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(54) Patch antenna

(57) Planar inverted antenna arrangement (PIFA) for a portable communication device, said antenna arrangement comprising:

a first upper L-shaped antenna patch (12) to be connected to a ground plane (15) having ground potential (V1), and
a second lower L-shaped transmission antenna patch (14) to be connected to a feeding potential (V2), said antenna patches (12, 14) being arranged adjacent to each other separated by a first gap (17a) forming a capacitance like structure to provide a frequency dependent capacitive feeding, wherein said second lower antenna patch (14) is separated by a second gap (17b) to the ground plane (15), which second gap (17b) comprises dielectric material.

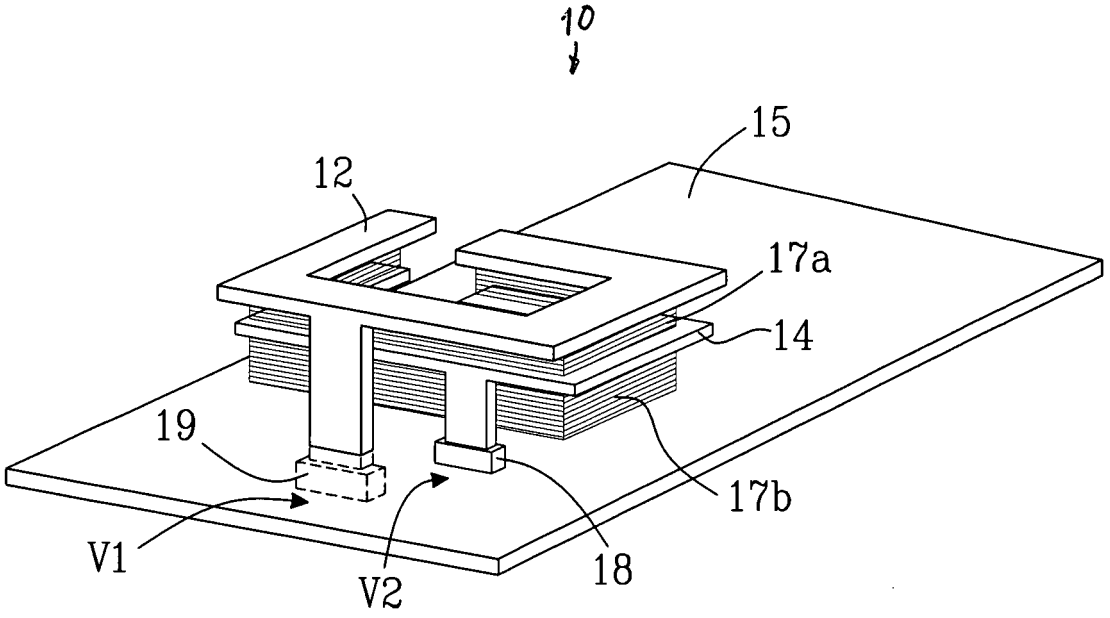

Fig. 1

EP 1 672 733 A1

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to the field of antennas and more particularly to a PIFA antenna arrangement for a portable communication device as well as a portable communication device including such an antenna arrangement.

DESCRIPTION OF RELATED ART

[0002] There is a trend within the field of portable communication devices, and especially within the field of cellular phones to have the antenna built-in, in the device itself. Probably, future portable communication devices will be small in size, and in particular thin devices are demanded by users. Typically, in such devices, compact, in particular thin, built-in antennas will then be required.

[0003] Today, existing portable communication devices such as cellular phones provided with built-in antennas normally have so-called "microstrip" antennas or so-called "planar inverted-F" antennas (PIFAs).

[0004] Since PIFAs are one of the most promising designs as regards compact antennas, they are often provided in mobile phones. See for instance K. Qassim, "Inverted F-antenna for portable handsets", IEEE Colloqium on Microwave Filters and Antennas for Personal Communication Systems, pp. 3/1-3/6, Feb. 1994, London, UK.

