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H1Q QHC

(56) Documents Cited

GB 2306056 A	GB 2305782 A	GB 2242573 A
GB 2213998 A	EP 0617520 A2	EP 0531125 A2
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(58) Field of Search
UK CL (Edition P) **H1Q QHC QHH QHX**
INT CL^6 **H01Q , H03H , H04B**

(54) Abstract Title
Antenna matching circuit for cordless telephone

(57) A paper cupper antenna, prints on a PCB, is connected immediately to a matching circuit in the form of a printed capacitor and a printed inductor on the same PCB. These are connected to the RF circuitry directly or via a coaxial cable. This enables the use of a short (0.44λ) antenna.

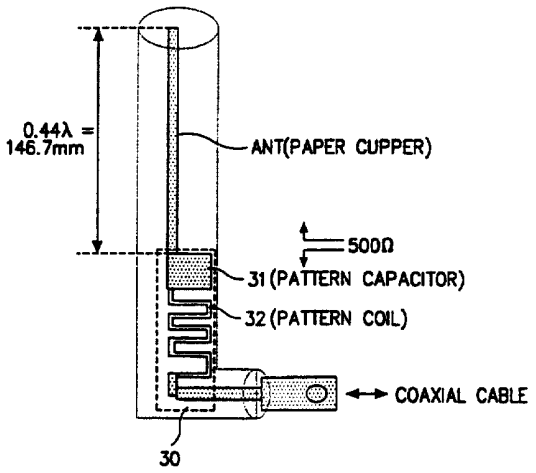

FIG. 3

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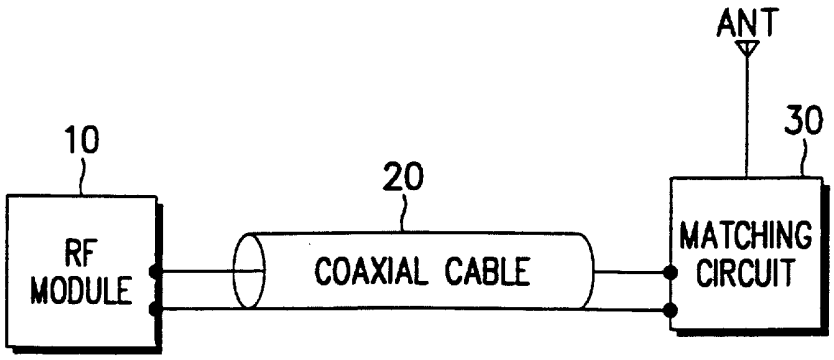
ANT
30
10
20
RF
MODULE
COAXIAL CABLE
MATCHING
CIRCUIT

