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(54) **Title:** DUPLEXER COMPONENT WITH HIGH SUPPRESSION OF SIGNALS BETWEEN AN INPUT AND OUTPUT PORT

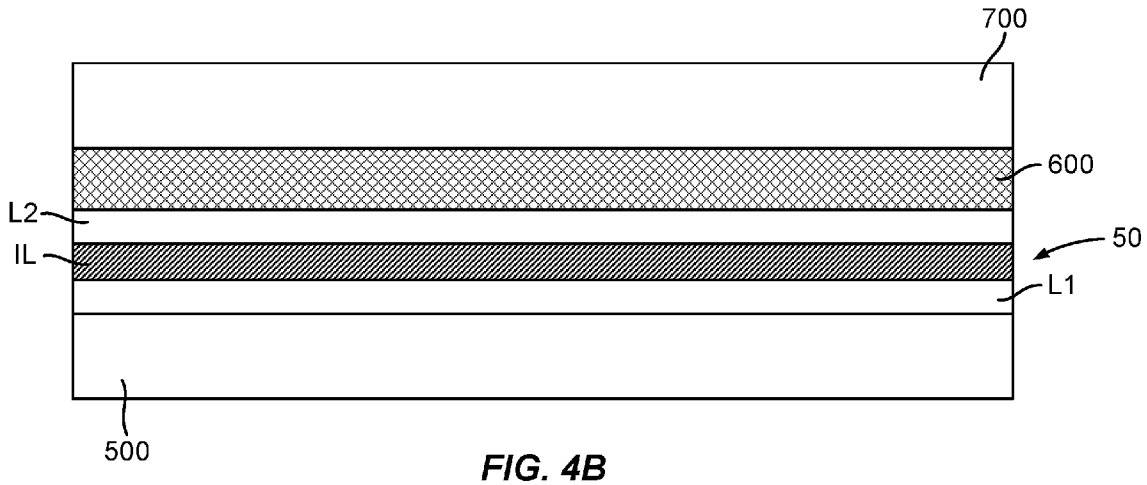


FIG. 4B

(57) **Abstract:** The duplexer component (1000) comprises a transmission filter (100) that is connected to an antenna port (2) by a first electric line (L1) and a reception filter (200). The transmission filter (100) comprises at least one series resonator (11, 12, 13, 14) being arranged in a serial path (SP) of the transmission filter (100). The transmission filter (100) comprises a parallel resonator (21) and an inductance (31) being arranged in series in a second electric line (L2) between the serial path (SP) and a connection (M) for applying a reference potential. A capacitor (50) is connected between the at least one parallel resonator (21) and the inductance (31) and the antenna port (2). The capacitor (50) is embodied as an overlap of the first electric line (L1) and the second electric line (L2) being arranged above each other on the carrier substrate (500).

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DUPLEXER COMPONENT WITH HIGH SUPPRESSION OF SIGNALS BETWEEN AN INPUT AND OUTPUT PORT

Cross Reference to Related Application

This application claims priority to German Application No. 102016125208.5, filed on December 21, 2016, which is expressly incorporated by reference in its entirety.

Description

The invention relates to a duplexer component with high suppression of signals between an input port coupled to a transmission path and an output port coupled to a reception path of the duplexer component.

A duplexer component, in particular an antenna duplexer, can have a transmission path and a reception path. The transmission path couples a signal input port to an antenna port of the duplexer component. The reception path couples the antenna port to a signal output port. The antenna port is coupled to an antenna to receive and transmit signals. A transmission filter can be provided in the transmission path of the duplexer component, said filter having a passband in the range of the frequencies of the transmission signal. A reception filter can be provided in the reception path of the duplexer component, said filter having a passband in the range of the frequencies of the signal received by the antenna. In order to prevent a signal having frequencies in the passband of the reception filter from being coupled from the transmission path into the reception path and being transferred by the reception filter to the output port of the duplexer component, a high signal suppression of the transmission filter for

frequencies in the passband of the reception filter is necessary.

In a duplexer component, an interference signal can be coupled from the transmission path into the reception path on various transfer paths within the duplexer component. By way of example, a signal at the output port of the duplexer component can be transferred directly between the transmission path and the reception path on account of the direction connection of the transmission and reception paths. An indirect signal transfer path runs from the input port of the duplexer component via the transmission path firstly to the antenna port and from there via the reception path to the output port of the duplexer component.

Particularly for the signal transfer section mentioned last, the isolation between the transmission and reception paths for signals having frequencies in the reception band of a duplexer is provided by the product of the suppression in the stop band of the transmission filter and the insertion loss in the passband of the reception filter. In order to obtain a high suppression/isolation, the insertion loss in the passband of the reception filter could be increased. Furthermore, the suppression of signals in the stop band of the transmission filter could be improved, but this generally results in a worsening of the insertion loss of the transmission filter. Both possibilities mentioned are thus associated with significant disadvantages since the insertion loss in the passband of the reception filter and the insertion loss in the passband of the transmission filter are inevitably increased.

It is desirable to specify a duplexer component comprising high suppression in the stop band of the transmission filter to provide a high isolation between the transmission and reception path whereby the high isolation between the transmission and reception path is realized with low consumption of the chip area of the duplexer component.

