PATROLL Winning Submission

U.S. Patent 8,674,887

U.S. Patent 8,674,887 ("*Fractus*" or the "patent-at-issue") was filed on July 24, 2012. According to the paragraph in the specification entitled "Cross-Reference to Related Applications," the patent-at-issue is a continuation of International Patent Application No. PCT/EP02/14706, filed on Dec. 22, 2002. Claim 1 of the patent-at-issue is generally directed to a A mobile communication device comprising communications circuitry mounted inside the structure of the device. The circuit board comprises a ground plane and a feeding point. A multi-band antenna is mounted on the circuit board with first and second radiating arms coupled to and extending from the common conductor in the feeding point. A space-filling curve constituting at least a part of the first radiating arm, which comprises at least ten segments that are shorter than a tenth of a free-space operating wavelength of the multi-band antenna, each of the segments being connected to its neighboring segments at an angle such that no pair of adjacent segments defines a longer straight segment, wherein any periodicity of the space-filling curve along a fixed straight direction of space involves a periodic structure having a period defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent ones of the connected segments defines a longer straight segment..

The primary reference, U.S. Patent 6,388,626 ("*Samsung*"), was filed on May 5, 1998. According to its cover page, the publication claims a priority date of July 9, 1997 on the basis of a prior foreign application. The publication is directed to an antenna device for a hand-portable radio communication unit including a casing with a ground plane means cooperating with the antenna device. The antenna device comprises first and second radiating elements being tuned to different resonant frequencies and having a common feed point. The radiating elements are disposed in a compact arrangement on a support means so as to be confined entirely in the casing.

The primary reference, U.S. Patent 7,023,385 ("*TDK*"), was filed on November 28, 2003. According to its cover page, the publication claims a priority date of November 29, 2002 on the basis of a prior foreign application. The patent is directed to a chip antenna that has pattern antennas, which are formed on a plurality of layers of a base member of a stacked structure and of which at least parts of their patterns are not overlapping with each other in the stacked direction, and a feeding terminal which is formed on a surface of the base member and which is connected to the pattern antennas.

The primary reference, U.S. Patent 6,791,497 ("*IAI*"), was filed on September 9, 2001, and claims priority on the same date. The patent is directed to a slot spiral miniaturized antenna. A slot arranged in the form of a spiral curve and having a slow-wave structure is formed in the conductive layer. The conductive layer strip has a shape that replicates a pattern of the two neighboring parts of the slotline. The antenna is geometrically smaller than another antenna performing the same functions, but without such features as the slow-wave structure of the slotline and the replication of a pattern of the slotline shape by a conductive layer strip.

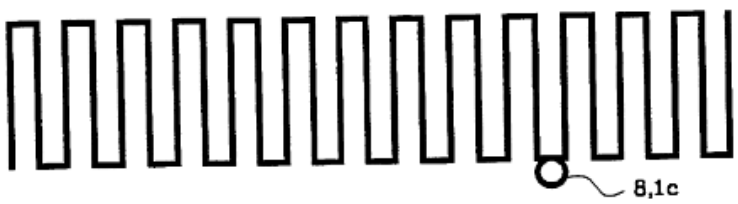
A sample claim chart comparing claim 1 of *Fractus* to *Samsung*, *TDK*, and *IAI* is provided below.

