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Assignee Name and Address:

Atmel Corporation
2325 Orchard Parkway
San Jose, CA 95131

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SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	1/15/11
Name	Scott Wornow	Telephone	408-436-4229
Title	Senior Vice President and Chief Legal Officer		

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PTO/SB/96 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Harald Philipp et al. 080900.1059

Application No./Patent No.: 12/179769 Filed/Issue Date: July 25, 2008

Titled: Proximity Sensor

Atmel Corporation , a Delaware corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in (The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy therefore is attached.

OR

B. [X] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Harald Philipp et al. To: QRG Limited

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[X] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/travis w. thomas/ REG. NO. 48667 — 26 May 2011

Signature — Date

Travis W. Thomas — Attorney of Record

Printed or Typed Name — Title

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Harald Philipp
Application No.:	Unassigned
Filing Date:	Herewith
Confirmation No.:	Unassigned
Title:	*Proximity Sensor*

Information Disclosure Statement

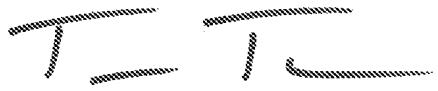
Applicant submits this Information Disclosure Statement under 37 C.F.R. § 1.97(b)(3). Applicant respectfully requests the Examiner to consider and cite in the examination of this Application the documents listed in the attached Form PTO/SB/08. This Application is a continuing application under 35 U.S.C. § 120 of U.S. Patent Application No. 12/179769, filed 25 July 2008. Under 37 C.F.R. § 1.98(d), Applicant has not provided copies of references previously submitted to or cited by the Office in U.S. Patent Application No. 12/179769. Moreover, under 37 C.F.R. § 1.98(a)(2)(ii), Applicant has not provided copies of U.S. patents and U.S. patent application publications.

Under 37 C.F.R. § 1.97(g), the filing of this IDS shall not be construed as a representation that a search has been made. Moreover, under 37 C.F.R. § 1.97(h), the filing of this IDS shall not be construed to be an admission that the information cited in this IDS is or is considered to be material to patentability as defined by 37 C.F.R. §1.56(b). Furthermore, the filing of this IDS shall not be construed to be an admission that any information cited in this IDS is or is considered to be prior art under 35 U.S.C. §§ 102-103.

The Commissioner may charge any fee due and credit any overpayment in this Application to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,

BAKER BOTTS L.L.P.
Attorneys for Applicant



Travis Thomas
Reg. No. 48,667

Date: 26 May 2011

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** Unassigned		**First Named Inventor:** Harald Philipp
	Attorney Docket No: 080900.1059	**Art Unit:** Unassigned	**Filing Date:** Herewith

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	FIRST NAMED INVENTOR
	A	5,730,165	03-24-1998	Philipp
	B	6,452,494	09-17-2002	Harrison
	C	6,452,514	09-17-2002	Philipp
	D	6,466,036	10-15-2002	Philipp
	E	7,091,727	08-15-2006	Lee
	F	7,567,088	07-28-2009	Yoshida
	G	7,714,595	05-11-2010	Fujiwara
	H	7,797,115	09-14-2010	Tasher
	I	2003/0132763	07-17-2003	Ellenz
	J	2006/0250142	11-09-2006	Abe
	K	2007/0062739	03-22-2007	Philipp
	L	2007/0076897	04-05-2007	Philipp
	M	2009/0027068	01-29-2009	Philipp

UNPUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	FILING DATE	FIRST NAMED INVENTOR
	N			
	O			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	COUNTRY	TRANSLATION (YES OR NO)
	P	1536314 A2	06-01-2005	EP	
	Q	2431725 A1	05/02/2007	GB	

NON-PATENT LITERATURE (NPL)

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	R	UK Intellectual Property Office, Search Report for GB 0813682.2	11-04-2008
	S	Datasheet "QT100-Charge Transfer IC," Quantum Research Group	2006
	T	Datasheet "QT110-Touch Sensor IC," Quantum Research Group	2004

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

PROXIMITY SENSOR

RELATED APPLICATIONS

[1] This application is a continuation under 35 U.S.C. § 120 of U.S. Patent Application No. 12/179769, filed 25 July 2008, which claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 60/952053, filed 27 July 2007.

TECHNICAL FIELD

[2] This disclosure generally relates to proximity sensors.

BACKGROUND

[3] Capacitive position sensors have recently become increasingly common and accepted in human interfaces and for machine control. For example, in the fields of portable media players it is now quite common to find capacitive touch controls operable through glass or plastic panels. Some mobile telephones are also starting to implement these kinds of interfaces.

[4] Many capacitive touch controls incorporated into consumer electronic devices for appliances provide audio or visual feedback to a user indicating whether a finger or other pointing object is present or approaches such touch controls. A capacitive sensing microprocessor may typically be comprised in touch-controlled devices which are arranged to provide an "on" output signal when a finger is adjacent to a sensor and an "off" output signal when a finger is not adjacent to a sensor. The signals are sent to a device controller to implement a required function dependent on whether a user's finger is in proximity with or touching an associated touch control.

[5] Some touch-controlled devices remain "on" or "active" despite the user having moved away from the device or a particular function no longer being required. This results in the device consuming a large amount of power which is not efficient.

OVERVIEW

[6] Particular embodiments provide a sensor for determining the presence of an object comprising: a sensing element; a capacitance measurement circuit operable to measure the capacitance of the sensing element; and a control circuit operable to determine whether an object is in proximity with the sensor based on a measurement of the capacitance of the sensing element, the control circuit further being operable to provide an output signal to control a function of an apparatus when it is determined that an object has not been in proximity with the sensor for a predetermined time duration.

[7] The control circuit may be configured so that the predetermined time duration is selectable from a number of different predefined time durations.

[8] The control circuit may include a time input terminal and the predetermined time duration may selectable from the number of different predefined time durations according to a voltage applied to the time input terminal.

[9] The control circuit may include a delay multiplier terminal and be configured so that a selected one of the number of different predefined time durations is multiplied by a multiplication factor according to a voltage applied to the delay multiplier terminal so as to provide the predetermined time duration.

[10] The control circuit may be configured so that the predetermined time duration is programmable by a user to provide a user-selected time duration.

[11] The sensor may comprise a resistor-capacitor (RC) network coupled to the control circuit and the predetermined time duration may depend on a time constant of the RC network.

[12] The control circuit may include a delay multiplier terminal and be configured so that the user-selected time duration is multiplied by a multiplication factor according to a voltage applied to the delay multiplier terminal to provide the predetermined time duration.

[13] The control circuit may be configured such that the provision of the output signal to control a function of an apparatus after the predetermined time duration may be overridden so the output signal is not provided when it is determined that an object has not been in proximity with the sensor for a predetermined time duration. For example, the control circuit may be operable to receive an override pulse and on receipt of the override pulse to retrigger the

predetermined time duration to so as to extend the time before the output signal to control a function of an apparatus is provided.

[14] The control circuit may be configured such that the provision of the output signal to control a function of an apparatus after the predetermined time duration may be overridden so the output signal is provided before it is determined that an object has not been in proximity with the sensor for a predetermined time duration. For example, the control circuit may be operable to receive an override pulse and on receipt of the override pulse to provide the output signal to control a function of an apparatus.

[15] The sensor may be configured to perform a recalibration when the sensor is powered up, when an object is determined to be in proximity with the sensor for more than a timer setting, and / or when an override is released.

[16] The control circuit may be configured such that the output signal is toggled between a high state and a low state when an object is determined to be in proximity with the sensor.

[17] The function of an apparatus controlled by the output signal may be a switch-off function.

[18] The capacitance measurement circuit may employ bursts of charge- transfer cycles to acquire measurements.

[19] The capacitance measurement circuit may be configured to operate in one of more than one acquisition modes depending on the output signal, for example a low-power mode or a fast mode.

[20] The capacitance measurement circuit and the control circuit may be comprised in a general purpose microcontroller under firmware control.

[21] The capacitance measurement circuit and the control circuit may be comprised within a six-pin integrated circuit chip package, such as an SOT23-6.

[22] Particular embodiments provide an apparatus including a sensor as described above.

[23] Particular embodiments provide a method for controlling a function of an apparatus comprising: determining whether an object is in proximity with a sensor based on a

measurement of the capacitance of a sensing element and providing an output signal to control the function of the apparatus when it is determined that an object has not been in proximity with the sensor for a predetermined time duration.

[24] The function of the apparatus controlled by the output signal may be a switch-off function.

[25] Particular embodiments provide a sensor for determining the presence of an object comprising: a sensing element, a capacitance measurement circuit operable to measure the capacitance of the sensing element, and a control circuit operable to determine whether an object is in proximity with the sensor based on a measurement of the capacitance of the sensing element, the control circuit also being operable to provide an output signal to control a function of an apparatus based on an object not being in proximity with the sensor and the output signal being produced after a predetermined time duration.

BRIEF DESCRIPTION OF THE DRAWINGS

[26] Reference is now made by way of example to the accompanying drawings in which:

[27] FIGURE 1 schematically shows sense electrode connections for an example chip for implementing an auto-off function in particular embodiments;

[28] FIGURE 2 schematically represent an application of drift compensation in the chip of FIGURE 1;

[29] FIGURE 3 schematically shows a basic circuit configuration for providing a 15 minute auto switch-off function in an active high output implementation of particular embodiments;

[30] FIGURE 4 schematically shows a series of fast mode bursts on the SNSK pin of the chip shown in FIGURE 1 where in an on condition;

[31] FIGURE 5 schematically shows a series of low-power mode bursts and a switch to fast mode power bursts on the SNSK pin of the chip shown in FIGURE 1 when switching from an off condition to an on condition;

[32] FIGURE 6 schematically shows use of an output configuration resistor Rop to configure the chip of FIGURE 1 to have an active high or an active low output;

[33] FIGURE 7 schematically shows an example circuit configuration for the chip shown in FIGURE 1 with the output connected to a digital transistor;

[34] FIGURE 8 schematically shows an example circuit configuration for the chip shown in FIGURE 1 configured to provide a predefined auto-off delay;

[35] FIGURE 9 schematically shows an example circuit configuration for the chip shown in FIGURE 1 configured to provide a programmable auto-off delay;

[36] FIGURE 10 schematically shows an example pulse applied to the chip shown in FIGURE 1 to override an auto-off delay;

[37] FIGURE 11 schematically shows another example pulse applied to the chip shown in FIGURE 1 to override an auto-off delay;

[38] FIGURE 12 schematically shows example voltage levels for the chip shown in FIGURE 1 in overriding of an auto-off delay;

[39] FIGURES 13 and 14 schematically show typical values of RC divisor K as

[40] a function of supply voltage VDD for the chip shown in FIGURE 1 with active high output and active low output respectively;

[41] FIGURE 15 schematically shows typical curves of auto-off delay as a function of timing resistor value for different capacitor values and different supply voltages for an active high output configuration;

[42] FIGURE 16 schematically shows typical curves of auto-off delay as a function of timing resistor value for different capacitor values and different supply voltages for an active low output configuration;

[43] FIGURE 17 schematically shows an example application of the chip shown in FIGURE 1 in an active low output configuration driving a PNP transistor with an auto-off time of 3.33 hours;

[44] FIGURE 18 schematically shows another example application of the chip shown in FIGURE 1 in an active high output configuration driving a high impedance with an auto-off time of 135 seconds;

[45] FIGURE 19 schematically shows an implementation of the chip shown in FIGURE 1 in an SOT23-6 package; and

[46] FIGURE 20 schematically shows a pin diagram for an implementation of the chip shown in FIGURE 1 in an SOT23-6 package.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[47] Particular embodiments may be implemented in an integrated circuit chip providing a proximity sensor function. The integrated circuit chip may thus be incorporated into a device or apparatus to provide and control a proximity sensor functionality for the device or apparatus in particular embodiments. For the purposes of explanation, a specific integrated circuit chip providing the functionality of an example embodiment will be described further below. The chip will in places be referred to by product name QT102. However, it will be appreciated that the QT102 chip is merely a specific example application of an example embodiment. Particular embodiments need not be implemented in a chip in this way, and furthermore, particular embodiments may be provided in conjunction with all, some or none of the additional features of the QT102 chip described further below.