An embodiment of a duplexer component that allows to realize a high signal suppression between the input and output port of a duplexer component with low consumption of the chip area is specified in claim 1.

The duplexer component with high suppression of signals between the input and output port of the duplexer component comprises an antenna port for coupling an antenna to the duplexer component, a carrier substrate, a transmission filter and a reception filter. The transmission filter and the reception filter are arranged on the carrier substrate. The transmission filter has an input node connected to the input port, and an output node connected to the antenna port. The output node of the transmission filter is connected to the antenna port by a first electric line. The reception filter has an input node connected to the antenna port, and an output node connected to the output port. The transmission filter comprises at least one series resonator being arranged in a serial path of the transmission filter between the input node and the output node of the transmission filter. The transmission filter comprises a parallel resonator and an inductance being arranged in series in a second electric line between the serial path and a connection for applying a reference potential.

The duplexer component further comprises a capacitor being arranged on the carrier substrate. The capacitor has a

connection connected between the at least one parallel resonator and the inductance, and a further connection being connected to the antenna port. The capacitor is embodied as an overlap of the first electric line and the second electric line being arranged above each other on the carrier substrate.

The transmission filter can be configured as a reactance filter in the duplexer component. By virtue of the fact that the capacitor is connected by one connection between a parallel resonator and an inductance connected relative to a reference voltage connection and is connected by the other connection to the antenna port of the duplexer component, it is possible to improve the isolation between a transmission path and reception path of the duplexer component in the reception band.

The duplexer component can be manufactured in a DSSP housing technology, wherein the carrier substrate is covered by a cap. The cap is attached to the carrier substrate by a polymer wall/frame that surrounds the carrier substrate. The polymer wall/frame is disposed on the carrier substrate and the cap is arranged on the polymer wall/frame. According to a preferred embodiment of the duplexer component, the structure of the capacitor is arranged underneath the polymer wall/frame. An insulation layer is provided between the first and the second electric line to realize a floating line crossing in the area of the capacitive structure. In particular, a BCB (Benzo-Cyclo-Butene) material (line crossing) can be used for the insulation layer between the first and the second electric line. The capacitive structure is similar to a parallel plate waveguide.

Further embodiments of the duplexer component can be gathered from the dependent claims.

The duplexer component is described in greater detail below with reference to figures showing exemplary embodiments of the duplexer component.

In the figures:

Figure 1 shows an embodiment of a duplexer component,

Figure 2 shows an embodiment of a duplexer component with a reactance transmission filter in a transmission path of the duplexer component,

Figure 3 shows an embodiment of the duplexer component manufactured in a DSSP housing technology,

Figure 4A shows a top view on a chip of the duplexer component to realize a capacitor of the duplexer component, and

Figure 4B shows a cross-sectional view of a chip of the duplexer component to realize a capacitor of the duplexer component.

Figure 1 shows an embodiment of a duplexer component 1000, in particular of an antenna duplexer. The duplexer component has a transmission path TP, which is located between an input port 1 of the duplexer component for applying an input signal ES and an antenna port 2 for connecting an antenna. By way of example, a transmitter can be connected to the input port 1, which transmitter applies a transmission signal as input signal ES to the input port

1 of the duplexer component. A transmission filter 100, for example a reactance filter, is provided in the transmission path TP. The transmission filter is embodied in such a way that a filter effect is obtained by the conversion of an electrical signal into an acoustic signal and by renewed conversion of the acoustic signal back into an electrical signal. The transmission filter 100 generates an output signal TS at an output node A100 of the transmission filter, said output signal being fed for emission to the antenna port 2.

The duplexer component 1000 furthermore has an output port 3, which is connected by a reception path RP to the antenna port 2. A reception filter 200 is provided in the reception path, which filter can likewise be embodied as a reactance filter. The reception filter has an arrangement of transducers by which an electrical input signal is converted into an acoustic signal and the acoustic signal is converted back again into an electrical signal, wherein a filter effect occurs between an input node E200 of the reception filter 200 and the output port 3 of the duplexer component. A signal AS received by the antenna 300 is therefore converted into an output signal RS, wherein the signal amplitude or damping of the filter 200 is dependent on the frequency of the antenna signal AS. An impedance 400 acts as a phase shifter that achieves matching between transmission path, reception path and antenna.

Figure 2 shows the embodiment of the duplexer component 1000 of Figure 1, wherein the transmission filter 100 is illustrated in greater detail. The transmission filter 100 is embodied as a reactance filter. The duplexer component 1000 with high suppression of signals between the input port 1 and output port 3 comprises a carrier substrate 500.

The carrier substrate 500 may comprises a material composed of lithium niobate or lithium tantalate or quartz. The transmission filter 100 is arranged on the carrier substrate 500. The transmission filter 100 has an input node E100 connected to the input port 1 and an output node A100 connected to the antenna port 2. The input port 1 is configured for applying an input signal ES. An output signal TS is output by the filter 100 in reaction to the input signal ES, wherein the amplitude of the output signal TS is dependent on the frequency of the input signal ES. At specific frequencies in the passband of the transmission filter 100, the filter has a low insertion loss, whereas the filter has a high insertion loss and thus a suppression for reception signals having frequencies in the stop band of the filter. The output node A100 of the transmission filter is connected to the antenna port 2 by a first electric line L1.