US8674887 ("*Fractus*")	**A. US6388626** (*"Samsung"*) **B. US7023385** (*"TDK"*) **C. US6791497** (*"IAI"*)
1.pre A **mobile communication device comprising**: 1.a **communications circuitry**;	**A. US6388626** "With reference to FIGS. 1, 4 and 11, there is shown a first, basic embodiment of the antenna device according to the invention, the antenna device 1 being disposed in one end portion of an elongated, box-like casing 2 of a hand-portable mobile telephone. **All parts of the telephone as such, including its electronic circuitry**, are left out from FIG. 1, even the rear wall of the casing." *Samsung* at col. 3:22-27 **B. US7023385** "FIG. 1 is a perspective view for schematically showing **a chip antenna unit** according to the first embodiment of the present invention. FIG. 2 is an exploded prospective view for schematically showing a chip antenna in the chip antenna unit illustrated in FIG. 1." *TDK* at col. 3:55-59 "2. **A wireless communication device in which said chip antenna** as claimed in claim 1 **is used**." *TDK* at claim 2 **C. US6791497** "FIG. 10 schematically illustrates an **antenna** 110 of the present invention mounted on a back surface 120 of **a mobile communication device** 100. When the antenna 110 includes a backed cavity (not shown), it radiates uni-directionally." *IAI* at col. 11:13-15 "The second surface 13 is also covered by a conductive layer (not shown). A portion of the layer is removed to produce a planar "infinite" balun 17. The procedures used to remove the portions of the conducting layers on the first and second surfaces may be any one of the common techniques used to produce **printed circuit boards** such as etching, milling or other standard printed circuit techniques." *IAI* at col. 6:40-46
1.b a circuit board comprising a **ground plane** and a **feeding point**, the **feeding point being coupled to the communications circuitry**;	**A. US6388626** "Each one of the meander radiating elements 1 a, 1 b has a length of approximately λ/4, λ being the respective wave length of the high frequency radiation, each radiating element cooperating with **a ground plane** 6, **e.g. in the form of a**

(cont.) 1.b a circuit board comprising a **ground plane** and a **feeding point**, the **feeding point being coupled to the communications circuitry**;	**metal layer on a dielectric substrate**. Preferably, as will be apparent from FIGS. 1 and 4, the ground plane means 6 is extended over the whole area of the casing 2. However, it is not strictly necessary that the ground plane means is extended all the way underneath the antenna device 1." *Samsung* at col. 3:62-67 through col. 4:1-3 "The two radiating elements 1 a, 1 b are tuned to different resonant frequencies allowing operation of the antenna device in two overlapping or separated frequency bands, for example 900 MHz and 1,8 GHz. **The common feed point** 1 c **is to be connected to a feeding circuitry of the telephone**." *Samsung* at col. 3:48-52 **B. US7023385** "As illustrated in FIG. 1, the chip antenna 10 is mounted on a mounting substrate 13. Accordingly, a chip antenna unit according to this embodiment of the present invention is constituted by the chip antenna 10 and the mounting substrate 13. **A ground electrode** 14 **is formed on the mounting substrate** 13. Further, **a feeding path** 15 **which supplies signals from a signal source** (not shown) **to the feeding terminal** 12 by keeping matching with an impedance of the circuit, for example, 50 Ω is also formed on the mounting substrate 13. Moreover, **fixing portions** 17 a, 17 b **which are composed of conductors and connected to the fixed terminals** 16 a, 16 b **and which thereby fix the base member** 11 **on the mounting substrate** 13 **are also formed on the mounting substrate** 13." *TDK* at col. 4:36-49 **C. US6791497** "The antenna 10 includes **a dielectric substrate** 11 **having a first surface** 12 and a second surface 13. **The first surface** 12 **is covered by a conductive layer** 14." *IAI* at col. 6:25-27 "**The conductive layer** 14 **acts as a ground plane for the conductive layer strip** 18. As shown in FIG. 1, **the conductive layer strip** 18 **is wound toward the feedpoint** 23 **and provides a balanced feed to the slot at the feedpoint** 23 that is defined by the place wherein the projection of said conductive layer strip 18 on the second side intercepts the slotline 16." *IAI* at col. 6:63-67 through col. 7:1-3