[48] Before turning specifically to the QT102 chip embodiment, a summary is provided.

[49] It is known that a touch sensitive sensor may comprise a sensor element, such as an etched copper electrode mounted on a PCB substrate, and a control circuit for measuring a capacitance of the sensor element to a system reference potential. The sensor element may be referred to as a sense electrode. The capacitance of the sense electrode is affected by the presence of nearby objects, such as a pointing finger. Thus the measured capacitance of the sense electrode, and in particular changes in the measured capacitance, may be used to identify the presence of an object adjacent the sense electrode. The control circuit may be configured to provide an output signal, e.g. by setting an output logic level as high or low, indicating whether or not an object is deemed to be adjacent the sense electrode. A controller of a device in which the touch sensitive sensor is implemented may receive the output signal and act accordingly.

[50] There are various known technologies for measuring capacitance of a sense electrode in a capacitive touch sensor. Particular embodiments may be implemented in conjunction with any of these technologies or measurement circuits. For example, the fundamental principles underlying the capacitive sensors described in U.S. Patent No. 5,730,165, U.S. Patent No. 6,466,036, and U.S. Patent No. 6,452,514 could be used.

[51] In particular embodiments, the control circuit of the sensor can determine whether an object or a user's finger is no longer in proximity with the sensor and based on a pre-determined time duration, the control circuit can produce an output signal automatically to prevent the capacitance measurement circuit from continually measuring changes in capacitance due to, for example, the perceived presence of an object in proximity with the sensor.

[52] Therefore, the control circuit is able to deactivate, turn-off, or power down the capacitance measurement circuit where an apparatus has inadvertently been left on or with the erroneous perception that a user is still present. This may, for example, be referred to as an "auto-off" feature. The signal for preventing the capacitance measurement circuit from continually measuring changes in capacitance may be referred to as an auto-off signal. The capacitance measurement circuit and the auto-off control circuit may be comprised in a general-purpose microcontroller under firmware control, for example, such as the QT102 chip described further below.

[53] As described in Section 3.5 of the below numbered sections, and in conjunction with the drawings, the control circuit of the sensor may be implemented by different methods—for example, the auto-off signal output may be produced automatically after different pre-determined time durations to effect powering down the capacitance measurement circuit due to no presence of the user; the control circuit may be programmed by a user so that it may power down an apparatus based on a user-selected time duration; the control circuit output signals may be overridden, for example, to extend time durations before an apparatus is turned-off or to immediately turn-off an apparatus when a user is no longer present.

[54] The sensor of particular embodiments may be useful in various applications, for example in kitchen appliances, light switches, headsets, and other electronic consumer devices. For example, a coffee machine incorporating a sensor of particular embodiments may be programmed to power-down after a time period of, say, 30 minutes, where the coffee machine has been left on inadvertently. This will beneficially conserve energy use and minimize the possibility of damage or accidents caused by the coffee machine or glass container(s) overheating.

[55] Aspects of the QT102 chip referred to above will now be described in the following numbered sections.

[56] The numbered sections may be considered to relate generally to features of the QT102 chip as follows: Section 1 – Overview (including 1.1 Introduction, 1.2 Electrode Drive, 1.3 Sensitivity, 1.3.1 Introduction, 1.3.2 Increasing Sensitivity, 1.3.3 Decreasing Sensitivity, 1.4 Recalibration Timeout, 1.5 Forced Sensor Recalibration, 1.6 Drift Compensation, 1.7 Response Time, 1.8 Spread Spectrum). Section 2 – Wiring and Parts (including 2.1 Application Note, 2.2 Cs Sample Capacitor, 2.3 Rs Resistor, 2.4 Power Supply, PCB Layout, 2.5 Wiring). Section 3 – Operation (including 3.1 Acquisition Modes, 3.1.1 Introduction, 3.1.2 OUT Pin "On" (Fast Mode), 3.1.3 OUT Pin "Off" (Low Power Mode), 3.2 Signal Processing, 3.2.1 Detect Integrator, 3.2.2 Detect Threshold, 3.3 Output Polarity Selection, 3.4 Output Drive, 3.5 Auto Off Delay, 3.5.1 Introduction, 3.5.2 Auto Off – Predefined Delay, 3.5.3 Auto Off – User-programmed Delay, 3.5.4 Auto Off – Overriding the Auto Off Delay, 3.5.5 Configuring the User-programmed Auto-off Delay, 3.6 Examples of Typical Applications). Section 4 – Specifications (including 4.1 Absolute Maximum Specifications, 4.2 Recommended Operating Conditions, 4.3 AC Specifications, 4.4 Signal Processing, 4.5 DC Specifications, 4.6 Mechanical Dimensions, 4.7 Moisture Sensitivity Level (MSL)).

1 Overview

1.1 Introduction

[57] The QT102 is a single key device featuring a touch on / touch off (toggle) output with a programmable auto switch-off capability.

[58] The QT102 is a digital burst mode charge-transfer (QT) sensor designed specifically for touch controls; it includes hardware and signal processing functions to provide stable sensing under a wide variety of changing conditions. In examples, low cost, non-critical components are employed for configuring operation.

[59] The QT102 employs bursts of charge-transfer cycles to acquire its signal. Burst mode permits power consumption in the microampere range, dramatically reduces radio frequency (RE) emissions, lowers susceptibility to electromagnetic interference (EMI), and yet permits good response time. Internally the signals are digitally processed to reject impulse noise, using a "consensus" filter which in this example requires four consecutive confirmations of a detection before the output is activated.

[60] The QT switches and charge measurement hardware functions are all internal to the QT102.

1.2 Electrode Drive

[61] FIGURE 1 schematically shows the sense electrode connections (SNS, SNSK) for the QT102.

[62] For improved noise immunity, it may be helpful if the electrode is only connected to the SNSK pin.

[63] In examples the sample capacitor Cs may be much larger than the load capacitance (Cx). E.g. typical values for Cx are 5 to 20pF while Cs is usually 1 or 2 to 50nF. (Note: Cx is not a physical discrete component on the PCB, it is the capacitance of the touch electrode and wiring. It is shown in FIGURE 1 to aid understanding of the equivalent circuit.)

[64] Increasing amounts of Cx destroy gain, therefore it is important to limit the amount of load capacitance on both SNS terminals. This can be done, for example, by minimizing trace lengths and widths and keeping these traces away from power or ground traces or copper pours.

[65] The traces and any components associated with SNS and SNSK will become touch sensitive and so may need to be considered to help in limiting the touch-sensitive area to the desired location.

[66] A series resistor, Rs, may be placed in line with SNSK to the electrode to suppress electrostatic discharge (ESD) and Electromagnetic Compatibility (EMC) effects.

1.3 Sensitivity

1.3.1 Introduction

[67] The sensitivity of the QT102 is a function of such things as:

- the value of Cs
- electrode size and capacitance
- electrode shape and orientation
- the composition and aspect of the object to be sensed
- the thickness and composition of any overlaying panel material
- the degree of ground coupling of both sensor and object

1 .3.2 Increasing Sensitivity

[68] In some cases it may be desirable to increase sensitivity; for example, when using the sensor with very thick panels having a low dielectric constant. Sensitivity can often be increased by using a larger electrode or reducing panel thickness. Increasing electrode size can have diminishing returns, as high values of Cx will reduce sensor gain.

[69] The value of Cs also has an effect on sensitivity, and this can be increased in value with the trade-off of slower response time and more power. Increasing the electrode's surface area will not substantially increase touch sensitivity if its diameter is already significantly larger in surface area than the object being detected. Panel material can also be changed to one having a higher dielectric constant, which will better help to propagate the field.

[70] Ground planes around and under the electrode and its SNSK trace may lead to high Cx loading and destroy gain. Thus in some cases the possible signal-to-noise ratio benefits of ground areas may be more than negated by the decreased gain from the circuit, and so ground areas around electrodes may be discouraged in some circumstances. Metal areas near the electrode may reduce the field strength and increase Cx loading and so it may be helpful if these are avoided if possible. It may be helpful to keep ground away from the electrodes and traces.

1 .4 Recalibration Timeout

[71] If an object or material obstructs the sense electrode the signal may rise enough to create a detection, preventing further operation. To help reduce the risk of this, the sensor includes a timer which monitors detections. If a detection exceeds the timer setting (known as the Max On-duration) the sensor performs a full recalibration. This does not toggle the output state but ensures that the QT102 will detect a new touch correctly. The timer is set to activate this feature after ~ 30 seconds. This will vary slightly with Cs.

1 .5 Forced Sensor Recalibration

[72] The QT102 has no recalibration pin; a forced recalibration is accomplished when the device is powered up, after the recalibration timeout or when the auto-off override is released.

[73] However, supply drain is low so it is a simple matter to treat the entire IC as a controllable load; driving the QT102's VDD pin directly from another logic gate or a microcontroller port will serve as both power and "forced recal(ibration)". The source resistance of most CMOS gates and microcontrollers are low enough to provide direct power without problems.

1 .6 Drift Compensation

[74] Signal drift can occur because of changes in Cx and Cs over time. It may be helpful if drift is compensated for, otherwise false detections, nondetections, and sensitivity shifts may follow.

[75] Drift compensation is schematically shown in FIGURE 2. Drift compensation is performed by making a reference level track the raw signal at a slow rate, but only while there is no detection in effect. It may be helpful if the rate of adjustment is performed relatively slowly,

otherwise there may be a risk that legitimate detections may be ignored. The QT102 drift compensates using a slew-rate limited change to the reference level; the threshold and hysteresis values are slaved to this reference.

[76] Once an object is sensed, the drift compensation mechanism ceases since the signal is legitimately high, and therefore should not cause the reference level to change (as indicated in FIGURE 2 during the period between the vertical dotted lines).

[77] The QT102's drift compensation is "asymmetric"; the reference level drift-compensates in one direction faster than it does in the other. Specifically, it compensates faster for decreasing signals than for increasing signals. It may be helpful if increasing signals are not compensated for quickly, since an approaching finger could be compensated for partially or entirely before approaching the sense electrode.