The transmission filter 100 comprises at least one series resonator 11, 12, 13, 14 being arranged in a serial path SP of the transmission filter 100 between the input node E100 and the output node A100. The transmission filter 100 further comprises a parallel resonator 21 and an inductance 31 being arranged in series in a second electric line L2 between the serial path SP and a connection M for applying a reference potential.

According to the illustrated embodiment of the duplexer component, the transmission filter 100 comprises several series resonators 11, 12, 13 and 14, which are connected in series in the serial path SP between the input node E100 and the output node A100 of the transmission filter. Furthermore, the transmission filter 100 comprises parallel resonators 21, 22, 23 and 24, which are arranged in several

electric lines L2, L3, L4 and L5 between the serial path SP and a connection M for applying a reference potential. The connection M can be embodied as a connection for applying a ground potential.

The parallel resonator 21 is connected to the serial path SP at a location S1. The location S1 is situated between the input port 1 of the duplexer component/input node E100 of the transmission filter 100 and the first series resonator 11 of the serial path SP. Furthermore, the parallel resonator 21 is connected via an inductance 31 in the electric line L2 to the connection M for applying the reference potential. The parallel resonator 22 is arranged in an electric line L3 and is connected to a location S2 of the serial path SP between the first series resonator 11 and the second series resonator 12. The parallel resonator 23 is arranged in an electric line L4 and is connected to the signal path SP at a location S3 of the signal path between the second series resonator 12 and the third series resonator 13. Both parallel resonators 22 and 23 are connected via an inductance 32 to the connection M for applying the reference potential. By means of suitable dimensioning of the inductances 31 and 32, poles of the filter curve of the transmission filter which are predefined by the transducer track of the transmission filter can be shifted to specific frequencies. A further parallel resonator 24 is arranged in an electric line L5 and is connected to the signal path SP at a location S4 of the signal path between the third series resonator 13 and the fourth series resonator 14 and is directly connected to the connection M for applying the reference potential.

The reception path RP is embodied as explained with reference to figure 1. The reception path RP comprises the

reception filter 200. The reception filter 200 is arranged on the carrier substrate 500. The reception filter 200 has an input node E200 connected to the antenna port 2 and an output node A200 connected to the output port 2. The antenna signal AS received by the antenna 300 is fed to the reception filter 200 at an input node E200 of the reception filter 200. The reception filter 200 outputs the output signal RS in a frequency-dependent manner at an output node A200 of the reception filter 200 that is connected to the output port 2 of the duplexer component. The reception filter 200 can likewise be embodied as a reactance filter comprising an arrangement of series and parallel resonators which are connected between the input node E200 and the output node A200 in a manner similar to that in the case of the transmission filter.

The junction point between transmission and reception paths TP, RP and the antenna 300 is connected via an impedance 400, which acts as a phase shifter, to the connection M for applying the reference potential.

According to the embodiment of the duplexer component 1000, a capacitor 50 is arranged on the carrier substrate 500. The capacitor 50 has a connection A50a and a further connection A50b. The connection A50a of the capacitor is connected between the at least one parallel resonator 21 and the inductance 31. The further connection A50b of the capacitor is connected to the antenna port 2.

The connection A50a of the capacitor 50 which is connected between the series connection of the parallel resonator 21 and the inductance 31 is preferably connected to the electric line L1 that is the parallel branch of the reactance filter which is closest to the input node E100 of

the transmission filter 100/the input port 1 of the duplexer component. The location S1 at which the electric line L2/the parallel branch comprising the parallel resonator 21 and the inductance 31 is connected to the transmission path SP is, for example, closer to the input node E100 of the transmission filter 100/the input port 1 of the duplexer component 1000 than the further locations S2, S3 and S4 at which the other electric lines L3, L4, L5/the other parallel branches of the transmission filter 100 are connected to the transmission path SP.

By connecting the capacitor 50 between the first parallel branch/electric line L2 and the antenna port 2, it is possible to improve the isolation in the reception band between the input port 1 and the output port 3 of a duplexer component. The suppression in the stopband of the transmission filter 100 is very large, especially for signal frequencies in the range of the passband of the reception filter 200. The insertion loss in the passband of the transmission filter 100 and the insertion loss in the passband of the reception filter 200 remain virtually unchanged in comparison with a duplexer that do not comprise a static capacitance between the electric line L2 and the antenna port 2.

The transfer path between the input port 1 and the output port 3 of the duplexer component has a significantly higher insertion loss for input signals ES having signal frequencies in the passband of the reception filter 200, that is to say in the reception band, with the use of the capacitor 50 providing a static capacitance between the connection of the parallel resonator 21 and the inductance 31 in the electric line L2 and the antenna port 2 in

comparison to a transfer path of a filter 100 that does not comprise the capacitor 50.

The higher insertion loss between the input port 1 and the output port 3 for signals having frequencies in the passband of the reception filter 200 prevents disturbing signals from being coupled into the reception path RP from the input port 1, which disturbing signals would subsequently appear at the output port 3 of the duplexer component. By providing a transmission filter in the embodiment shown in Figure 2, wherein a capacitor is additionally provided between the electric line L2 and the antenna port 2, it is thus possible to realize a duplexer component in which the isolation between transmission path TP and reception path RP for signals in the reception band is improved. On the other hand, the insertion loss of the passband of the transmission filter 100 and the insertion loss in the passband of the reception filter remain low without change.