1.c a **mounting structure positioned within the mobile communication device**, a section of the mounting structure **extending over the circuit board**; and	**A. US6388626** "With reference to FIGS. 1, 4 and 11, there is shown a first, basic embodiment of the antenna device according to the invention, the antenna device 1 being disposed in one end portion of an **elongated, box-like casing** 2 **of a hand-portable mobile telephone**." *Samsung* at col. 3:22-25 "According to a first aspect of the present invention, the antenna device 1 comprises first and second radiating elements 1a, 1b carried by a **support means** 3, **which** in this embodiment **is formed by a straight bar** 3 constituted by a hollow, molded body of plastic material, such as polypropene or teflon, whereby the weight of the antenna device will be low. The **bar** 3 **extends transversely between the opposite longer sides** 2a, 2b **of the casing** 2 and can be snapped into the shown position." *Samsung* at col. 3:32-40 **B. US7023385** "2. **A wireless communication device in which said chip antenna** as claimed in claim 1 **is used**." *TDK* at claim 2 **C. US6791497** "FIG. 10 schematically illustrates **an antenna** 110 **of the present invention mounted on a back surface** 120 **of a mobile communication device** 100. When the antenna 110 includes a backed cavity (not shown), it radiates uni-directionally. Such implementation of the antenna eliminates the aforementioned drawback of conventional antennas, since the radiation directed towards the user (not shown) will be significantly decreased, when compared with the bi-directional radiation of the conventional communication devices." *IAI* at col. 11:13-21
1.d a **multi-band antenna secured to the mounting structure and laterally offset from an edge of the ground plane**, the multi-band antenna comprising:	**A. US6388626** "In a second embodiment of the antenna device, as shown in FIG. 6, the **meander-configured radiating elements** 1 a **and** 1 b **are mounted on a L-shaped support body** 3′, **the first meander radiating element** 1 a **being oriented with its longitudinal axis along one edge (the shorter edge) of the rectangular ground plane means** 6, **and the other meander radiating element** 1 b **being oriented with its longitudinal axis adjacent and in parallel to the adjacent, longer edge of the ground plane means** 6." *Samsung* at col. 4:33-41

(cont.) 1.d a **multi-band antenna secured to the mounting structure and laterally offset from an edge of the ground plane**, the multi-band antenna comprising:	**B. US7023385** "As illustrated in FIG. 1, **the chip antenna** 10 **is mounted on a mounting substrate** 13. Accordingly, **a chip antenna unit according to this embodiment of the present invention is constituted by the chip antenna** 10 **and the mounting substrate** 13." *TDK* at col. 4:36-40 **C. US6791497** "The antenna 10 includes **a dielectric substrate** 11 **having a first surface** 12 and a second surface 13. **The first surface** 12 **is covered by a conductive layer** 14." *IAI* at col. 6:25-27 "**The conductive layer** 14 **acts as a ground plane for the conductive layer strip** 18. As shown in FIG. 1, the conductive layer strip 18 is wound toward the feedpoint 23 and provides a balanced feed to the slot at the feedpoint 23 that is defined by the place wherein the projection of said conductive layer strip 18 on the second side intercepts the slotline 16." *IAI* at col. 6:63-67 through col. 7:1-3
1.e a **common conductor coupled to the feeding point**; **first and second radiating arms coupled to and extending from the common conductor; and**	**A. US6388626** "According to a first aspect of the present invention, the **antenna device** 1 **comprises first and second radiating elements** 1 a, 1 b carried by a support means 3, which in this embodiment is formed by a straight bar 3 constituted by a hollow, molded body of plastic material, such as polypropene or teflon, whereby the weight of the antenna device will be low." *Samsung* at col. 3:32-38 "The antenna elements 1 a and 1 b are constituted by flat meander-configured elements of an electrically conductive material, normally a metal material such as aluminium or copper. Although the meander element is shaped as a continuous meander element, **there are two radiating elements** 1 a **and** 1 b **extending from a common feed point** 1 c in opposite directions to a respective free end 1 aa, 1 bb (FIG. 11). The two radiating elements 1 a, 1 b are tuned to different resonant frequencies allowing operation of the antenna device in two overlapping or separated frequency bands, for example 900 MHz and 1,8 GHz. **The common feed point** 1 c **is to be connected to a feeding circuitry of the telephone**." *Samsung* at col. 3:41-52