[0005] To further decrease thickness, meandering inverted F-antennas have been described, see for instance WO-A1-96/27 219, whereby antenna size can be further reduced compared to conventional PIFAs.

[0006] However, as the portable communication devices become smaller, conventional PIFAs (or small microstrip antennas) will still not be able to provide sufficient multi-band capability, and in particular not sufficient bandwidth and be compact enough to fit into small chassis for portable communication devices.

[0007] For instance, in US-A-5 754 190, a PIFA is described that is compact and suitable for use in portable phones. The PIFA comprises capacitve load to provide a yet smaller design, which unfortunately at the same time reduces the bandwidth of the antenna.

[0008] Thus, there is still a need for a PIFA antenna arrangement for a portable communication device, which is very compact, in particular such an antenna arrangement which is very thin, and at the same time provide broad band capability.

SUMMARY OF THE INVENTION

[0009] The present invention is directed towards solving the problem of providing a PIFA antenna arrangement that is very compact, i. e. more compact than a conventional PIFA and at the same time provide broad band capability.

[0010] An object of the present invention is thus to provide a PIFA antenna arrangement solving the problem (s) stated above.

[0011] According to a first aspect of the present invention, this is achieved by a PIFA antenna arrangement comprising:

a first upper L-shaped antenna patch to be connected to a ground plane having ground potential, and

a second lower L-shaped transmission antenna patch to be connected to a feeding potential, said antenna patches being arranged adjacent to each other separated

by a first gap forming a capacitance like structure to provide a frequency dependent variable capacitive feeding, wherein said second lower antenna patch is separated by a second gap to the ground plane, which second gap comprises dielectric material.

[0012] Herein, the term "gap" is meant a space where no conducting elements are placed.

[0013] In this way, a compact PIFA antenna arrangement having a variable capacitance is provided which is frequency dependent due to the gap(s) between antenna patch elements.

[0014] A second aspect of the present invention is directed towards an antenna arrangement including the features of the first aspect, wherein also the first gap comprises dielectric or forming material.

[0015] A third aspect of the present invention is directed towards an antenna arrangement including the features of the first, second, third or fourth aspect, wherein the patches have a length approximately equal to a quarter of a wavelength at the operating frequency band.

A fourth aspect of the present invention is directed towards an antenna arrangement including the features of the first, second, or third aspect, wherein the connection between the feeding potential, provided by a radio circuit (source) and lower patch is screened.

[0016] A fifth aspect of the present invention is directed towards an antenna arrangement including the features of the first, second, third, or fourth, aspect, wherein the radio circuit is connected to the second patch at an edge thereof.

[0017] A sixth aspect of the present invention is directed towards an antenna arrangement including the features of any one of the preceding aspects, wherein at least one of the antenna patches has a slot shape.

[0018] A seventh aspect of the present invention is directed towards an antenna arrangement including the features of any one of the preceding aspects, wherein at least one of the antenna patches has a branch shape.

[0019] Another object of the present invention is directed towards providing a portable communication device including an antenna arrangement.

[0020] According to an eight aspect of the present invention, this object is achieved by a portable communication device, said device comprising a chassis having

a microphone, a speaker
opening, and a keypad, wherein the device further comprises a PIFA antenna arrangement,
said antenna arrangement comprising:

a first upper L-shaped antenna patch to be connected to a ground plane having ground potential, and
a second lower L-shaped transmission antenna patch to be connected to a feeding potential, said antenna patches being arranged adjacent to each other separated by a first gap forming a capacitance like structure to provide a frequency dependent variable capacitive feeding, wherein said second lower antenna patch is separated by a second gap to the ground plane, which second gap comprises dielectric material.

[0021] The invention has the following advantages: The antenna arrangement is very compact, in particular very thin and has broad-band capability, whereby much wider bandwidth can be achieved by using the same volume as prior art antennas. It is cheap and easy to implement in a portable communication device.

[0022] It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of state d features, integers, steps or components, but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The present invention will now be described in more detail in relation to the enclosed
drawings, in which:

Fig. 1 schematically shows a perspective view of antenna arrangement according to a first embodiment of the invention.