FIG. 1

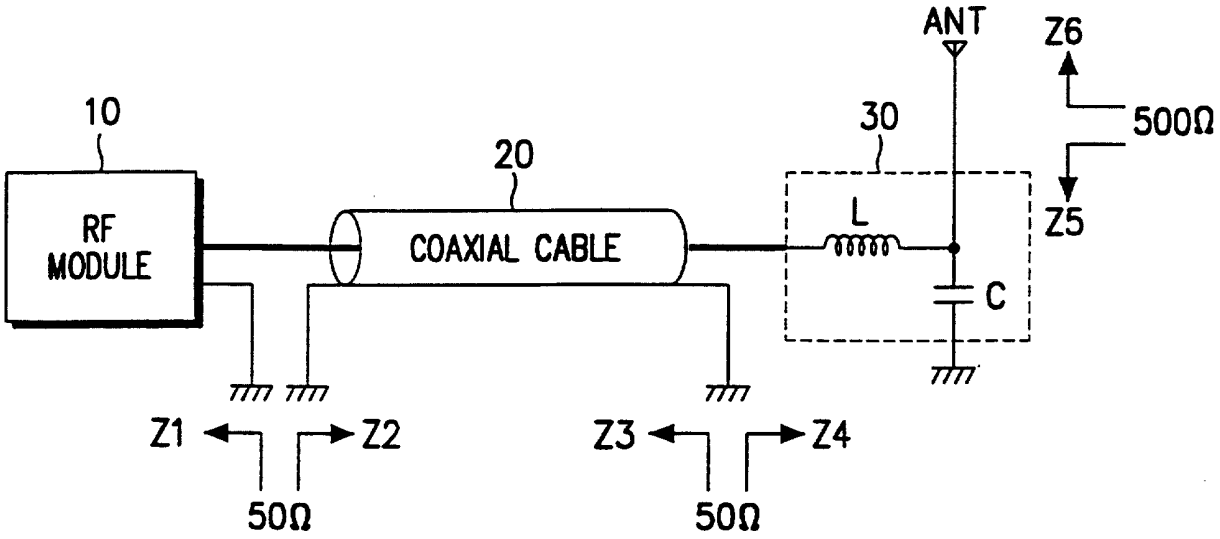
ANT
Z6
500Ω
10
30
20
RF
MODULE
COAXIAL CABLE
L
Z5
C
Z1
Z2
Z3
Z4
50Ω
50Ω

FIG. 2

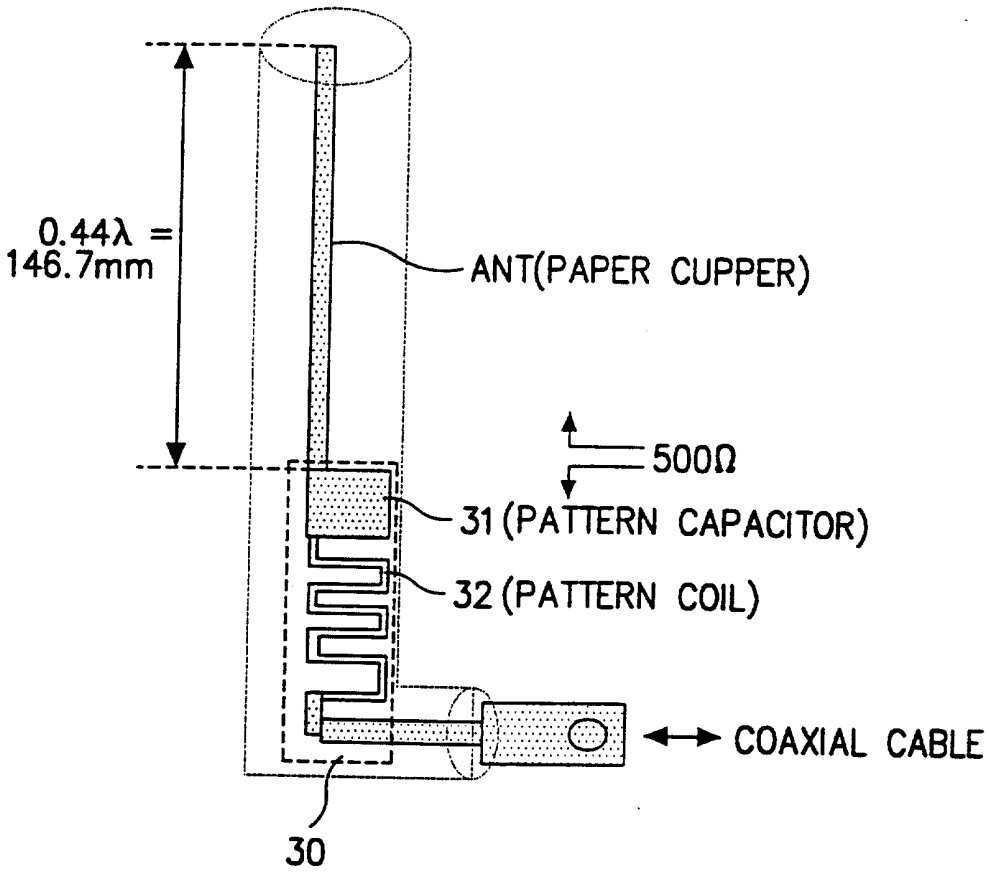
0.44λ =
146.7mm
ANT(PAPER CUPPER)
500Ω
31 (PATTERN CAPACITOR)
32 (PATTERN COIL)
COAXIAL CABLE
30