[78] However, an obstruction over the sense pad, for which the sensor has already made full allowance, could suddenly be removed leaving the sensor with an artificially elevated reference level and thus become insensitive to touch. In this latter case, the sensor will compensate for the object's removal more quickly, for example in only a few seconds.

[79] With relatively large values of Cs and small values of Cx, drift compensation will appear to operate more slowly than with the converse. Note that the positive and negative drift compensation rates are different.

1.7 Response Time

[80] The QT102's response time is dependent on burst length, which in turn is dependent on Cs and Cx. With increasing Cs, response time slows, while increasing levels of Cx reduce response time.

1 .8 Spread Spectrum

[81] The QT102 modulates its internal oscillator by ±7.5 percent during the measurement burst. This spreads the generated noise over a wider band reducing emission

levels. This also reduces susceptibility since there is no longer a single fundamental burst frequency.

2 Wiring and Parts

[82] FIGURE 3 schematically shows a basic circuit configuration for an implementation of particular embodiments.

2.1 Application Note

[83] Although not necessarily relevant to particular embodiments, for completeness, reference may be made to Application Note AN-KD02 ("Secrets of a Successful QTouch™ Design"), included herein in its entirety by reference, and downloadable from the Quantum Research Group website, for information on example construction and design methods. Go to http://www.qprox.com, click the Support tab and then Application Notes.

2.2 Cs Sample Capacitor

[84] Cs is the charge sensing sample capacitor. The required Cs value depends on the thickness of the panel and its dielectric constant. Thicker panels require larger values of Cs. Typical values are 1 or 2 nF to 50nF depending on the sensitivity required; larger values of Cs may demand higher stability and better dielectric to ensure reliable sensing.

[85] The Cs capacitor may be a stable type, such as X7R ceramic or PPS film. For more consistent sensing from unit to unit, 5 percent tolerance capacitors are recommended. X7R ceramic types can be obtained in 5 percent tolerance for little or no extra cost. In applications where high sensitivity (long burst length) is required, the use of PPS capacitors is recommended.

[86] Series resistor Rs is in line with the electrode connection and may be used to limit electrostatic discharge (ESD) currents and to suppress radio frequency interference (RF1). It may be approximately 4.7kΩ to 33kΩ, for example.

[87] Although this resistor may be omitted, the device may become susceptible to external noise or RF1. For more details of how to select these resistors see the Application Note AN-KD02 referred to above in Section 2.1.

2.4 Power Supply, PCB Layout

[88] The power supply (between VDD and VSS / system ground) can range between 2.0V and 5.5V for the QT102 implementation. If the power supply is shared with another electronic system, it may be helpful if care is taken to ensure that the supply is free of digital spikes, sags, and surges which can adversely affect the device. The QT102 will track slow changes in VDD, but it may be more affected by rapid voltage fluctuations. Thus it may be helpful if a separate voltage regulator is used just for the QT102 to isolate it from power supply shifts caused by other components.

[89] If desired, the supply can be regulated using a Low Dropout (LDO) regulator. See Application Note AN-KD02 (see Section 2.1) for further information on power supply considerations.

[90] Suggested regulator manufacturers include:

- Toko (XC6215 series)
- Seiko (S817 series)
- BCDSemi (AP2121 series)

[91] Parts placement: The chip may be placed to minimize the SNSK trace length to reduce low frequency pickup, and to reduce Cx which degrades gain. It may be helpful if the Cs and Rs resistors (see FIGURE 3) are placed close to the body of the chip so that the trace between Rs and the SNSK pin is relatively short, thereby reducing the antenna-like ability of this trace to pick up high frequency signals and feed them directly into the chip. A ground plane can be used under the chip and the associated discretes, but it may be helpful if the trace from the Rs resistor and the electrode do not run near ground, to reduce loading.

[92] For improved Electromagnetic compatibility (EMC) performance the circuit may be made entirely with surface mount technology (SMT) components.

[93] Electrode trace routing: It may be helpful to keep the electrode trace (and the electrode itself) away from other signal, power, and ground traces including over or next to ground planes. Adjacent switching signals can induce noise onto the sensing signal; any adjacent trace or ground plane next to, or under, the electrode trace will cause an increase in Cx load and desensitize the device.

[94] Note: a 100nF (0.1 μF) ceramic bypass capacitor (not shown in FIGURE 3) might be used between VDD and VSS in cases where it is considered appropriate to help avoid latch-up if there are substantial VDD transients; for example, during an ESD (electrostatic discharge) event. It may furthermore be helpful if the bypass capacitor is placed close to the device's power pins.

Table 2.1 QT102 Pin Descriptions (referring to the pin numbering shown in FIGURE 3)

PIN	NAME	TYPE	DESCRIPTION
1	OUT	O	To switched circuit and output polarity selection resistor (Rop)
2	VSS	P	Ground power pin
3	SNSK	IO	To Cs capacitor and to sense electrode
4	SNS	IO	To Cs capacitor and multiplier configuration resistor (Rm). Rm connected to either VSS or VDD. Refer to Section 3.5 for details.
5	VDD	P	Positive power pin
6	TIME	I	Timeout configuration pin, connected to either VSS, VDD, OUT or an RC network. Refer to Section 3.5 for details.

Type: P – Ground or power; IO – Input and output; OD – Open drain output; O – Output only, push-pull; I- Input only

[95] Regarding FIGURE 3, the following sections provide guidance for some example component values: Section 2.2 for Cs capacitor (Cs); Section 2.3 for Sample resistor (Rs); Section 2.4 for Voltage levels; Section 3.5.2 for Rm; and Section 3.3 for Rop.

3 Operation

3.1 Acquisition Modes

3.1.1 Introduction

[96] The polarity for the OUT pin of the QT102 can be configured to be "active high" or "active low" (see Section 3.3). If configured active high, then "on" is high and "off" is low. If configured active low, then "on" is low and "off" is high.

[97] The QT102 has more than one acquisition mode with the mode depending on the state of the OUT pin (on or off) and whether a touch is detected. In the following text "on" is when the output is in its active state (which could be high or low depending on how the polarity for the OUT pin is configured).

3.1.2 OUT Pin "On" (Fast Mode)

[98] The QT102 runs in a "Fast mode" when the OUT pin is on. In this mode the device runs at maximum speed at the expense of increased current consumption. The delay between bursts in Fast mode is approximately 2.6ms. FIGURE 4 schematically shows bursts on the SNSK pin during fast mode acquisition.

3.1.3 OUT Pin "Off" (Low Power Mode)

[99] The QT102 runs in Low Power (LP) mode if the OUT pin is off. In this mode it sleeps for approximately 85ms at the end of each burst, saving power but slowing response. On detecting a possible key touch, it temporarily switches to Fast mode until either the key touch is confirmed or found to be spurious (via the detect integration process). If the touch is confirmed the QT102 will switch to Fast mode. If a touch is denied the device will revert to normal LP

mode operation automatically. FIGURE 5 schematically shows bursts on the SNSK pin during a touch detection event. Also schematically represented is the output signal on the OUT pin. A key touch occurs around halfway along the figure. Prior to the key touch, the OUT pin is off (schematically shown here as a low logic level) and the QT102 is running in Low Power mode with sleep periods between bursts. The capacitance measured during the first burst after the key touch is higher and this triggers Fast mode acquisition. Following four burst in which the higher capacitance is seen (see Section 3.2.1), the OUT pin switches to on (schematically shown here as a high logic level) and Fast mode acquisition continues.

3.2 Signal Processing

3.2.1 Detect Integrator

[100] It is desirable to suppress detections generated by electrical noise or from quick brushes with an object. To accomplish this, the QT102 incorporates a "detect integration" (DI) counter that increments with each detection until a limit is reached, after which the output is activated. If no detection is sensed prior to the final count, the counter is reset immediately to zero. In the QT102, the required count is four. The DI can also be viewed as a "consensus" filter, that requires four successive detections to create an output.

3.2.2 Detect Threshold

[101] The device detects a touch when the signal has crossed a threshold level, in this example the threshold level is fixed at 10 counts.

3.3 Output Polarity Selection

[102] The output (OUT pin) of the QT102 can be configured to have an active high or active low output by means of the output configuration resistor Rop. The resistor is connected

between the output an output configuration voltage Vop, which may be either VSS or VDD as schematically shown in FIGURE 6. For the QT102, if Vop is VSS, the output polarity is configured active high. If Vop is VDD, the output polarity is configured active low

[103] It is noted that some devices, such as Digital Transistors, have an internal biasing network that will naturally pull the OUT pin to its inactive state. If these are being used then the resistor Rop is not required, as schematically shown in FIGURE 7.

3.4 Output Drive

[104] The OUT pin in the QT102 embodiment can sink or source up to 2mA. When a relatively large value of Cs (e.g. >20nF) is used, it may be helpful if the OUT pin current is limited to <1 mA to reduce the risk of gain-shifting side effects. These may happen when the load current creates voltage drops on the die and bonding wires; in some cases these small shifts can materially influence the signal level to cause detection instability.

3.5 Auto Off Delay

3.5.1 Introduction

[105] In addition to toggling the output on/off with key touch, the QT102 can automatically switch the output off after a specific time. This feature can be used to save power in situations where the switched device could be left on inadvertently.

[106] The QT102 has:

- three predefined delay times (Section 3.5.2)
- the ability to set a user-programmed delay (Section 3.5.3)
- the ability to override the auto off delay (Section 3.5.4)

[107] The QT102 chip is programmed such that the TIME and SNS pins may be used to configure the auto-off delay t_o and may be connected in one of the ways described in Sections 3.5.2, 3.5.3 and 3.5.4 to provide different functionality.

3.5.2 Auto Off – Predefined Delay

[108] To configure a predefined delay t_o the TIME pin may be wired to a voltage V_t, as schematically indicated in FIGURE 8. Voltage V_t may be VSS, VDD or OUT. These provides nominal values of t_o = 15 minutes, 60 minutes or infinity (remains on until toggled off) as indicated in Table 3.2 for an active high output configuration and in Table 3.3 for an active low output configuration.

[109] Furthermore, also as shown in FIGURE 8, a resistor Rm (e.g. a 1 MΩ resistor) may be connected between the SNS pin and the logic level Vm to provide three auto off functions: namely delay multiplication, delay override and delay retriggering. On power-up the logic level at Vm is assessed and a delay multiplication factor is set to x1 or x24 accordingly (see Table 3.4). At the end of each acquisition cycle the logic level of Vm is monitored to see if an Auto off delay override is required (see Section 3.5.4).

[110] Setting the delay multiplier to x24 will decrease the key sensitivity. Thus in some cases it may be appropriate to compensate for this by increasing the value of Cs.