Fig. 2 shows a view from the side of the antenna element illustrated in Fig. 1.

Fig. 3 illustrates a portable communication device including the antenna arrangement illustrated in Fig. 1 and 2.

DETAILED DESCRIPTION OF EMBODIMENTS

[0024] As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely examples of the invention that may be further embodied in various and alternative forms other than described below. The drawings are not necessarily to scale, and some elements may be exaggerated or minimized to show details of particular components or features. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting in any sense, but merely as a basis for the claims and as a representative basis for enabling one skilled in the art to variously put the present invention into practice.

[0025] Fig. 1 schematically shows a perspective view of the antenna arrangement according to a first embodiment of the invention. The antenna arrangement 10 includes a first upper L-shaped antenna patch 12 herein in the form of a conducting layer, to be connected to ground potential V1, and a second lower L-shaped transmission antenna patch 14, herein in the form of a conducting layer, to be connected to a feeding potential V2.

[0026] The antenna patches 12, 14 can be made of any suitable material, such as metal, polymer material or the like.

[0027] Now is referred to Fig. 2 illustrating a view from the side of the antenna arrangment illustrated in Fig. 1.

[0028] The antenna patches 12, 14 are arranged adjacent to each other and separated by a first gap 17a forming a capacitance like structure to provide a frequency dependent capacitive feeding, i. e. a variable capacitance, being variable due to the gap between antenna patches. Moreover, the second lower antenna patch 14 is separated by a second gap 17b to the ground plane 15, which second gap 17b comprises dielectric material. Preferably, the dielectric material is provided as load of dielectric block. However, both gaps 17a, b could be dielectric block filled. The gap size(s) depend(s) on the coupling between the upper antenna patch 12 and the lower antenna patch 14. The size of the dielectrics 17a and 17b are merely schematic illustrated in the drawing figures and can be any suitable depending on design parameters. Thus, the sizes illustrated in Fig. 1 and 2 are not limiting the scope of the invention in any sense to these particular.

[0029] Preferably, the patches have the form of L-shaped conducting layers stacked onto each other in a capacitor like structure. The short between the upper patch 12 and ground can be formed, for instance by threading conducting fabric through a slot 19. The arrangement of the antenna arrangement 10 in a portable communication device will be further described below; however, design parameters such as sufficient distance from a chassis of the device (not shown) and other parameters obvious for a person skilled in the art to design, will not be described.

[0030] Different dielectric or forming (electret) material can therefore be placed here. Materials to be employed as dielectric materials in the gap should preferably have low dielectric constants (such materials are dependent on the frequency at "high" frequencies, but normally not at "low" frequencies). Normally, in application within the field of the present invention, frequencies are high. Particular examples of materials are for instance: polytetrafluorethylene (PTFE) or low-density polyethylene (LDPE).

[0031] An insulated conductor 18, connecting to a radio circuit or other source (not shown) is connected to

the lower patch 14. The conductor 18 can for instance be a conventional coaxial cable, whereby for instance a centre conductor of the same is connected to the lower patch 14, typically at an edge of the first patch 12, for instance by soldering or other suitable conventional fastening method.

[0032] The patches can have different area. For instance, by controlling the length (or the width) of the patches, the antenna arrangement can also be capable of being tuned to different frequencies, for instance to be able also to operate in multiple frequency bands. For example, a first band may be a GSM band and the second band a DCS band. Of course, other combinations of frequency bands may be implemented without departing from the invention. Examples are: GSM+PCS, GSM+WCDMA etc.

[0033] In a preferred embodiment, the patches has a length approximately equal to, or approaching a quarter wavelength at the operating frequency band (e.g. around 450 MHz for a cellular phone). It can also be equal to the full wavelength or any suitable multi-band quarter wavelength resonant.

[0034] The physical form of the patches can be any suitable, for instance planar layers, curved surfaces etc provided that they can be arranged in a capacitor-like fashion. The patches can for instance be slot or branch shaped.