FIG. 3

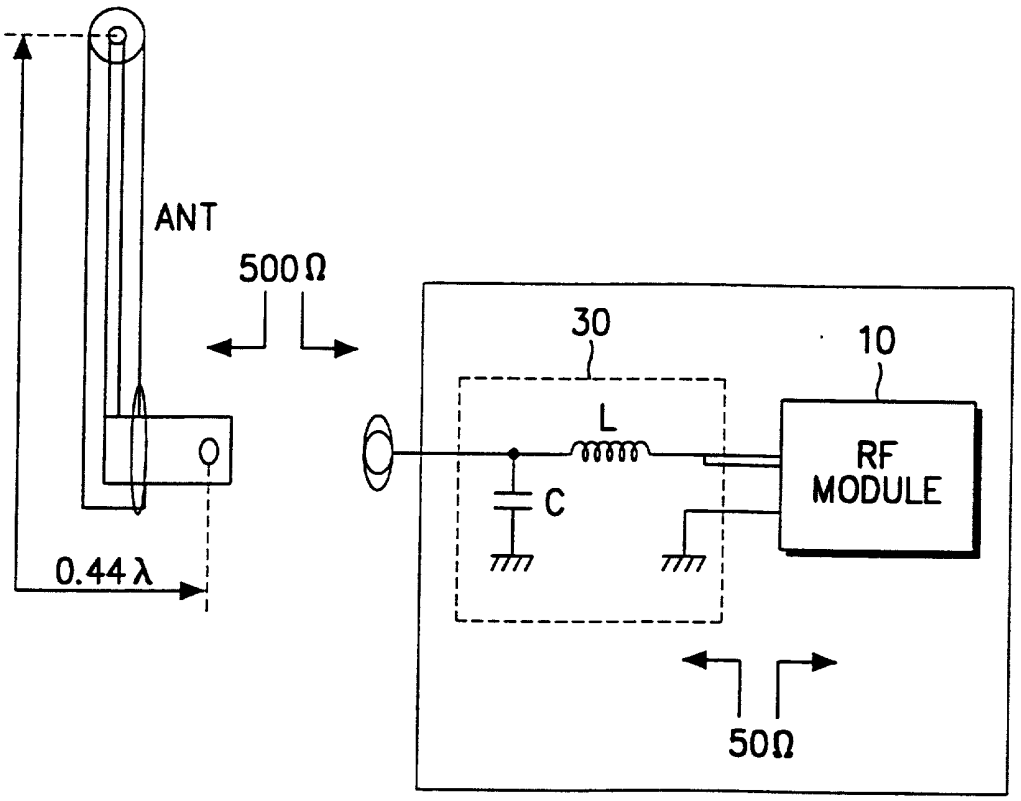

FIG. 4

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ANTENNA MATCHING CIRCUIT FOR CORDLESS TELEPHONE

Background of the Invention

The present invention relates to an antenna of a cordless telephone, and in particular, to an antenna circuit having a circuit for matching different impedances of an antenna and a radio frequency (RF) module.

Cordless telephones or similar devices are provided with an antenna and an RF module, in order to transmit and/or receive RF signals over the air. In their early development, a $\lambda/4$ antenna was typically used in cordless telephones and similar devices. Despite the advantage of its small length, this $\lambda/4$ antenna offers a low gain. Therefore $\lambda/2$ dipole antennae having high-efficiency gain are currently used in telephones with RF modules, instead of the $\lambda/4$ antenna.

However, this $\lambda/2$ dipole antenna causes problems for the current trend for increasingly minimising telephone size, due to its long length. For example, the length of a $\lambda/2$ dipole antenna used for a typical cordless telephone frequency band of 914-959MHz is 166.7mm long, longer than the body of a typical such telephone.

Many efforts have been expended to overcome the problems caused by the length of the $\lambda/2$ dipole antenna.

There is a need for a circuit matching the impedances of the RF module and antenna without shortening the antenna, because the impedance characteristics of the antenna vary with its decreased length. Though an antenna and an RF module have hitherto typically been designed to each have an impedance of 50Ω, the current trend is to design an antenna of length other than $\lambda/2$, and accordingly, with an impedance value other than 50Ω.