(cont.) 1.e a **common conductor coupled to the feeding point**; **first and second radiating arms coupled to and extending from the common conductor; and**	**B. US7023385** "As illustrated in FIG. 1, **a feeding terminal** 12 **is formed from a bottom surface of the base member** 11 **to an upper surface thereof through one side surface thereof**. Further, fixed terminals 16 a, 16 b are formed on two side surfaces opposite to each other and adjacent surfaces around the two side surfaces. Thus, the feeding terminal 12, the fixed terminal 16 a and the fixed terminal 16 b are formed on the surfaces f the base member 11, respectively. As depicted in detail in FIG. 2, **the feeding terminal** 12 **is connected to one end of each of the first and the second pattern antennas** A1, A2, the fixed terminal 16 a is connected to another end of the first pattern antenna A1, and the fixed terminal 16 b is connected to another end of the second pattern antenna A2, respectively." *TDK* at col. 4:22-35 **C. US6791497** "According to one non-limiting example, **the feedpoint** 23 **is arranged at the center of an aperture of the antenna**. **The center may include a bridge** 24 **connecting the two arms of the slotted spiral**, **and the feedpoint** 23 **is arranged at the bridge** 24." *IAI* at col. 7:21-25
1.f **a space-filling curve constituting at least a part of the first radiating arm, wherein the space-filling curve comprises at least ten segments that are shorter than a tenth of a free-space operating wavelength of the multi-band antenna, each of the segments being connected to its neighboring segments at an angle such that no pair of adjacent segments defines a longer straight segment, wherein any periodicity of the space-filling curve along a fixed straight direction of space involves a periodic structure having a period defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent ones of the connected segments defines a longer straight segment.**	**A. US6388626** "The **antenna elements** 1 a **and** 1 b **are constituted by flat meander-configured elements** of an electrically conductive material, normally a metal material such as aluminium or copper." *Samsung* at col. 3:41-43 "Moreover, according to a second aspect of the invention, the **antenna device may include only one internal radiating element with multiple turns**, e.g. **a meander element such as the element** 1 a in FIG. 6 or a helical element such as the element 21 a in FIG. 10, in combination with a rod element 11 being perpendicular to the longitudinal axis of the internal element with multiple turns." *Samsung* at col. 6:1-7  Fig. 13

(cont.)
1.f **a space-filling curve constituting at least a part of the first radiating arm, wherein the space-filling curve comprises at least ten segments that are shorter than a tenth of a free-space operating wavelength of the multi-band antenna, each of the segments being connected to its neighboring segments at an angle such that no pair of adjacent segments defines a longer straight segment, wherein any periodicity of the space-filling curve along a fixed straight direction of space involves a periodic structure having a period defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent ones of the connected segments defines a longer straight segment.**