Table 3.2 Predefined Auto-off Delay
(Active High Output)

Vt	**Auto-off delay (t_o)**
VSS	Infinity (remain on until toggled to off)
VDD	15 minutes
OUT	60 minutes

Table 3.3 Predefined Auto-off Delay
(Active Low Output)

Vt	**Auto-off delay (t_o)**
VSS	15 minutes

VDD	Infinity (remain on until toggled to off)
OUT	60 minutes

Table 3.4 Auto-off Delay Multiplier

Vm	**Auto-off delay multiplier**
VSS	t_o * 1
VDD	t_o * 24

3.5.3 Auto Off – User-programmed Delay

[111] If a user-programmed delay is desired, a resistor Rt and capacitor Ct can be used to set an auto-off delay (see Table 3.5 and FIGURE 9). The delay time is dependent on the RC time constant (Rt * Ct) the output polarity (i.e. whether active high or active low), and the supply voltage. Section 3.5.5 gives more details of how to configure the QT102 to have auto-off delay times ranging from 1 minute to up to 24 hours.

Table 3.5 Programmable Auto Off Delay

Output type	**Auto Off Delay (seconds)**
Active high	(Rt * Ct * 15) / 42
Active low	(Rt * Ct * 15) / 14.3

[112] Notes: The RC divisor values K(42 and 14.3) may be obtained from FIGURES 13 and 14. In this example the values are for a supply voltage VDD = 3.5 volts. For the parameterization shown in Table 3.5, Rt is in kΩ and Ct is in nF.

3.5.4 Auto Off – Overriding the Auto Off Delay

[113] In normal operation the QT102 output is turned off automatically after the auto-off delay. However, in some applications it may be useful to extend the auto-off delay ("sustain" function), or to switch the output off immediately ("cancel" function). This can be achieved by pulsing the voltage on the delay multiplier resistor Rm as schematically shown in FIGURE 10 (positive-going pulse from VSS to VDD for delay multiplier xl configuration) and FIGURE 11 (negative- going pulse from VDD to VDD for delay multiplier x24 configuration). The pulse duration tp may determine whether a retrigger of the auto-off delay or a switch of the output to off is desired. To help ensure the pulse is detected it may be present for a time greater than the burst length as shown in Table 3.6.

Table 3.6 Time Delay Pulse

Pulse Duration	**Action**
tp > burst time + 10ms (typical value 25ms)	Retrigger (reload auto-off delay counter)
tp > burst time + 50ms (typical value 65ms)	Switch output to off state and inhibit further touch detection until Vm returns to original state

[114] While Vm is held in the override state (i.e. the duration of the pulse) the QT102 inhibits bursts and waits for Vm to return to its original state (at the end of the pulse). When Vm returns to its original state the QT102 performs a sensor recalibration before continuing in its current output state.

[115] FIGURE 12 schematically shows override pulses being applied to a QT102 with delay multiplier set to xl (i.e. Vm normally at VSS with positive going pulses). The QT102 OUT signal is shown at the top of FIGURE 12. Vm is shown in the middle. Acquisition bursts on SNSK are shown at the bottom. Each short pulse P on Vm causes a sensor recalibration C and a restart of the auto-off timer. During the long pulse applied to Vm (i.e. where tp > t_{off}), the output is switched off at O. When the pulse finishes, the output remains switched off and a sensor recalibration C is performed.

3.5.5 Configuring the User-programmed Auto-off Delay

[116] As described in Section 3.5.3 the QT102 can be configured to give auto-off delays ranging from minutes to hours by means of a simple CR network and the delay multiplier input.

[117] With the delay multiplier set at x1 the auto-off delay is calculated as follows:

Delay value = integer value of (Rt * Ct / K) * 15 seconds.

(i.e. Rt * Ct = Delay value (in seconds) * K / 15

Note: Rt is in kΩ, Ct is in nF.

[118] In some applications improved operation may be achieved if the value of Rt * Ct is between 4 and 240. Values outside this range may be interpreted as the hard wired options TIME linked to OUT and TIME linked to "off" respectively, causing the QT102 to use the relevant predefined auto-off delays (see Tables 3.2 and 3.3).

[119] FIGURES 13 and 14 show typical values of K versus supply voltage for a QT102 with active high or active low output.

Example using the formula to calculate Rt and Ct

[120] Requirements / operating parameters:

- Active high output (Vop connected to VSS)
- Auto-off delay 45 minutes
- VDD = 3.5v

[121] Proceed as follows:

1. Calculate Auto-off delay in seconds 45 * 60 = 2700
2. Obtain K from FIGURE 13 (active high): K= 42 for VDD = 3.5v
3. Calculate Rt * Ct = 2700 * 42 / 15= 7560
4. Select a value for Ct (or conversely Rt). E.g. Ct = 47nF

5. Calculate Rt (or conversely Ct) = 7560 / 47 = 160kΩ

[122] As an alternative to calculation, Rt and Ct values may be selected from pre-calculated curves such as shown in FIGURES 15 and 16. FIGURES 15 and 16 show charts of typical curves of auto-off delay against resistor and capacitor values for active high (FIGURE 15) and active low (FIGURE 16) outputs at various values of VDD and for delay multiplier = x1.

Example using plot shown in FIGURE 15 or 16 to calculate Rt and Ct

[123] Requirements / operating parameters:

- Active low output (Vop connected to V55)
- Auto-off delay 10 hours
- VDD = 4V

[124] Proceed as follows:

1. Calculate Auto-off delay in seconds 10 x 60 x 60 = 36000. This value is outside of the range of the charts so use the x24 multiplier (connect Rm to VDD).

Note: this will decrease the key sensitivity, so in some circumstances it may be helpful to increase the value of Cs.

2. Find 36000 /24 = 1500 on the 4V chart in FIGURE 16
3. Read across to see appropriate Rt / Ct combinations. This example shows the following Rt / Ct combinations to be appropriate: 100nF / 10kΩ, 47nF / 27kSΩ, 22nF / 60kΩ, and 10nF / 130kΩ.

[125] Of course the Auto-off delay times given here are nominal and will vary slightly from chip to chip and with capacitor and resistor tolerance.

3.6 Examples of Typical Applications

[126] FIGURE 17 shows a first example application of a QT102 chip in particular embodiments. Here the QT102 is in an active low configuration and is shown driving a PNP transistor with an auto off time of 500s x 24 (3.33 hours)

[127] The auto off time for the circuit configuration shown in FIGURE 16 may be obtained from the VDD = 3V chart in FIGURE 16. Setting the delay multiplier to x24 will decrease the key sensitivity, so it may be helpful in some cases to increase the value of Cs.

[128] FIGURE 17 shows a second example application of a QT102 chip in particular embodiments. Here the QT102 is in an active high configuration and is shown driving high impedance with an auto off time of 135s x 1 (2.25 minutes).

[129] The auto off time for the circuit configuration shown in FIGURE 18 may be obtained from the VDD = 5V chart in FIGURE 15.

4. Example Specifications for an example QT102 chip

[130] An example chip incorporating particular embodiments may have the following specifications.

4.1 Suggested Maximum Operating Specifications

[131] Operating temperature: -40°C to +85°C

Storage temperature: -55°C to +125°C

VDD: 0 to +6.5V

Maximum continuous pin current, any control or drive pin: ±20mA

Short circuit duration to VSS, any pin: infinite

Short circuit duration to VDD, any pin: infinite

Voltage forced onto any pin: -0.6 to (VDD + 0.6) Volts

4.2 Recommended Typical Operating Conditions

[132] VDD: +2.0 to 5.5V

Short-term supply ripple+noise: ±5mV

Long-term supply stability: ±100mV

Cs value: 1 or 2 nF to 50nF

Cx value: 5 to 20pF

4.3 AC Specifications

[133] VDD = 3.0V, Cs = 10nF, Cx = 5pF, Ta = recommended range, unless otherwise noted

Parameter	**Description**	**Min**	**Typ**	**Max**	**Units**	**Notes**
T_{RC}	Recalibration time		250		ms	Cs and Cx dependent
T_{PC}	Charge duration		2		µs	±7.5% spread spectrum variation
T_{PT}	Transfer duration		2		µs	±7.5% spread spectrum variation
T	Time between end of burst and start of the next (Fast mode)		2.6		ms	
T_{GZ}	Time between end of burst and start of the next (LP mode)		85		ms	Increases with reducing VDD
T_{BL}	Burst length		20		ms	VDD, Cs and Cx dependent. See Section 2.2 for capacitor selection.
T_R	Response time			100	ms	

4.4 Signal Processing

Description	Min	Typ	Max	Units	Notes
Threshold differential		10		counts	
Hysteresis		2		counts	
Consensus filter length		4		samples	
Recalibration timer		40		secs	Will vary with VDD

4.5 DC Specifications

[134] VDD = 3.0V, Cs = 10nF, Cx = 5pF, Ta = recommended range, unless otherwise noted

Parameter	**Description**	**Min**	**Typ**	**Max**	**Units**	**Notes**
V_{pp}	Supply voltage	2		5/5.5	V	
I_{DD}	Supply current	5		60	µA	Depending on supply and run mode
IddI	Supply current, LP Mode		23 37 90		µA	2V 3V 5V
V_{DDS}	Supply turn-on slope	100			V/s	Required for proper start-up
V_{IL}	Low input logic level			0.8	V	
V_{HL}	High input logic level	2.2			V	
V_{OL}	Low output voltage			0.6	V	OUT, 4тA sink
V_{OH}	High output voltage	VDD-0.7			V	OUT, 1 mA source
I_{IL}	Input leakage current			±1	µA	
Cx	Load capacitance range	0		100	pF	
A_R	Acquisition resolution		9	14	bits	

4.6 Mechanical Dimensions

[135] In one example embodiment a chip implementing the above-described QT102 chip functionality may be provided in an SOT23-6 package type. Referring to FIGURE 19, the chip may thus have the following dimensions.

Package type: SOT23-6						
Symbol	Millimeters			Inches		
	Min	Max	Notes	Min	Max	Notes
M	2.8	3.10		0.110	0.122	
W	2.6	3.0		0.102	0.118	
Aa	1.5	1.75		0.059	0.069	
H	0.9	1.3		0.035	0.051	
h	0.0	0.15		0	0.006	
D	-	-	0.95 BSC	-	-	0.038 BSC
L	0.35	0.5		0.014	0.02	
E	0.35	0.55		0.014	0.022	
e	0.09	0.2		0.004	0.008	
Φ	0°	10°		0°	10°	

[136] A QT102 chip provided in an SOT23-6 package type may have a pin arrangement as schematically indicated in FIGURE 20.

4.7 Moisture Sensitivity Level (MSL)

[137] A chip implementing the above-described QT102 chip functionality may be rated as follows:

MSL Rating	**Peak Body Temperature**	**Specifications**
MSL1	260°C	1PC/JEDEC J-STD-020C

[138] Thus, in particular embodiments, the QT102 charge-transfer (QT) touch sensor is a self-contained digital IC capable of detecting near-proximity or touch. It may project a touch

or proximity field through any dielectric like glass, plastic, stone, ceramic, and even most kinds of wood. It can also turn small metal-bearing objects into intrinsic sensors, making them responsive to proximity or touch. This capability, coupled with its ability to self calibrate, can lead to entirely new product concepts. It may be implemented in human interfaces, like control panels, appliances, toys, lighting controls, or anywhere a mechanical switch or button may be found.

