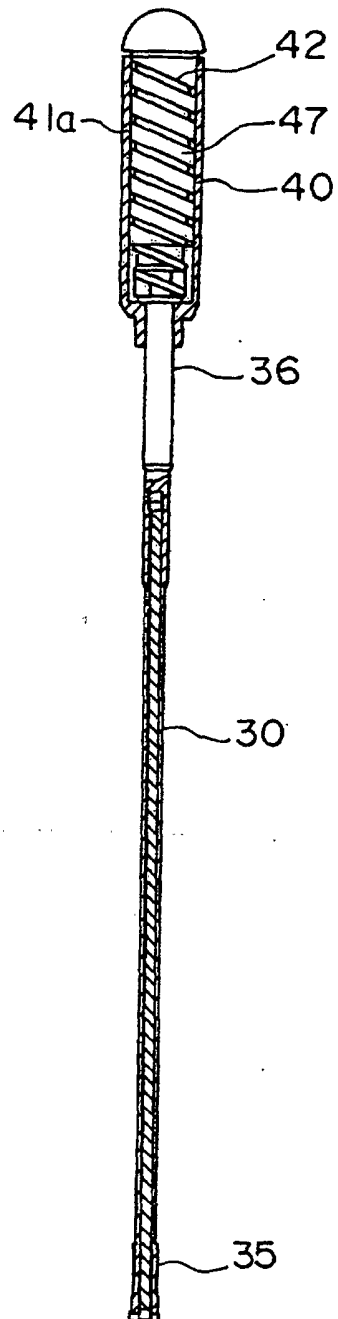


FIG.2

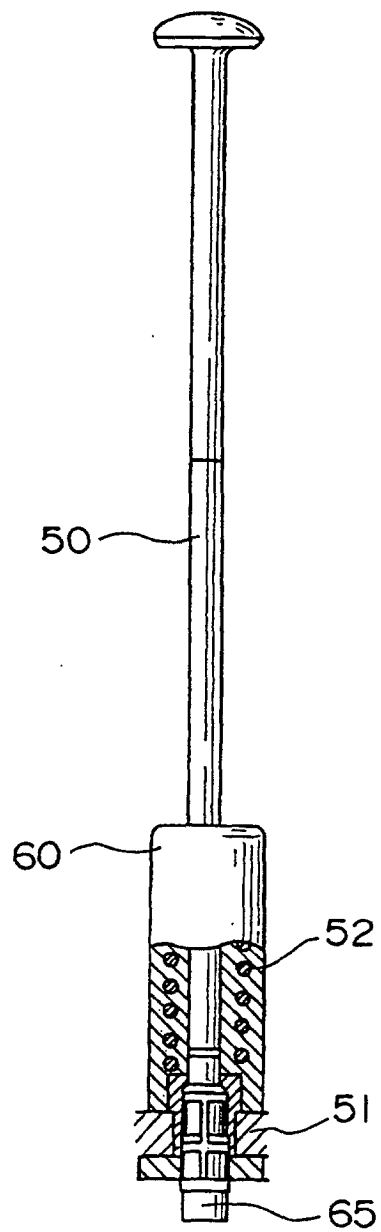


FIG.3

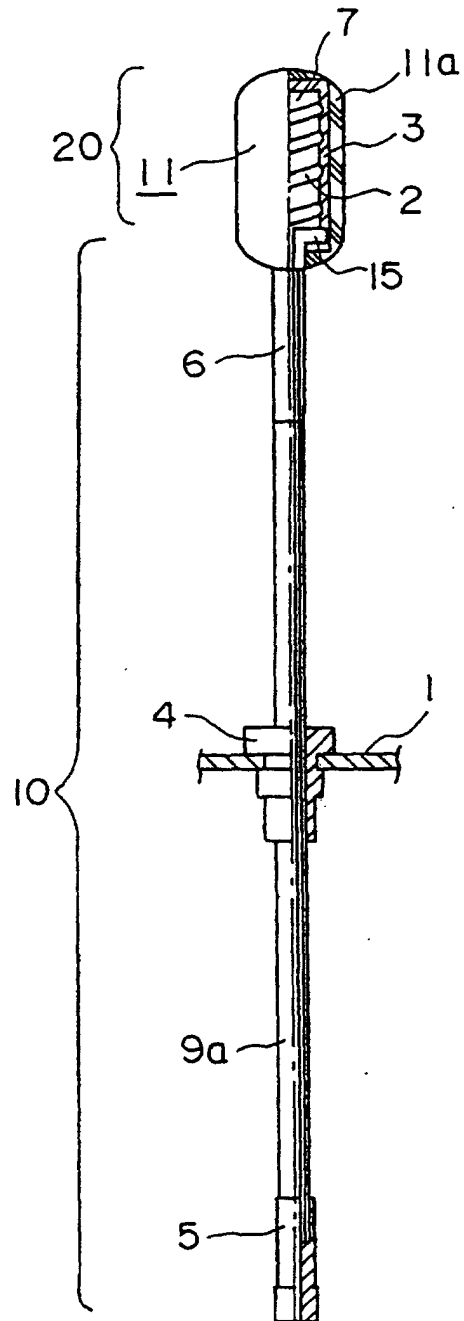


FIG.4

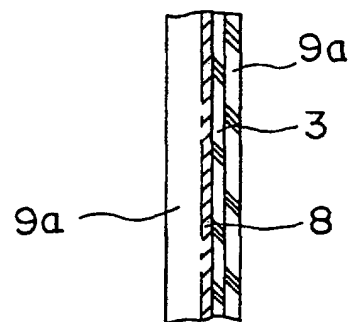


FIG.6

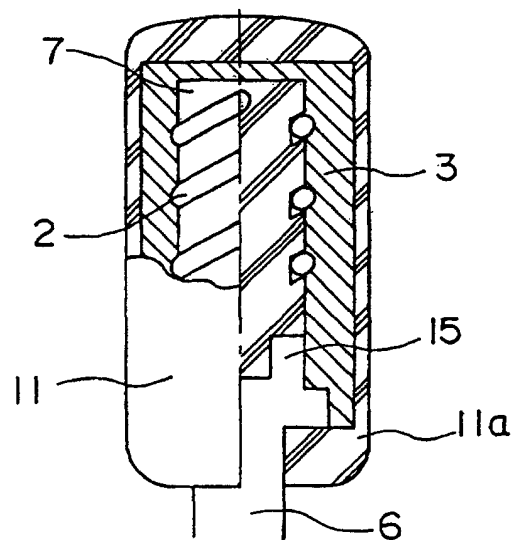
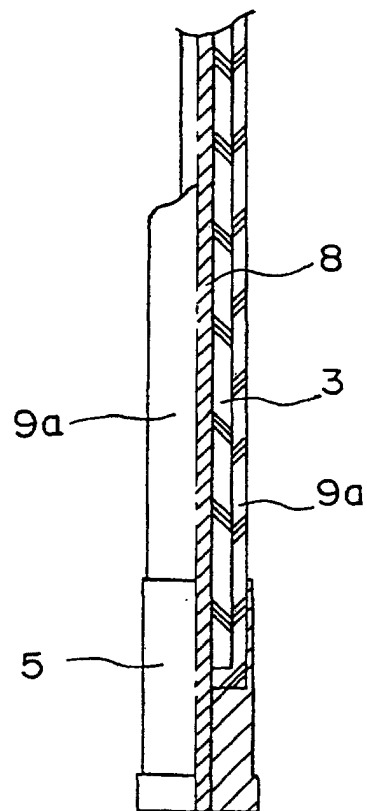


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP99/03493

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁶ H01Q17/00, H01Q9/30, H01Q1/10, H01Q1/24, H01Q1/36 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) Int.Cl. ⁶ H01Q17/00, H01Q9/30, H01Q1/10, H01Q1/24, H01Q1/36-1/38 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1999 Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP, 9-93034, A (Tokin Corp.), 4 April, 1997 (04. 04. 97) & EP, 764954, A & CN, 1149747, A & SG, 48471, A & US, 5827445, A	1-10
Y	JP, 9-46756, A (Toru Ito), 14 February, 1997 (14. 02. 97), Refer to Fig. 3 (Family: none)	1-10
Y	JP, 11-4095, A (Hidenori Tsuboi), 6 January, 1999 (06. 01. 99), Refer to Fig. 1 (Family: none)	1-10
Y	JP, 9-294104, A (Sony Corp.), 11 November, 1997 (11. 11. 97), Refer to Fig. 2 (Family: none)	3-10
A	JP, 10-512407, A (Bickert Paul Francis), 24 November, 1998 (24. 11. 98), & WO, 9621254, A & AU, 4325896, A & EP, 801820, A & US, 5907307, A	1-10
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 19 July, 1999 (19. 07. 99)		Date of mailing of the international search report 3 August, 1999 (03. 08. 99)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
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