Figure 3 shows an embodiment of the duplexer component 1000 that is manufactured in a DSSP housing technology. The duplexer component 1000 comprises the carrier substrate 500. The acoustic structure of the transmission filter 100 and the reception filter 200 is disposed on the carrier substrate. The area of the carrier substrate 500 comprising the acoustic structure of the transmission filter 100 and the reception filter 200 is surrounded by a polymer wall 600. The polymer wall 600 serves as a supporting layer on which a cap 700 is disposed. The cap 700 covers the transmission and the reception filter 100, 200 so that the transmission and the reception filter 100, 200 are housed on the carrier substrate 500 by the polymer wall 600 and

the cap 700. External contacts 800 are arranged on the cap 700 to externally contact the duplexer component 1000.

Figure 4A shows a top view on a chip of the duplexer component 1000 to realize the static capacitance of the capacitor 50 of the duplexer component. Figure 4A only shows the first electric line L1 that is connected to the antenna port 3 and the second electric line L2 that is connected to the ground potential M of the transmission filter 100. The capacitor 50 is embodied as an overlap of the first electric line L1 and the second electric line L2 being arranged above each other on the carrier substrate 500. The structure of the capacitor 50 is arranged underneath the polymer wall 600. The polymer wall 600 has a width of between 80 to 100 microns.

Figure 4B shows a cross-sectional view of the portion of the chip of the duplexer component at which portion the static capacitance of the capacitor 50 is realized by the overlap of the first electrich line L1 and the second electric line L2 underneath the polymer wall 600. The first electric line L1 and the second electric line L2 are electrically separated by an insulation layer IL. The insulation layer IL comprises a BCB (Benzo-Cyclo-Butene) material. That means that a conventional capacitor that may be realized by a rotated interdigital transducer is replaced with the floating line crossing structure shown in Figures 4A and 4B. This capacitive structure of the capacitor 50 is similar to a parallel plate waveguide.

The capacitor 50 can be produced during the production of the transmission and reception filter 100 and 200. The capacitor 50 can be formed together with the tracks of the parallel and series resonators on the carrier substrate 500

in a simple manner. The technique allows to use the space underneath the polymer structures 600 to realize the capacitor 50. Therefore, effective use of space and possible size reduction can be obtained. The smaller size of the device is particularly achieved for SAW duplexer components in the 700 MHz range. The arrangement of the capacitive structure 50 underneath the polymer wall 600 allows to avoid routing losses compared to a technology, wherein the capacitor 50 is realized on the carrier substrate by a rotated IDT track.

List of Reference Signs

1	input port
2	antenna port
3	output port
11, 12, 13, 14	series resonators
21, 22, 23, 24	parallel resonators
31, 32	inductances
100	transmission filter
200	reception filter
300	antenna
400	matching impedance
500	carrier substrate
600	polymer wall
700	cap
800	external connections
1000	duplexer component

Claims

1. A duplexer component with high suppression of signals between an input and output port, comprising:
- an antenna port (2) for coupling an antenna (300) to the duplexer component (1000),
- a carrier substrate (500),
- a transmission filter (100) being arranged on the carrier substrate (500), the transmission filter having an input node (E100) connected to the input port (1) and an output node (A100) connected to the antenna port (2) by a first electric line (L1),
- a reception filter (200) being arranged on the carrier substrate (500), the reception filter having an input node (E200) connected to the antenna port (2) and having an output node (A200) connected to the output port (3)
- wherein the transmission filter (100) comprises at least one series resonator (11, 12, 13, 14) being arranged in a serial path (SP) of the transmission filter (100) between the input node (E100) and the output node (A100) of the transmission filter,
- wherein the transmission filter (100) comprises a parallel resonator (21) and an inductance (31) being arranged in series in a second electric line (L2) between the serial path (SP) and a connection (M) for applying a reference potential,
- a capacitor (50) being arranged on the carrier substrate (500), wherein the capacitor (50) has a connection (A50a) and a further connection (A50b), wherein the connection (A50a) of the capacitor is connected between the at least one parallel resonator (21) and the inductance (31), and wherein the further

connection (A50b) of the capacitor is connected to the antenna port (2),

- wherein the capacitor (50) is embodied as an overlap of the first electric line (L1) and the second electric line (L2) being arranged above each other on the carrier substrate (500).

2. The duplexer component of claim 1,
wherein the first electric line (L1) and the second electric line (L2) are electrically separated by an insulation layer (IL).

3. The duplexer component of claims 1 or 2,
wherein the insulation layer (IL) comprises a Benzo-Cyclo-Butene material.

4. The duplexer component of one of the claims 1 to 3, comprising:

- a polymer wall (600) surrounding the transmission filter (100) and the reception filter (200) on the carrier substrate (500),

- wherein the capacitor (50) is arranged underneath the polymer wall (600).

5. The duplexer component of claim 4,
wherein the polymer wall (600) has a width of between 80 to 100 microns.

6. The duplexer component of claims 4 or 5, comprising:
a cap (700) being arranged on the polymer wall (500) to cover the transmission filter (100) and the reception filter (200) on the carrier substrate (500).