There is accordingly a need for a circuit for matching the

impedances of an RF module and an antenna. Due to the change of the impedance of an antenna from 50Ω to a different value, a matching circuit for matching the impedances of the antenna and the RF module has typically been provided near the RF module in the telephone. Generally, the RF module is not directly connected to the antenna of the telephone, but on the PCB (Printed Circuit Board) far from the antenna. Therefore, the matching circuit is connected to the RF module, and a wire is connected between this matching circuit and the antenna to conduct RF signals between the antenna and the matching circuit. Because the matching circuit is provided on the PCB, the wire is soldered to the PCB and then connected to the antenna. The wire typically has an impedance very different from that of the antenna.

Disadvantageously a reactance component is produced between the wire and the PCB, since the wire is not assembled uniformly. The reactance component varies in accordance with the position of the wire. With the variation of the reactance component, the impedance of the matching circuit varies from the value of 50 Ω determined in designing the matching circuit, mismatching the impedances of the antenna and the RF module. Therefore, the performance of the telephone is degraded, that is, RF power is lost.

The RF power loss refers to loss of electrical power emitted in the air. As a result, a call distance of the telephone is reduced.

Summary of the Invention

According to a first aspect of the invention there is provide an antenna circuit for a telephone, comprising an antenna having a first impedance, an RF module having a second impedance, for sending and receiving an RF signal through the antenna, and a matching circuit, for matching the impedances of the antenna and the RF module, in which the matching circuit is connected directly to the antenna.

Preferably, the circuit further comprises a coaxial cable having the second impedance, connecting the RF module to the matching circuit.

Preferably, the RF module is connected directly to the matching circuit.

Preferably, the matching circuit is under the antenna.

Preferably, the matching circuit comprises one or more printed components on a printed circuit board.

Preferably, the antenna is printed on a printed circuit board.

Preferably, the matching circuit comprises a capacitor having one terminal connected to the antenna, and an inductor having one terminal connected to the antenna.

Preferably, the other terminal of the inductor is connected directly, or indirectly, to the RF module.

Preferably, the capacitor and the inductor are conductive elements such as a pattern capacitor and a pattern coil, respectively. For example, the capacitor and inductor may be foil pattern components.

Preferably, a conductive material such as a paper cupper is used for the antenna.

According to a further aspect there is a telephone incorporating a circuit as described herein.

Thus, the invention provides a circuit for alleviating RF power loss caused by a mismatch between the impedances of an antenna and an RF module in a telephone including an RF module.

Preferably, the invention also provides a circuit for alleviating power loss caused by a mismatch between the impedances of an antenna and an RF module in a telephone including an RF module.

Preferably, the present invention provides a circuit for increasing a call distance of a telephone including an RF module.

Brief Description of the Drawings

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the attached drawings.

FIG. 1 is a block diagram of an antenna circuit according to an embodiment of the present invention.

FIG. 2 is a detailed block diagram of the antenna circuit shown in FIG. 1.

FIG. 3 illustrates another embodiment of the matching circuit shown in FIG. 2.

FIG. 4 is a block diagram of the antenna circuit according to another embodiment of the present invention.

Detailed Description of the Invention

In FIG. 1, an antenna circuit according to a first embodiment of the present invention includes an antenna ANT, an RF module 10, a coaxial cable 20, and a matching circuit 30. The antenna ANT and the RF module 10 respectively have first and second, different, impedances. The matching circuit 30 matches the impedances of the antenna ANT and the RF module 10, and is provided adjacent to the antenna ANT. The coaxial cable 20 is connected between the matching circuit 30 and the RF module 10, for conducting RF signals between the antenna ANT having the

matching circuit 30 and the RF module 10.

Variation of a reactance component depending on the position of the coaxial cable 20 is prevented, by providing the matching circuit 30 in the antenna ANT, and connecting the coaxial cable 20 between the matching circuit 30 and the RF module 10. This is because the impedances of the coaxial cable 20 respectively viewed from the RF module 10 and the matching circuit 30 are constant even with the coaxial cable 20 at a varied position. The impedances of the RF module 10 and the matching circuit 30 connected to the coaxial cable 20 are fixed at preselected values. As a result, because there is no change in the reactance component caused by changing the length of the coaxial cable 20, the matching circuit 30 is safe from the influence of the reactance component variation.