[139] The QT102 example embodiment may be seen as a single key chip combining a touch-on / touch-off toggle mode with timeout and timing override functions, oriented towards power control of small appliances and battery- operated products, for example. With a small low-cost SOT-23 package, this device can suit almost any product needing a power switch or other toggle-mode controlled function.

[140] An environmentally friendly ("green") feature of the QT102 is the timeout function, which can turn off power after a specified time delay ranging from minutes to hours. Furthermore, external "sustain" and "cancel" functions permit designs where the timeout needs to be extended further or terminated early. A user's interaction with a product might trigger a "sustain" input, prolonging the time to shutoff. A safety sensor, such as a tip-over switch on a space heater, can feed the "cancel" function to terminate early.

[141] The QT102 embodiment(s) features automatic self-calibration, drift compensation, and spread-spectrum burst modulation. The device can in some cases bring inexpensive, easy-to-implement capacitive touch sensing to all kinds of appliances and equipment, from toys to coffee makers. The small, low cost SOT-23 package lets this unique combination of features reside in almost any product.

[142] The QT102 chip embodying particular embodiments may be summarized as having the following operational features / application parameters:

Number of keys: One touch on/touch off (toggle mode), plus hardware programmable auto switch-off / switch-off delay and external cancel

Technology: Spread-spectrum charge-transfer (direct mode)

Example key outline sizes: 6mm x 6mm or larger (generally panel thickness dependent); widely different sizes and shapes possible

Example electrode design: Solid or ring electrode shapes

PCB Layers required: One

Example electrode materials: Etched copper, silver, carbon, Indium Tin Oxide (ITO), Orgacon (RTM)

Example electrode substrates: PCB, FPCB, plastic films, glass

Example panel materials: Plastic, glass, composites, painted surfaces (including relatively low particle density metallic paints)

Example panel thickness: Up to 50mm glass, 20mm plastic (generally electrode size dependent)

Key sensitivity: Settable via external capacitor

Interface: Digital output, active high or active low (hardware configurable)

Moisture tolerance: Good

Power: 2V ~ 5.5V; drawing , for example, 23μA at 2V

Example package: SOT23-6 (3x3 mm) RoHS compliant

Signal processing: Se1f-calibration, auto drift compensation, noise filtering

Example Applications: Power switch replacement in countertop appliances, irons, battery powered toys, heaters, lighting controls, automotive interior lighting, commercial and industrial equipment such as soldering stations and cooking equipment

[143] In particular embodiments, the above-described sensors may be used in apparatus or devices with one touch key. In particular embodiments the sensing element of the sensor may include more than one key, for example two, three, or more keys.

[144] Herein, "or" is inclusive and not exclusive, unless expressly indicated otherwise or indicated otherwise by context. Therefore, herein, "A or B" means "A, B, or both," unless expressly indicated otherwise or indicated otherwise by context. Moreover, "and" is both joint and several, unless expressly indicated otherwise or indicated otherwise by context. Therefore,

herein, "A and B" means "A and B, jointly or severally," unless expressly indicated otherwise or indicated otherwise by context.

[145] This disclosure encompasses all changes, substitutions, variations, alterations, and modifications to the example embodiments herein that a person having ordinary skill in the art would comprehend. Similarly, where appropriate, the appended claims encompass all changes, substitutions, variations, alterations, and modifications to the example embodiments herein that a person having ordinary skill in the art would comprehend. Moreover, reference in the appended claims to an apparatus or system or a component of an apparatus or system being adapted to, arranged to, capable of, configured to, enabled to, operable to, or operative to perform a particular function encompasses that apparatus, system, component, whether or not it or that particular function is activated, turned on, or unlocked, as long as that apparatus, system, or component is so adapted, arranged, capable, configured, enabled, operable, or operative.

WHAT IS CLAIMED IS:

1. An apparatus comprising:

a sensing element of a touch screen; and

one or more computer-readable non-transitory storage media coupled to the sensing element and embodying logic that is operable when executed to:

determine an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and

if the amount of time that has elapsed exceeds a predetermined time duration, then initiate a particular function of the apparatus.

2. The apparatus of Claim 1, wherein the particular function comprises deactivation of measurement of changes in capacitance by the sensing element.

3. The apparatus of Claim 1, wherein the particular function comprises recalibration of measurement of changes in capacitance by the sensing element.

4. The apparatus of Claim 1, wherein the logic is further operable to calculate the predetermined time duration based on one of a plurality of power supply voltages or an output voltage of the sensing element.

5. The apparatus of Claim 1, wherein the logic is further operable to calculate the predetermined time duration based on one of a plurality of delay multipliers determined by a polarity of a voltage pulse.

6. The apparatus of Claim 1, wherein the particular function comprises turning off the apparatus.

7. The apparatus of Claim 1, wherein sensing element comprises a control circuit.

8. The apparatus of Claim 7, wherein the sensing element further comprises a pattern of electrodes within the touch screen, the electrodes being coupled to the control circuit.

9. The apparatus of Claim 8, wherein the electrodes comprise indium tin oxide (ITO).

10. A method comprising:

monitoring detection by a sensing element of a key touch on a touch screen, the sensing element being of the touch screen;

determining an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and

if the amount of time that has elapsed exceeds a predetermined time duration, then initiating a particular function of an apparatus.

11. The method of Claim 10, wherein the particular function comprises deactivating measurement of changes in capacitance by the sensing element.

12. The method of Claim 10, wherein the particular function comprises recalibrating measurement of changes in capacitance by the sensing element.

13. The method of Claim 10 further comprises calculating the predetermined time duration based on one of a plurality of power supply voltages or an output voltage of the sensing element.

14. The method of Claim 10 further comprises calculating the predetermined time duration based on one of a plurality of delay multipliers determined by a polarity of a voltage pulse.

15. The method of Claim 10, wherein the particular function comprises turning off power to an apparatus.

16. A computer-readable non-transitory storage media embodying logic that is operable when executed to:

monitor detection by a sensing element of a key touch on a touch screen, the sensing element being of a touch screen;

determine an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and

if the amount of time that has elapsed exceeds a predetermined time duration, then initiate a particular function of an apparatus.

17. The media of Claim 16, wherein the particular function comprises deactivation of measurement of changes in capacitance by the sensing element.

18. The media of Claim 16, wherein the particular function comprises recalibration of measurement of changes in capacitance by the sensing element.

19. The media of Claim 16, wherein the logic is further operable to calculate the predetermined time duration based on one of a plurality of power supply voltages or an output voltage of the sensing element.

20. The media of Claim 16, wherein the logic is further operable to calculate the predetermined time duration based on one of a plurality of delay multipliers determined by a polarity of a voltage pulse.

PROXIMITY SENSOR

ABSTRACT

In one embodiment, a method includes monitoring detection by a sensing element of a key touch on a touch screen; determining an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and, if the amount of time that has elapsed exceeds a predetermined time duration, then initiating a particular function of an apparatus.