7. The duplexer component of one of the claims 1 to 6,

- wherein the transmission filter (100) comprises at least one further parallel resonator (22, 23, 24), which is connected in at least one third electric line (L3, L4, L5) between the serial path (SP) and the connection (M) for applying the reference potential,
- wherein the parallel resonator (21) is connected to the serial path (SP) at a first location (S1) of the serial path (SP) and the at least one further parallel resonator (22, 23, 24) is connected to the serial path (SP) at a second location (S2, S3, S4) of the serial path (SP),
- wherein the first location (S1) is arranged nearer to the input port (1) than the second location (S2, S3, S4).

8. The duplexer component of one of the claims 1 to 7, wherein the at least one series resonator (11, 12, 13, 14) and the parallel resonator (21) of the transmission filter (100) are embodied in each case as a single-port resonator.

9. The duplexer component of one of the claims 1 to 8, wherein the carrier substrate (500) comprises a material composed of lithium niobate or lithium tantalate or quartz.

10. The duplexer component of one of the claims 1 to 9, wherein the connection (M) for applying the reference potential is embodied as a connection for applying a ground potential.

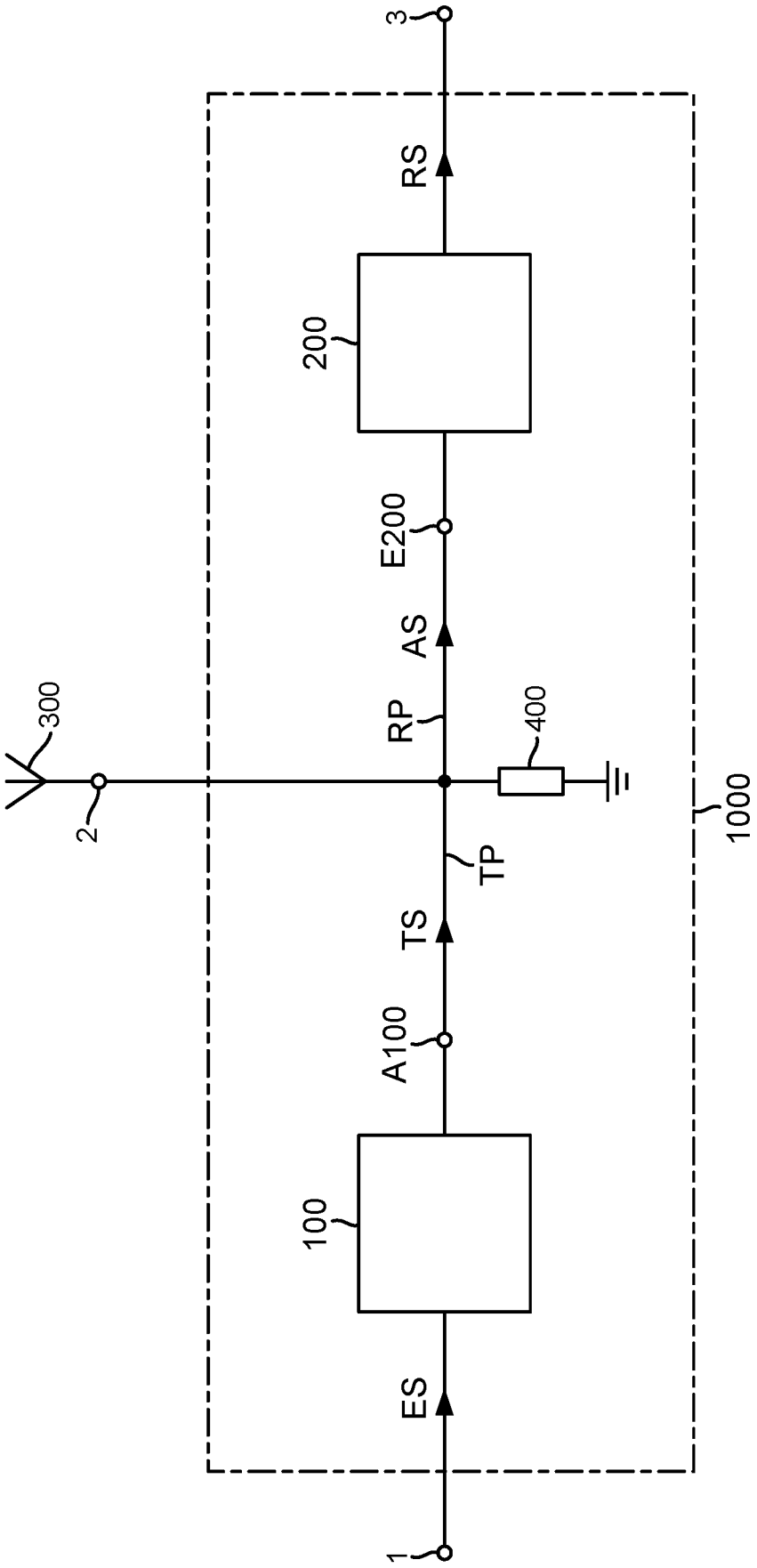


FIG. 1

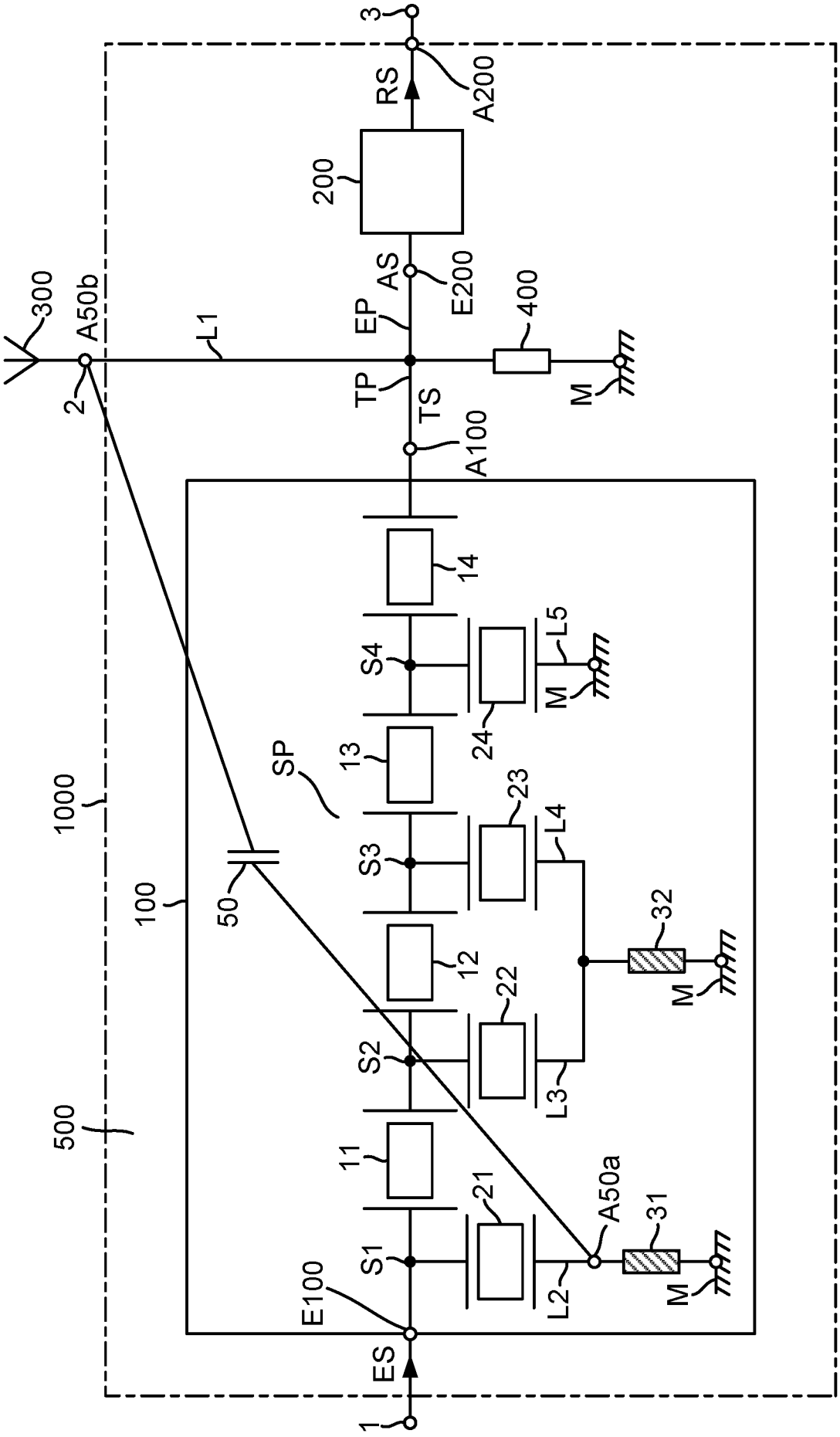

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RS
A200
200
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400
300
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L1
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2
TP
TS
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S4
L5
M
24
SP
13
23
S3
L4
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50
100
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L2
ES
1