FIG. 2 is a detailed block diagram of the circuit shown in FIG. 1, showing the impedances of the components. It is assumed that the antenna ANT and the RF module 10 have impedances of 500Ω and 50Ω, respectively.

In FIG. 2, the matching circuit 30 includes a capacitor C connected between the antenna ANT and a ground, and an inductor L connected between the antenna ANT and the coaxial cable 20. The coaxial cable 20 has an impedance of 50Ω, and is connected between an feeding point of the RF module 10 and the matching circuit 30, for conducting RF signals between the antenna ANT and the RF module 10.

By appropriate selection of capacitance and inductance values in the matching circuit 30, both an impedance Z6 viewed from the matching circuit 30 toward the antenna ANT and an impedance Z5 viewed from the antenna ANT toward the matching circuit 30 may be 500Ω. Both an impedance Z3 viewed from the matching circuit 30 toward the coaxial cable 20 and an impedance Z4 viewed from the coaxial cable 20 toward the matching circuit 30 are matched to 50Ω. In

addition, both an impedance Z1 viewed from the coaxial cable 20 toward the RF module 10 and an impedance Z2 viewed from the RF module 10 and the coaxial cable 20 are also matched to 50Ω. This is because the coaxial cable 20 connected between the RF module 10 and the matching circuit 30 has the same impedance characteristic even if its length varies.

As described above, since the matching circuit 30 of the present invention is provided in the antenna ANT, and the coaxial cable 20 is connected between the RF module 10 and the matching circuit 30, the impedances of the antenna ANT and the RF module 10 are less prone to being mismatched due to possible change in the position of the coaxial cable 20. Thus, RF power loss and the decrease of a call distance are alleviated.

Another problem relating to antennae in cordless telephones is that they are likely to be warped or broken due to careless handling. The matching circuit 30, as shown in FIG. 2, and installed adjacent to, and preferably under, the antenna ANT, can be broken. Specifically, the warpage or breakage of the antenna ANT causes warpage or breakage of the inductor L and the capacitor C in the matching circuit 30.

FIG. 3 illustrates a structure of the matching circuit 30, according to a second embodiment of the present invention, implemented to overcome the problem. The dotted line in FIG. 3 indicates portions of the antenna and matching circuit 30.

In FIG. 3, a foil pattern capacitor 31 and a foil pattern coil 32 are used as capacitor C and inductor L respectively in the matching circuit 30. These elements are flexible to some extent, thus reducing the risk of damage to the matching circuit 30 despite warpage or breakage of the antenna ANT.

The warpage and breakage of the antenna ANT can be reduced by using a general conductive material such as a paper cupper for the antenna ANT.

As illustrated in FIG. 3, a 500Ω antenna may have a length of 0.44λ. For a typical cordless telephone, this corresponds to 146.7mm, which is a saving of 20mm over a full 50Ω, λ/2 antenna. The overall size of the cordless telephone may be reduced accordingly.

FIG. 4 is a block diagram of the antenna circuit according to a third embodiment of the present invention. This antenna circuit is designed to reduce damage to the matching circuit caused by warpage or breakage of the antenna ANT as described with reference to FIG. 3, in a different manner. This is achieved by changing the position of the matching circuit 30 instead of by forming the inductor L and the capacitor C of the matching circuit 30 into foil patterns.

In FIG. 4, the matching circuit 30 is directly connected to the RF module 10 within a cordless telephone, which is different from the structures shown in FIGs. 1-3. Thus, warpage or breakage of matching circuit 30 due to warpage or breakage of antenna ANT is reduced. However, the matching circuit 30 is directly connected to the antenna ANT, without a wire intervening between the matching circuit 30 and the antenna ANT as in conventional arrangements.