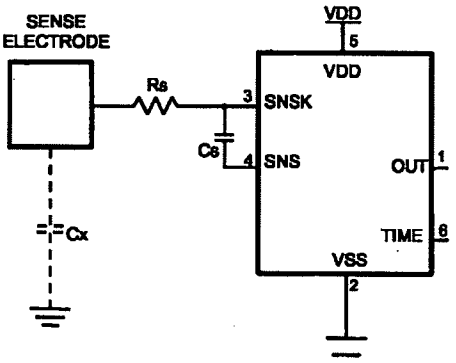


Fig. 1

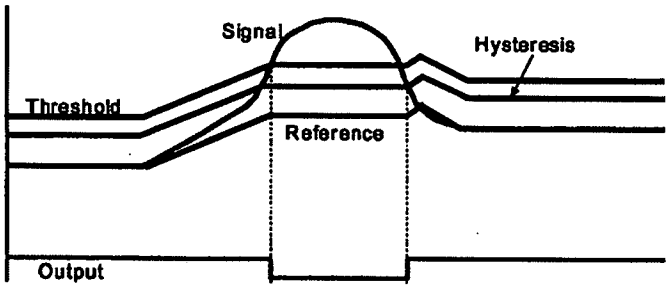


Fig. 2

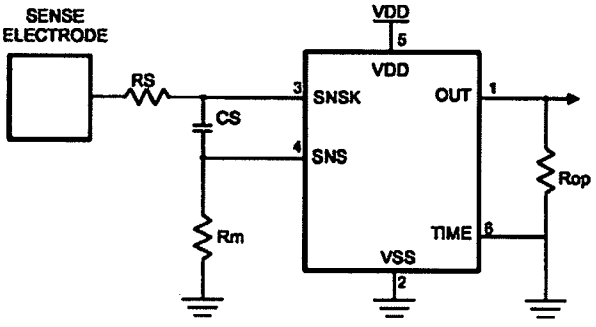


Fig. 3

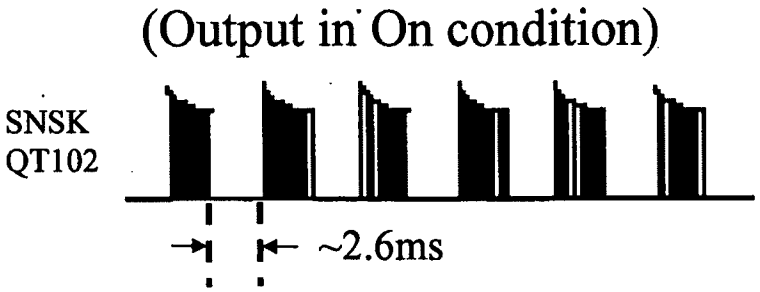


Fig. 4

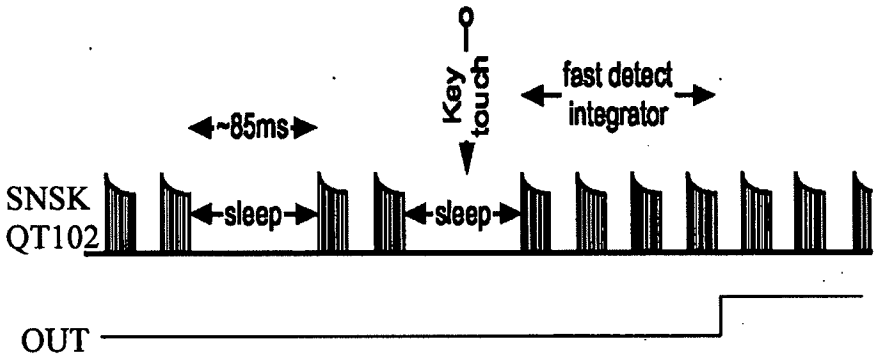


Fig. 5

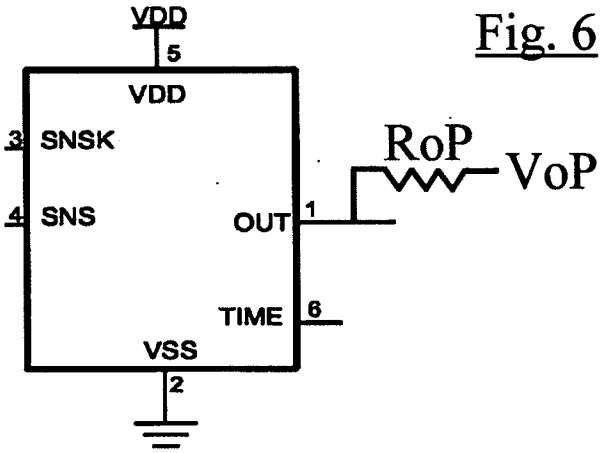


Fig. 6

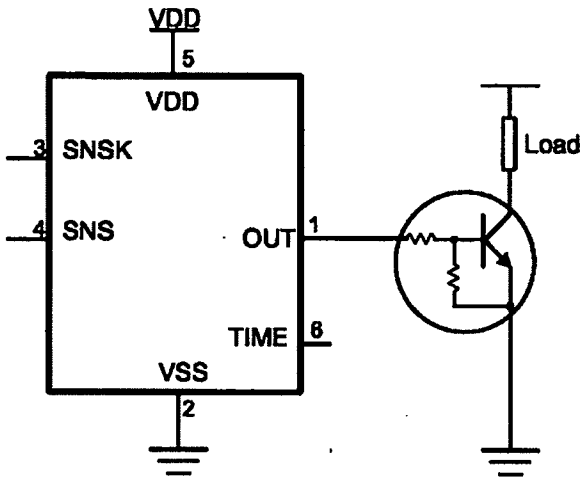

VDD
5
VDD
3
SNSK
4
SNS
OUT
1
TIME
6
VSS
2
Load

Fig. 7

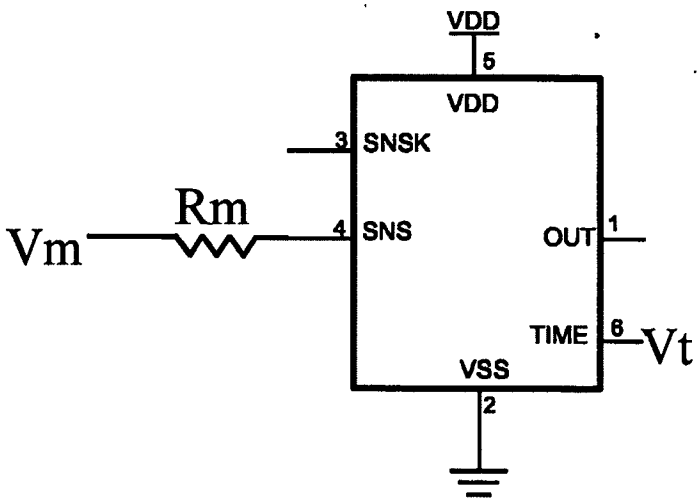

VDD
5
VDD
3
SNSK
Rm
Vm
4
SNS
OUT
1
TIME
6
Vt
VSS
2

Fig. 8

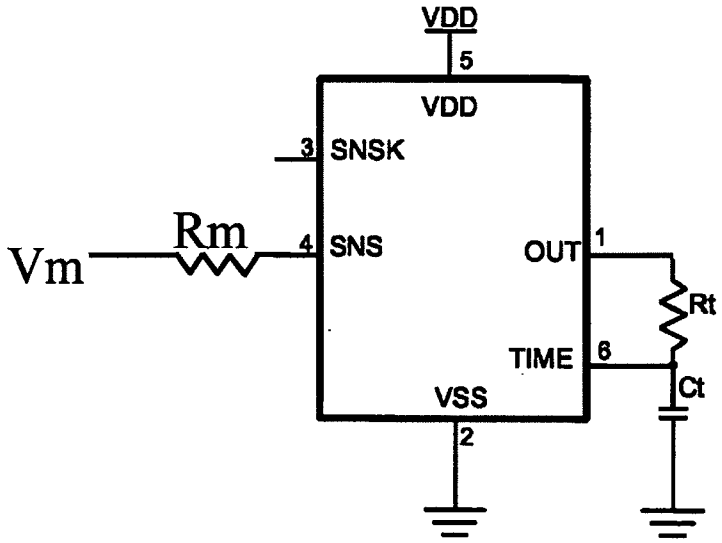

VDD
5
VDD
3
SNSK
Rm
Vm
4
SNS
OUT
1
Rt
TIME
6
Ct
VSS
2

Fig. 9

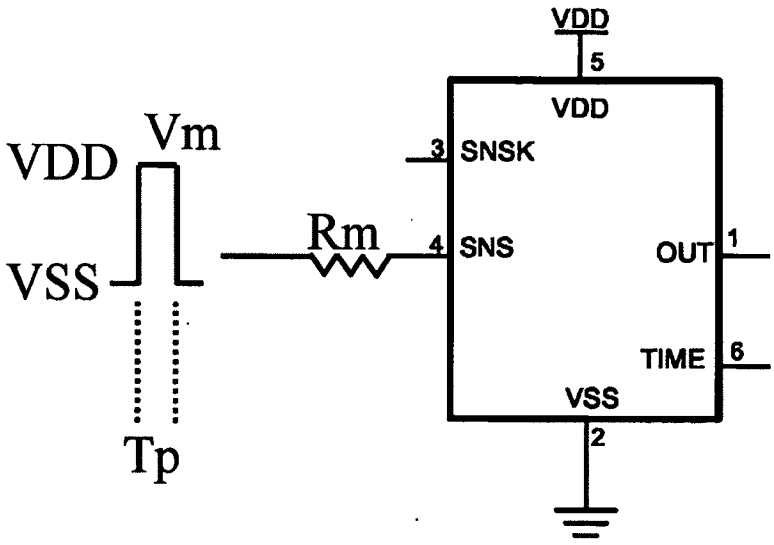

VDD
5
VDD
Vm
VDD
3
SNSK
Rm
4
SNS
OUT
1
VSS
TIME
6
VSS
Tp
2

Fig. 10

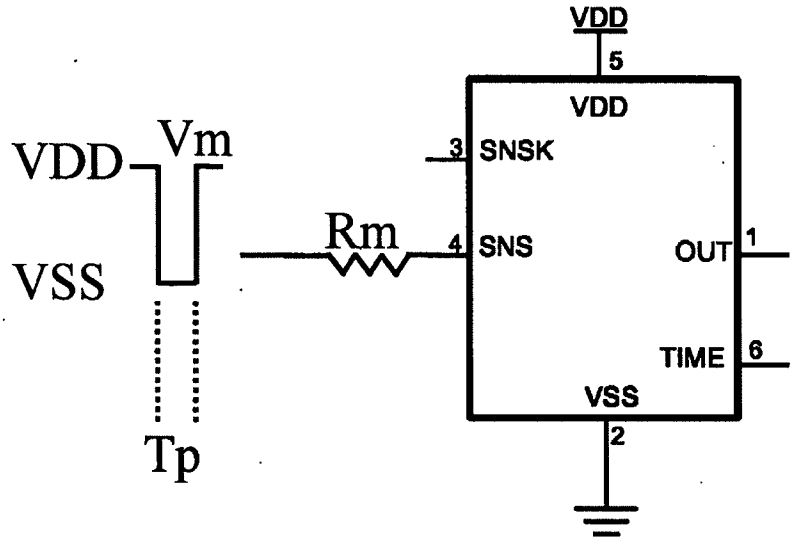


Fig. 11

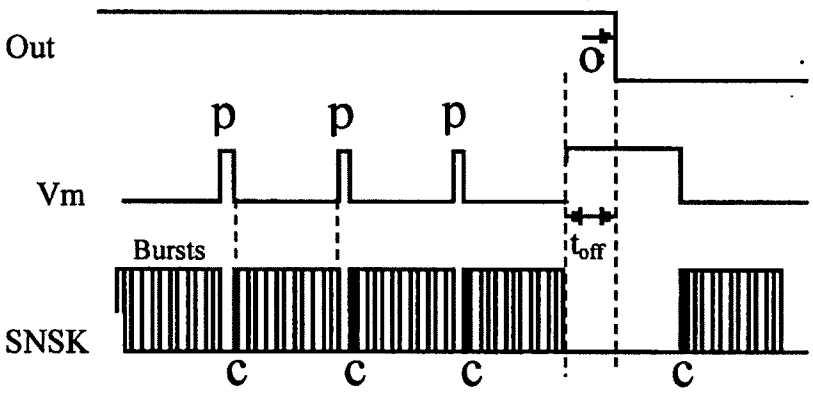


Fig. 12

P - override (reload auto off delay)

O - switch output off (t_{off} burst time + 50ms)

C - sensor recalibration

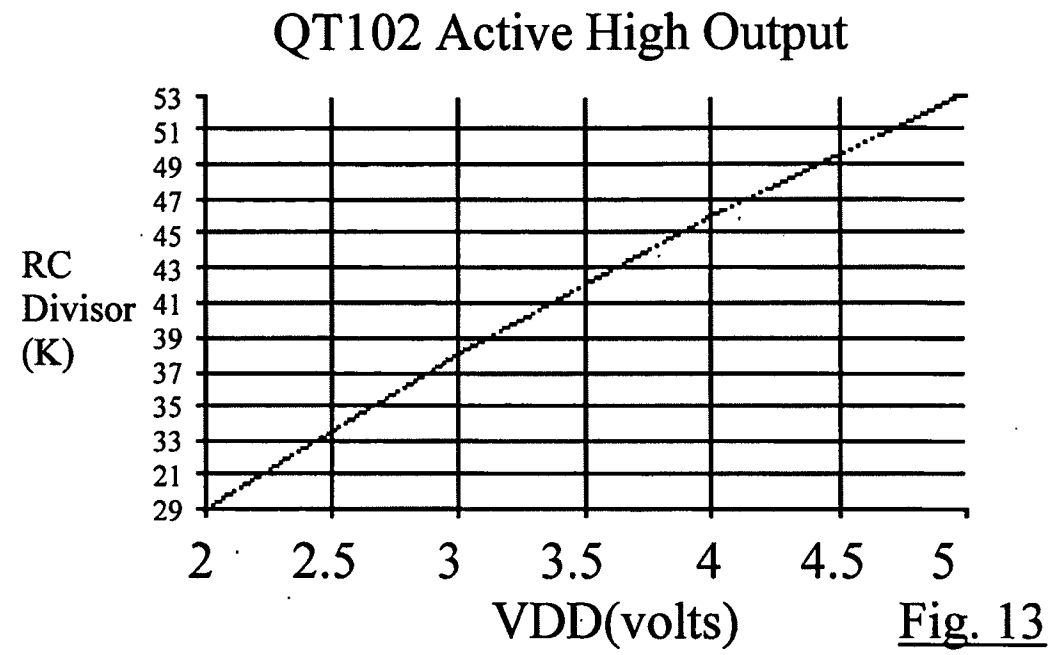

QT102 Active High Output
RC Divisor (K)
53
51
49
47
45
43
41
39
37
35
33
21
29
2
2.5
3
3.5
4
4.5
5
VDD(volts)