Fig. 14

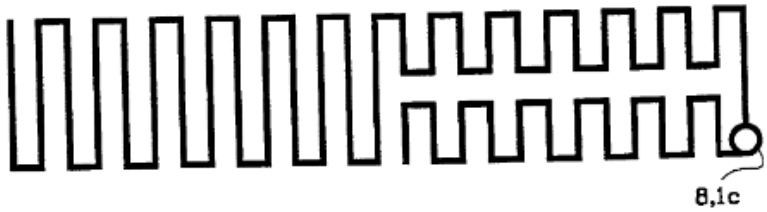


Fig. 15

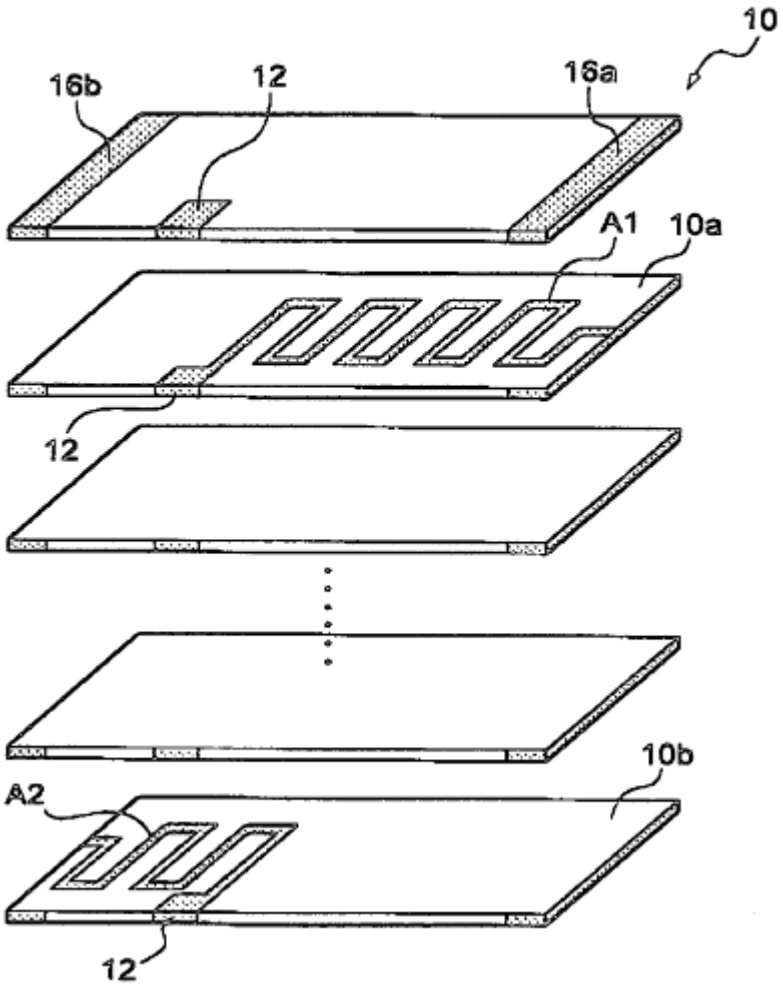
B. US7023385
"**Pattern antennas are formed on a plurality of layers of the base member** 11. As illustrated in FIG. 2, **a pattern antenna A1 having a first pattern of a meander shape is formed on a first pattern layer** 10 a while **a pattern antenna** A2 **having a second pattern of another meander shape different from that of the first pattern** is formed on a second pattern layer 10 b. Besides, the first and the second pattern antennas A1, A2 are formed to have the first and the second patterns of meander shapes, respectively, in this embodiment. **However, the first and the second pattern antennas A1, A2 may be formed to have various patterns of, for example, a circular shape, a rectangular shape, a three-dimensional helical shape over a plurality of layers, and the like**. Further, even when the first and the second pattern antennas A1, A2 are formed to have the first and the second patterns of meander shapes, as mentioned above, the first and the second pattern antennas A1, A2 may be formed to have patterns composed of a plurality of layers for obtaining reactance capacity." *TDK* at col. 4:4-21

"Thus, even though frequency characteristics of one pattern antenna (for example, the first pattern antenna A1) are adjusted by changing a shape thereof, little influence is given to frequency characteristics of another pattern antenna (for example, the second pattern antenna A2). **As a result, a predetermined pattern antenna (for example, the first**

(cont.)
1.f **a space-filling curve constituting at least a part of the first radiating arm, wherein the space-filling curve comprises at least ten segments that are shorter than a tenth of a free-space operating wavelength of the multi-band antenna, each of the segments being connected to its neighboring segments at an angle such that no pair of adjacent segments defines a longer straight segment, wherein any periodicity of the space-filling curve along a fixed straight direction of space involves a periodic structure having a period defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent ones of the connected segments defines a longer straight segment.**

pattern antenna A1) can be adjusted to have an optimized resonant frequency without influencing the frequency characteristics of another pattern antenna (for example, the second pattern antenna A2)." *TDK* at col. 5:12-21