Conventionally, because the matching circuit 30 is connected to the RF module 10, and a wire is connected between this matching circuit 30 and the antenna ANT, the matching circuit 30 is influenced by a change in the position of the wire, thereby mismatching the impedances of the antenna ANT and the RF module 10.

On the other hand, in the antenna circuit shown in FIG. 4 according to the third embodiment of the invention, the RF module 10 is positioned near to the antenna ANT, and the matching circuit 30 is interposed between the RF module 10 and the antenna ANT. One portion of the PCB having matching circuit 30 is connected to the RF module 10, and another portion of the PCB is connected to the antenna ANT. In this embodiment, connection between the matching circuit 30 and the RF module 10, and between the matching circuit 30 and the antenna ANT is implemented by soldering.

In this embodiment of the invention, a 500Ω, 0.44λ antenna is measured from the point of connection with the matching circuit. As can be seen in figure 4, this can lead to a further reduction in the length of antenna to be accommodated within the cordless phone.

In the present invention, a matching circuit is provided adjacent to the antenna. Furthermore, the RF module may be connected to the matching circuit either directly, or by use of a coaxial cable. Thus, different impedances of the RF module and the antenna are matched, and a reactance component of the coaxial cable does not vary, regardless of the position of the RF module on a PCB of a telephone. As a result, RF power loss and the decrease of a call distance are prevented.

CLAIMS

1. An antenna circuit for a telephone, comprising:
an antenna having a first impedance;
an RF module having a second impedance, for sending and receiving an RF signal through the antenna; and
a matching circuit, for matching the impedances of the antenna and the RF module, in which the matching circuit is connected directly to the antenna.

2. A circuit according to claim 1, further comprising a coaxial cable having the second impedance, connecting the RF module to the matching circuit.

3. A circuit according to claim 1, in which the RF module is connected directly to the matching circuit.

4. A circuit according to claims 1, 2 or 3, in which the matching circuit is under the antenna.

5. A circuit according to any preceding claim, in which the matching circuit comprises one or more printed components on a printed circuit board.

6. A circuit according to any preceding claim, in which the antenna is printed on a printed circuit board.

7. A circuit according to any preceding claim, in which the matching circuit comprises:
a capacitor having one terminal connected to the antenna; and
an inductor having one terminal connected to the antenna.

8. A circuit according to claim 7, in which the other terminal of the inductor is connected directly, or indirectly, to the RF module.

9. A circuit according to claim 7 or 8, in which the capacitor and the inductor are a pattern capacitor and a pattern coil, respectively.

10. An antenna circuit according to any preceding claim in which a conductive material is used for the antenna.

11. An antenna circuit according to claim 10, in which a paper cupper is used for the antenna.

12. A portable telephone incorporating a circuit according to any preceding claim.

13. An antenna circuit for a telephone substantially as described with reference and/or as illustrated in Figures 1, 2, 3 and/or 4.

14. A telephone substantially as described, with reference and/or illustrated in Figures 1,2,3 and/or 4.

The Patent Office

Application No:	GB 9807629.2	**Examiner:**	Dr E P Plummer
Claims searched:	all	**Date of search:**	10 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H1Q (QHC, QHH, QHX)

Int Cl (Ed.6): H01Q, H04B, H03H

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2306056A	NOKIA eg figure 2, page 9 lines 17 to 19, page 7 lines 16 and 17	1,2,4, 10,12
X	GB2305782A	MOTOROLA eg abstract, figure 3	1,4,10,12
X	GB2242573A	TECHNOPHONE whole document	1,4,7,8, 10,12
X	GB2213998A	TECHNOPHONE whole document	1,2,4,7,8, 10,12
X	EP0617520A2	NEC whole doocument	1,4
X	EP0531125A2	NEC whole document	1,3,5,7,8, 9,10,12
XE	WO98/07208A	CENTURION INTERNATIONAL whole document	1-14

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

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Application No: GB 9807629.2 **Examiner:** Dr E P Plummer
Claims searched: all **Date of search:** 10 July 1998

Category	Identity of document and relevant passage		Relevant to claims
X	WO96/29756A1	MINNESOTA MINING AND MANUFACTURING whole document	1,2,4,5,6, 7,8,9,10, 11,12

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.