Fig. 13

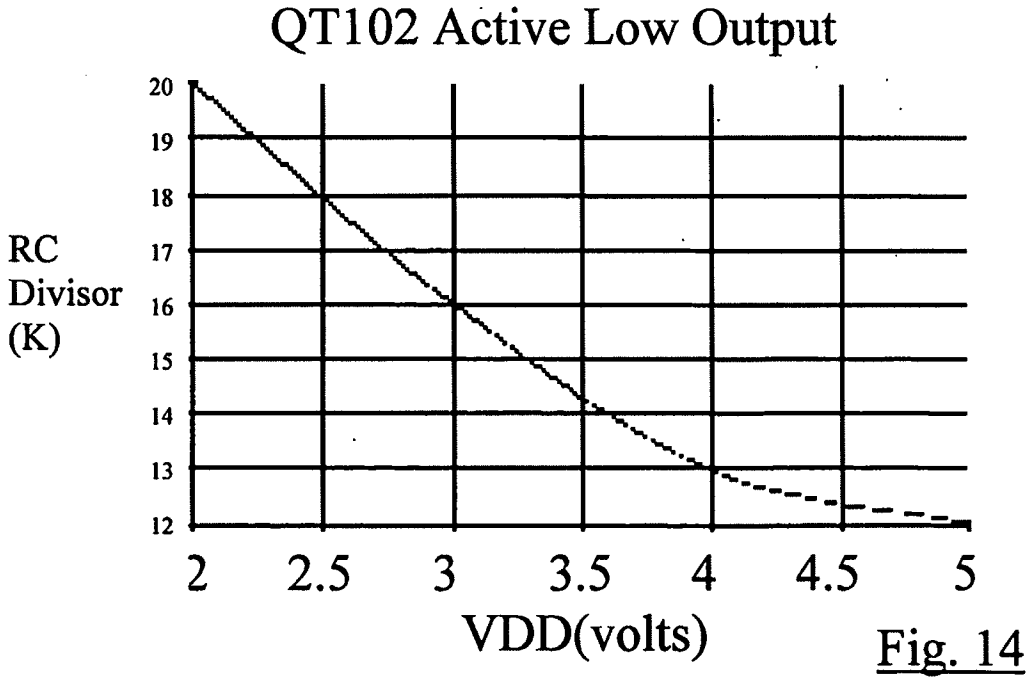

QT102 Active Low Output
RC Divisor (K)
20
19
18
17
16
15
14
13
12
2
2.5
3
3.5
4
4.5
5
VDD(volts)

Fig. 14

Vm = Vss (delay multiplier = x1)

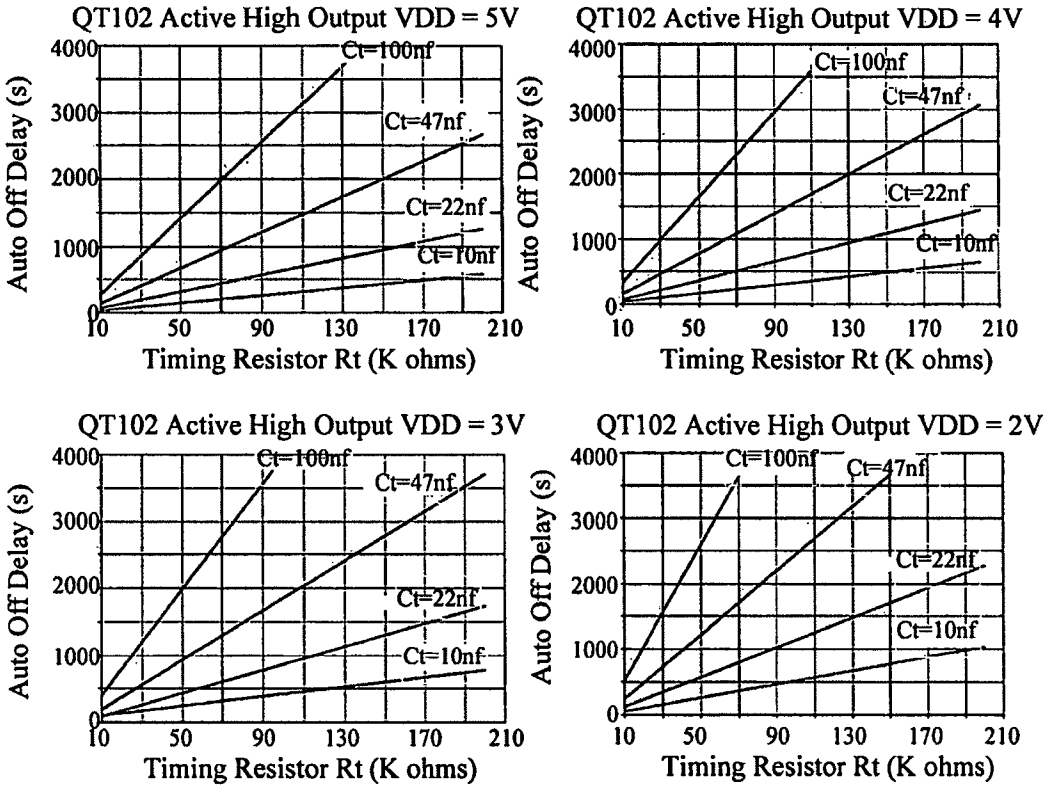


Fig. 15

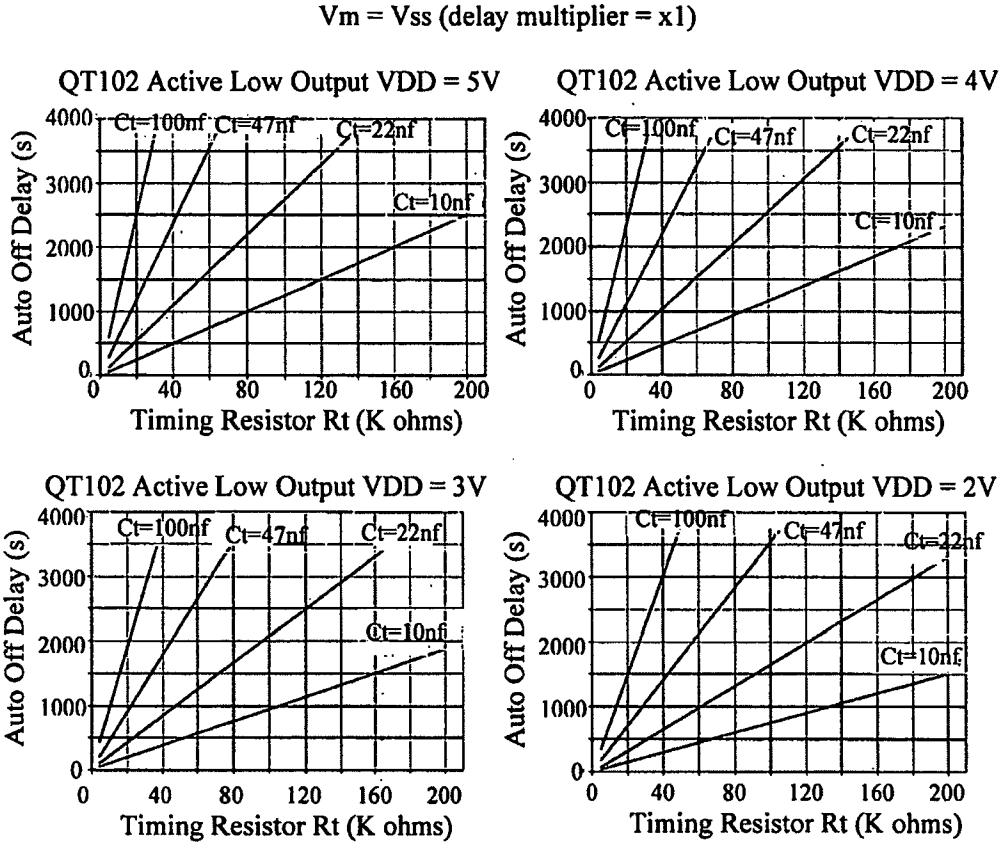

Vm = Vss (delay multiplier = x1)
QT102 Active Low Output VDD = 5V
QT102 Active Low Output VDD = 4V
QT102 Active Low Output VDD = 3V
QT102 Active Low Output VDD = 2V
Auto Off Delay (s)
Timing Resistor Rt (K ohms)
Ct=100nf
Ct=47nf
Ct=22nf
Ct=10nf
0
1000
2000
3000
4000
0
40
80
120
160
200

Fig. 16

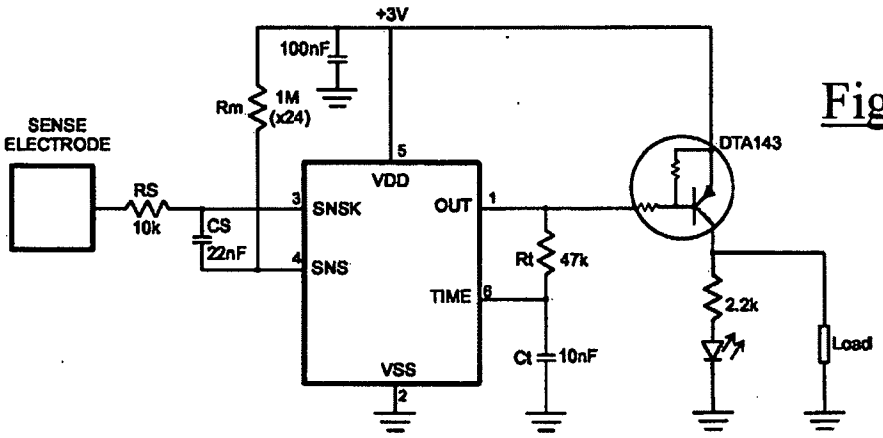

+3V
100nF
Rm
1M
(x24)
SENSE
ELECTRODE
RS
10k
CS
22nF
5
VDD
3
SNSK
OUT
1
4
SNS
TIME
6
VSS
2
Rt
47k
Ct
10nF
DTA143
2.2k
Load

Fig. 17

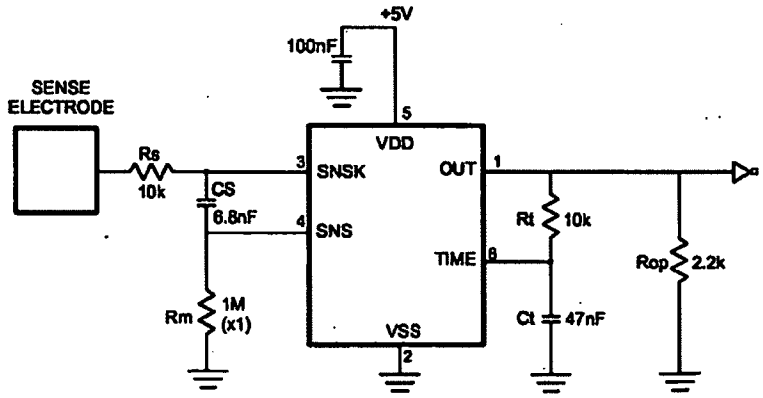

+5V
100nF
SENSE
ELECTRODE
Rs
10k
CS
6.8nF
Rm
1M
(x1)
5
VDD
3
SNSK
OUT
1
4
SNS
TIME
6
VSS
2
Rt
10k
Ct
47nF
Rop
2.2k