FIG. 2

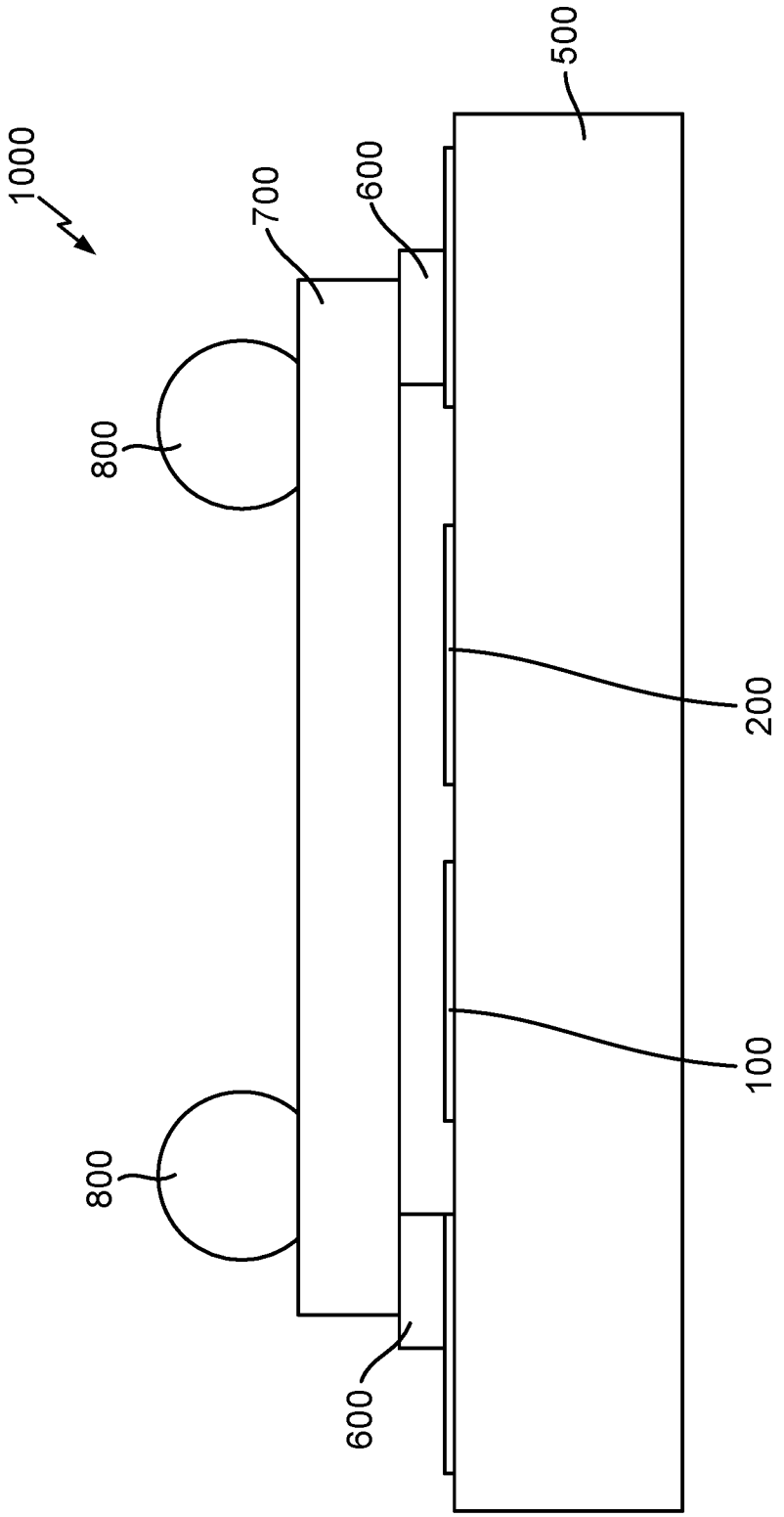


FIG. 3

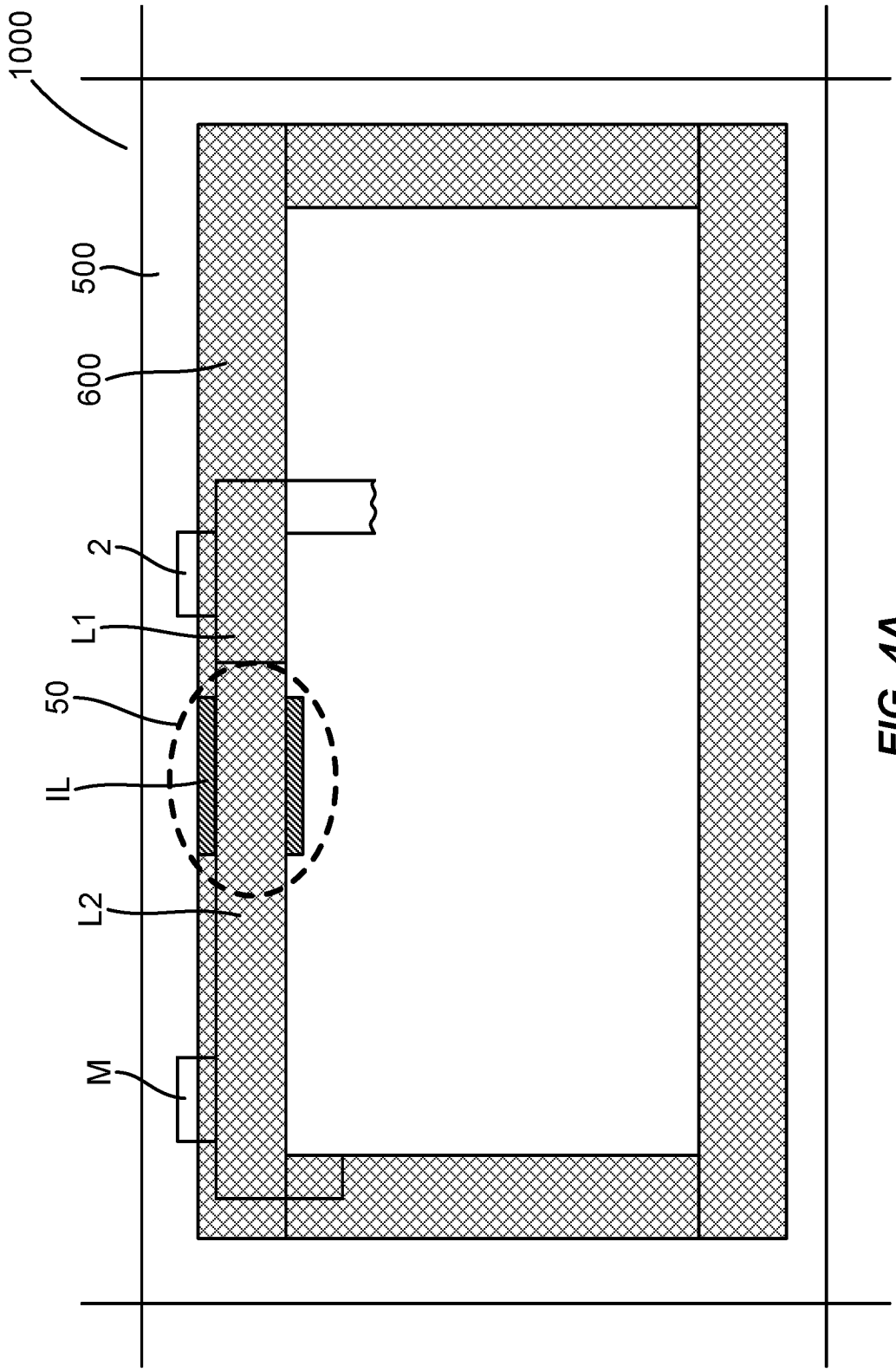


FIG. 4A

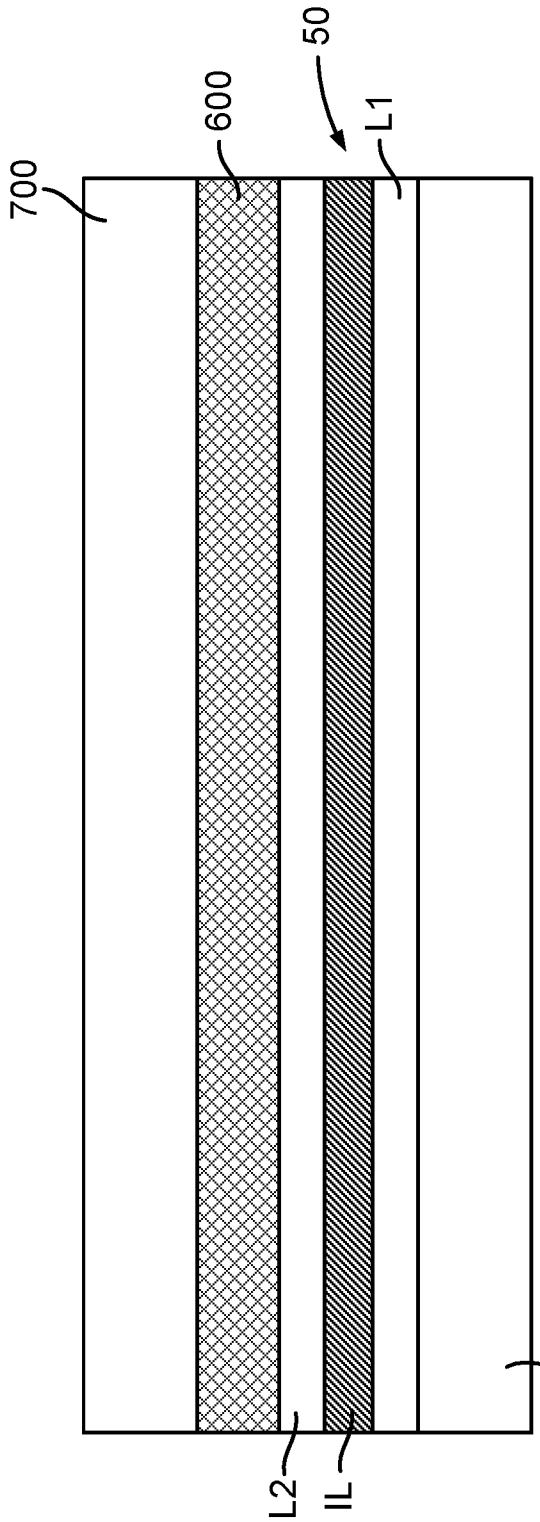


FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/065616

A. CLASSIFICATION OF SUBJECT MATTER
INV. H03H9/70 H03H9/72 H03H9/05
ADD.

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)
H03H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014/010122 A1 (KREMS TOBIAS [DE] ET AL) 9 January 2014 (2014-01-09)	1-3,7-10
A	abstract paragraph [0019] - paragraph [0032]; figures 1 - 3 paragraph [0041] - paragraph [0043]; figure 7	4-6

Y	US 2011/018653 A1 (BRADLEY PAUL [US] ET AL) 27 January 2011 (2011-01-27)	1-3,7-10
A	paragraph [0020] - paragraph [0036]; figures 1, 2	4-6

Y	US 2011/063046 A1 (FUJIWARA JOJI [JP] ET AL) 17 March 2011 (2011-03-17)	1-3,7-10
A	paragraph [0064] - paragraph [0075]; figures 8 - 10	4-6

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Trafidlo, Renata

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	paragraph [0016] - paragraph [0017]; figures 5, 6 paragraph [0024] - paragraph [0025]; figures 13, 14	4-6

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