[0035] Tuning of the antenna arrangement can be accomplished for instance by a matching bridge (not shown).

Typically, the gaps are dimensioned such that its length and impedance allow the antenna arrangement to be fed with an intended radio frequency bandwidth to stay within limits for broad-band performance and the antenna arrangement to work well. Radiation characteristics, drive point impedance and simple construction are parameters that typically have to be considered. However, since they are well-known for a person skilled in the art to design, they will not be further discussed herein. Preferably, the first gap 17a is about 0,1 to 0,3 percent of the wavelength. However, this is not necessary, since it depends on the dielectric block. Thus, any suitable gap could be provided.

[0036] As described above, the resonant frequencies f0 and bandwidth of the built-in antenna arrangement according to the present invention are dependent upon thickness of the dielectric material, but also the type of dielectric material (j. e. the dielectric constant) will influence. The resonant frequencies could be described by a well-known general formula

(I):

$$f0 = 1/2\pi\ LC \qquad (I)$$

[0037] By designing the patches smartly, broad band characteristics could be further improved. For instance a loading resistor could be provided to further enhance bandwidth.

[0038] Because of the size of the antenna arrangement of the present invention, the antenna is easily driven in many frequency bands, for instance GSM/900/1800, PCS 1900, UMTS bands and even GPS bands. The different frequency bands are easily provided by the radio circuits including components such as tuning filter or a tuning network in order to comply with the different frequency bands.

The present invention has many advantages. The frequency dependent capacitance feeding, realised by two patches coupled to each other, provides two resonances adjacent to each other. In this way the bandwidth is doubled compared to a conventional PIFA. The antenna arrangement provides better wideband performance because of the capacitive feeding compared to conventional PIFAs.

[0039] The antenna arrangement finds application in a portable communication device such as a mobile phone, which is a preferred embodiment of the invention.

[0040] It can be other types of portable communication devices though, like a cordless phone, a communication module, a PDA or any other type of portable device communicating with radio waves. Most likely, there will be a number of varying portable communication devices in the future when the 3rd generation cellular systems are implemented. Therefore, preferably, the portable communication device according to the present invention, provides adequate gain and bandwidth in all existing present and future frequency bands, typically within a range of 300-3000 MHz.

[0041] The portable communication device, herein a mobile phone, illustrated in Fig. 3 comprises a built-in antenna arrangement according to the present invention. The mobile phone 200

includes a chassis 210 having a microphone opening 220 and speaker opening 230 located approximately next to the position of the mouth and ear, respectively of a user. A keypad 240 allows the user to interact with the communication device, e. g. by inputting a telephone number to be dialed. The mobile phone 200 also includes a built-in antenna, the details of which have been described above.

[0042] The foregoing has described the principles, preferred embodiments and modes of operation of the present invention. However, the invention should not be construed as being limited to the particular embodiments discussed above. Thus, the above-described embodiments should be regarded as illustrative rather than restrictive, and it should be appreciated that variations may be made in those embodiments by workers skilled in the art without departing from the scope of the present invention as defined by the following claims.

Claims

1. Planar inverted antenna arrangement (PIFA) for a portable communication device, said antenna arrangement comprising:

   a first upper L-shaped antenna patch (12) to be connected to a ground plane (15) having ground potential (V1), and
   a second lower L-shaped transmission antenna patch (14) to be connected to a feeding potential (V2), said antenna patches (12, 14) being arranged adjacent to each other separated by a first gap (17a) forming a capacitance like structure to provide a frequency dependent capacitive feeding, wherein said second lower antenna patch (14) is separated by a second gap (17b) to the ground plane (15), which second gap (17b) comprises dielectric material.

2. Antenna arrangement according to claim 1, wherein also the first gap (17a) comprises dielectric or forming material.

3. Antenna arrangement according to any one of the claims 1-2, wherein the antenna patches (12, 14) have a length approaching a quarter wavelength at the operating frequency band.

4. Antenna arrangement according to any one of the preceding claims, wherein the connection (18) between the feeding potential (V_2), provided by radio circuit (a source) (5) and second lower patch (14) is screened.