FIG. 2



C. US6791497
"**The slotline** 16 **is arranged in the form of a spiral curve to form a two arm slotted spiral. It should be appreciated that the spiral curve of the slotline** 16 **may be in any form, e.g., rectangular, Archimedean, logarithmic**, etc. It should be appreciated that the slotline 16 may also have an acentric and non-symmetric form that is a combination of various forms. **The spiral may be of any size, have any number and density of turns and growth rates. The density of the turns**

(cont.)
1.f **a space-filling curve constituting at least a part of the first radiating arm, wherein the space-filling curve comprises at least ten segments that are shorter than a tenth of a free-space operating wavelength of the multi-band antenna, each of the segments being connected to its neighboring segments at an angle such that no pair of adjacent segments defines a longer straight segment, wherein any periodicity of the space-filling curve along a fixed straight direction of space involves a periodic structure having a period defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent ones of the connected segments defines a longer straight segment.**

may be non-uniform, i.e. may depend on the spiral rotation angle and a location of a feed point 23." *IAI* at col. 6:30-39

"Turning to FIG. 4a and FIG. 4b, a conventional zigzag 42 and a modified zigzag 44 are shown, according to one embodiment of the present invention. **The conventional zigzag** 42 **has straight-line teeth** 43, **while the modified zigzag 44 has a reversed S-type shape** 45. **Using various configurations**, e.g., **the configurations** 45 **through** 47 **of the modified zigzag, it is possible to further increase the length of the slotline** (16 in FIG. 1), **when compared with using the length** 43 **of the conventional zigzag** 42. As a consequence of the increase in the zigzag length, the slow-wave factor of the configuration decreases, and the low frequency limit of the antennas' operation is extended without changes of the overall antenna geometry in the position and number of the zigzag's teeth." *IAI* at col. 8:7-19

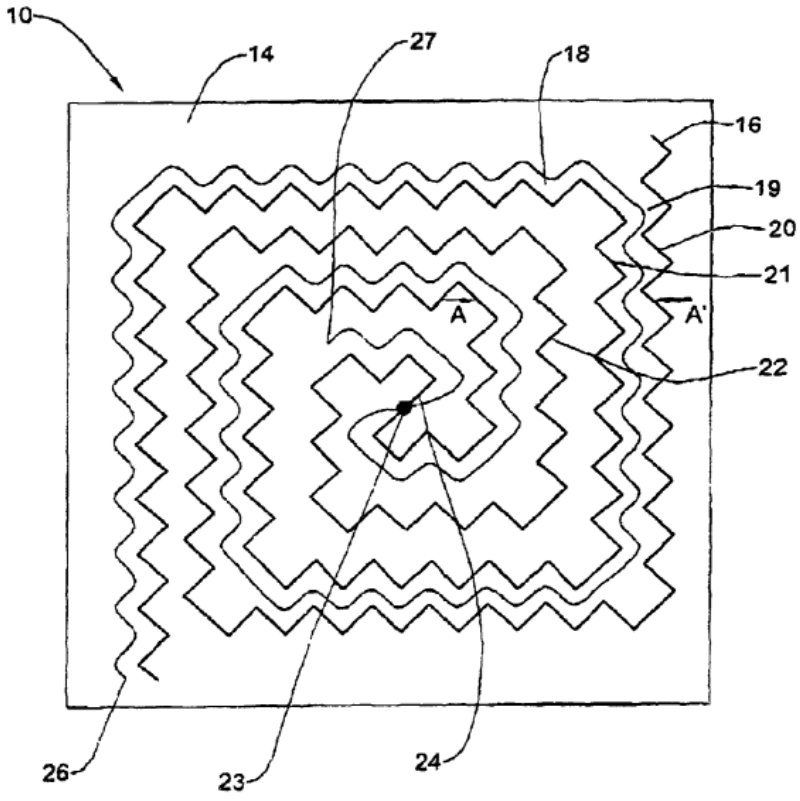


FIG. 1