5. Antenna arrangement according to any one of the preceding claims, wherein the radio circuit (5) is connected to the second lower antenna patch (14) at an edge thereof.

6. Antenna arrangement according to any one of the preceding claims, wherein at least one of the antenna patches (12, 14) has a slot shape.

7. Antenna arrangement according to any one of the preceding claims, wherein at least one of the antenna patches (12, 14) has a branch shape.

8. Portable communication device, said device (200) comprising a chassis (210) having a microphone (220), a speaker opening 230, and a keypad (240), wherein the device (200) further comprises an antenna arrangement (10), said antenna arrangement (10) comprising an antenna arrangement according to claim 1.

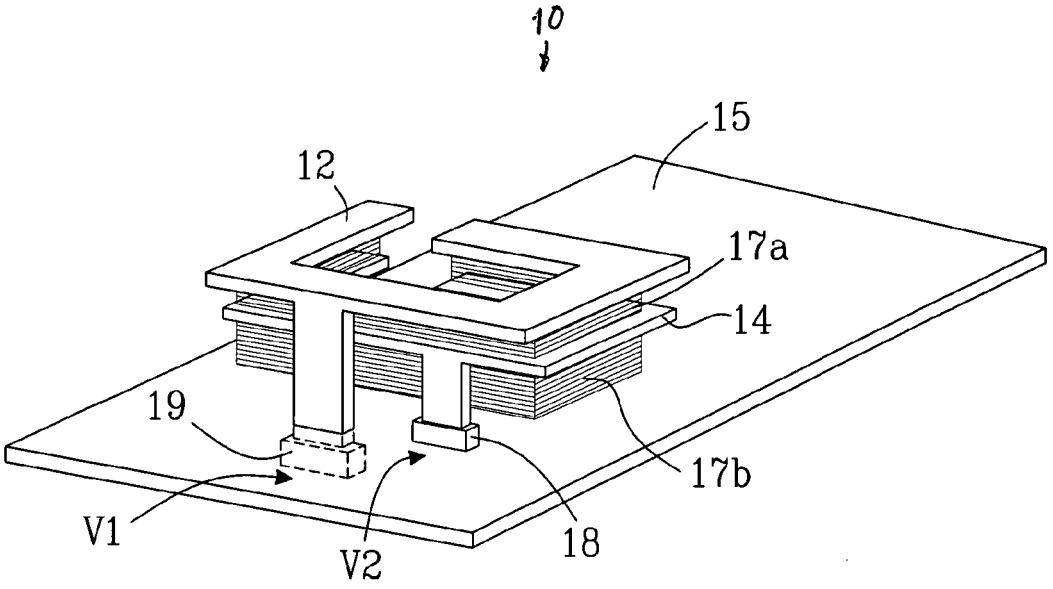

Fig.1

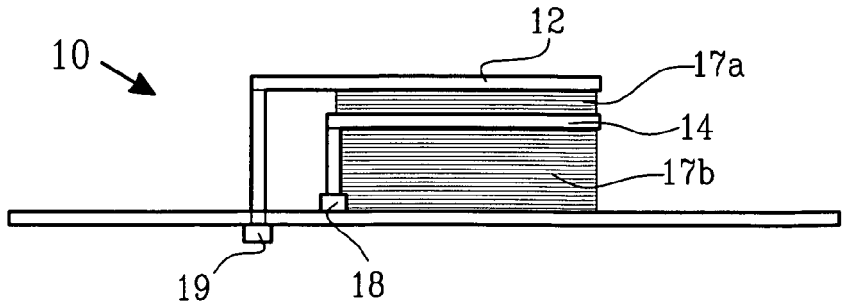

Fig.2

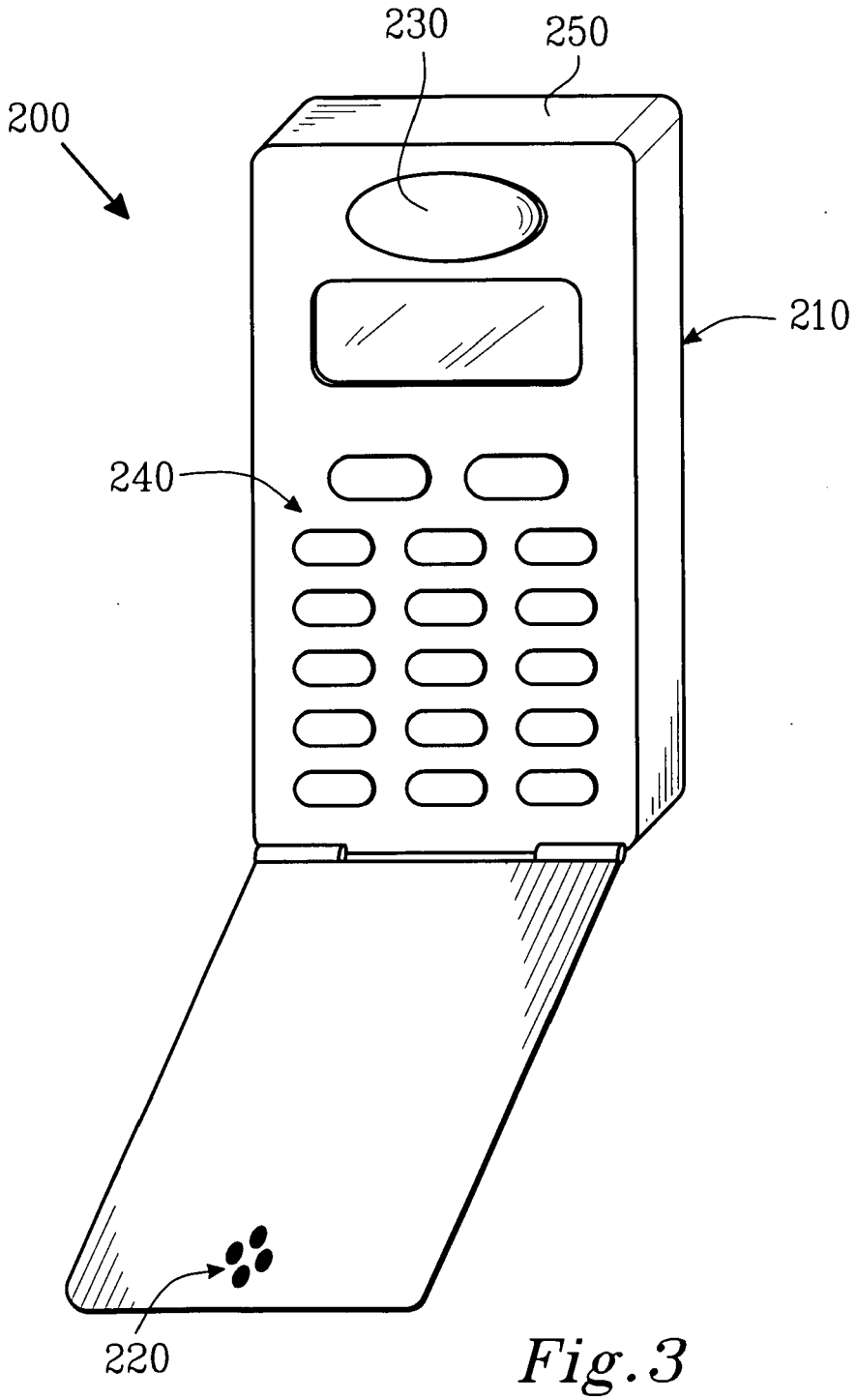

Fig.3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 9526

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 2003/098812 A1 (YING ZHINONG ET AL) 29 May 2003 (2003-05-29) * paragraphs [0012], [0013], [0029] - [0032], [0035], [0038], [0039], [0042]; figure 3 *	1-8	H01Q1/24 H01Q9/04
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 May 2005	Fredj, A

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 02 9526

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