Fig. 18

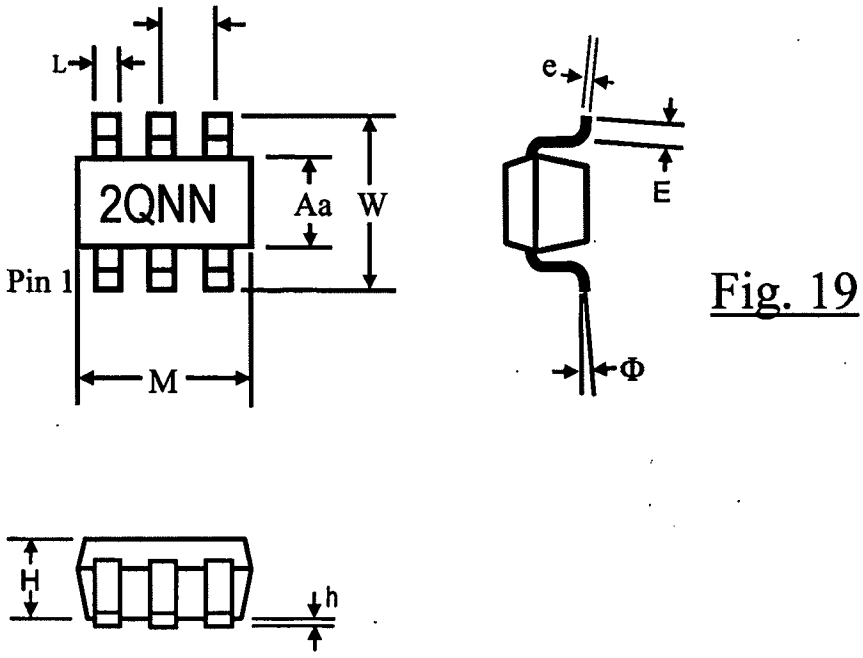


Fig. 19

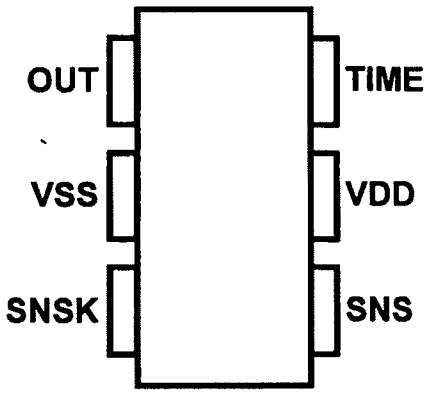


Fig. 20

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Filer:	Travis W. Thomas/Paula Hurley
Attorney Docket Number:	080900.1059

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1090**

Electronic Acknowledgement Receipt

EFS ID:	10178219
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Travis W. Thomas/Paula Hurley
Filer Authorized By:	Travis W. Thomas
Attorney Docket Number:	080900.1059
Receipt Date:	26-MAY-2011
Filing Date:	
Time Stamp:	16:45:34
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1090
RAM confirmation Number	3833
Deposit Account	020384
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS_080900_1059.pdf	1031857 f075630632b95c9a62778967dfb8d07f55ec9758	no	5
Warnings:					
Information:					
2	Oath or Declaration filed	Declaration_080900_1059.pdf	83236 97684629fe643bc3a6d28b54db2f7495e7309dea	no	1
Warnings:					
Information:					
3	Power of Attorney	POA_080900_1059.pdf	84616 dda6000a4a56111d9f69b51817817371cbabbf6b	no	1
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73(b).	Stmt373b_080900_1059.pdf	163865 c9cddf57ecd252508335453d33afd72f87768602	no	1
Warnings:					
Information:					
5	Transmittal Letter	IDS_080900_1059.pdf	94092 cbb59c50413cc759e6d11b8eb46b7f4c6f32f7f5	no	1
Warnings:					
Information:					
6	Information Disclosure Statement (IDS) Filed (SB/08)	SB08_080900_1059.pdf	77134 8a4cf866ce7360eae87e1064ccbcdec80aad15af	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
7		Application_080900_1059.pdf	209162 272f0ef038b9e44e70e650369122a4713dc2a45b	yes	37

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**

	Specification		1		33
	Claims		34		36
	Abstract		37		37
Warnings:					
Information:					
8	Drawings-only black and white line drawings	Figures_080900_1059.pdf	160153 6fb200e52cf01f33f1d96df3b18b3ea0f08ca202	no	10
Warnings:					
Information:					
9	Fee Worksheet (PTO-875)	fee-info.pdf	32283 40b63a79150a37f8ce88353b65a08aab0932e97d	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1936398		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	080900.1059
	Application Number	
Title of Invention	Proximity Sensor	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Harald		Philipp	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Zug	Country Of Residence[i]	CH
Citizenship under 37 CFR 1.41(b)[i]	DE		

Mailing Address of Applicant:

Address 1	Baer & Karrer AG		
Address 2	Baarerstrasse 8		
City	Zug	State/Province	
Postal Code	CH-6301	Country[i]	CH

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kevin		Snoad	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Chicester	Country Of Residence[i]	GB
Citizenship under 37 CFR 1.41(b)[i]	GB		

Mailing Address of Applicant:

Address 1	QRG Limited		
Address 2	1560 Parkway, Solent Business Park, Whitely		
City	Fareham, Hampshire	State/Province	
Postal Code	PO15 7AG	Country[i]	GB

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	080900.1059
	Application Number	
Title of Invention	Proximity Sensor	

Customer Number	12323		
Email Address	PTOmail1@bakerbotts.com	Add Email	Remove Email

Application Information:

Title of the Invention	Proximity Sensor		
Attorney Docket Number	080900.1059	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)	2858		
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	1

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	12323		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	12179769	2008-07-25
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
12/179769	non provisional of	60952053	2007-07-27

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	080900.1059
	Application Number	
Title of Invention	Proximity Sensor	

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			○ Yes ◉ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☒			
Organization Name	Atmel Corporation		
Mailing Address Information:			
Address 1	2325 Orchard Parkway		
Address 2			
City	San Jose	**State/Province**	CA
Country [i] US		Postal Code	95131
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Travis Thomas/			Date (YYYY-MM-DD)	2011-05-26
First Name	Travis	Last Name	Thomas	Registration Number	48667

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	080900.1059
	Application Number	
Title of Invention	Proximity Sensor	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/01A (07-07)
Approved for use through 06/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Proximity Sensor

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☑ Application No. 12/179,769 filed on July 25,2008

☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

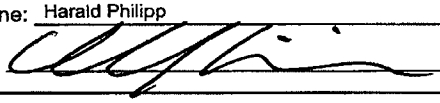
WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

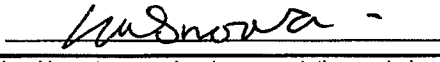
All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Harald Philipp Date: 17 September 2008

Signature:  Citizen of: US

Inventor two: Kevin Snoad Date: 3 August 2008

Signature:  Citizen of: GB

☐ Additional inventors or a legal representative are being named on _____ additional form(s) attached hereto.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Harald Philipp
Application No.:	13/116764
Filed:	26 May 2011
Confirmation No.:	6159
Title:	*Proximity Sensor*

Preliminary Amendment

Please amend this Application as follows prior to its initial examination.

The Specification

Please amend Paragraph 1 as follows:

[1] This application is a continuation under 35 U.S.C. § 120 of U.S. Patent Application No. 12/179769, filed 25 July 2008, which claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 60/952053, filed ~~27~~ 26 July 2007.

Remarks

Applicant has amended the Specification of this Application to correct a typographical error.

Conclusion

The Commissioner may charge any fee due and credit any overpayment for this Application to Deposit Account No. 02-0384 of Baker Botts LLP.

If a telephone conference would advance prosecution of this Application, please call Travis Thomas, Attorney for Applicant, at 650.739.7503.

Respectfully submitted,

BAKER BOTTS L.L.P.
Attorneys for Applicant

Travis Thomas
Reg. No. 48667

Date: 1 June 2011

SUPPLEMENTAL APPLICATION DATA SHEET

APPLICATION INFORMATION

Application No.::	13116764
Filing Date::	05-26-2011
Application Type::	Regular
Subject Matter::	Utility
CD-ROM or CD-R?::	None
Title::	Proximity Sensor
Attorney Docket Number::	080900.1059
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	1
Total Drawing Sheets::	10
Small Entity?::	No
Petition included?::	No

APPLICANT INFORMATION

Applicant Authority Type::	Inventor
Primary Citizenship Country::	DE
Status::	Full Capacity
Given Name::	Harald
Family Name::	Philipp
City of Residence::	Zug
Country of Residence::	CH
Street of mailing address::	Baer & Karrer AG, Baarerstrasse 8
City of mailing address::	Zug

Country of mailing address::	CH
Postal or Zip Code of mailing address::	CH-6301

Applicant Authority Type::	Inventor
Primary Citizenship Country::	GB
Status::	Full Capacity
Given Name::	Kevin
Family Name::	Snoad
City of Residence::	Chicester
Country of Residence::	GB
Street of mailing address::	QRG Limited, 1560 Parkway, Solent Business Park, Whitely
City of mailing address::	Fareham, Hampshire
Country of mailing address::	GB
Postal or Zip Code of mailing address::	PO15 7AG

CORRESPONDENCE INFORMATION

Correspondence Customer Number::	12323
Name::	Travis Thomas
Company Name::	Baker Botts L.L.P.
Street of mailing address::	2001 Ross Avenue, Suite 600
City of mailing address::	Dallas
State or Province of mailing address::	TX
Postal or Zip Code of mailing address::	75201-2980
Phone number::	214-953-6500
Fax Number::	214-953-6503

REPRESENTATIVE INFORMATION

Representative Customer Number:: 12323

DOMESTIC PRIORITY INFORMATION

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
13116764	Continuation of	12179769	07-25-2008
12179769	*An application claiming the benefit under 35 USC 119(e) of*	60952053	07-26-2007

ASSIGNEE INFORMATION

Assignee name::	Atmel Corporation
Street of mailing address::	2325 Orchard Parkway
City of mailing address::	San Jose
State or Province of mailing address::	CA
Country of mailing address::	US
Postal or Zip Code of mailing address::	95131

Electronic Acknowledgement Receipt

EFS ID:	10205821
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Travis W. Thomas/Paula Hurley
Filer Authorized By:	Travis W. Thomas
Attorney Docket Number:	080900.1059
Receipt Date:	01-JUN-2011
Filing Date:	
Time Stamp:	13:26:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	Preliminary_Amendment_080900_1059.pdf	108499 6378454e628e30628c8499c0095d31bdda6ee104	no	4

Warnings:	
Information:	

2	Application Data Sheet	Supplemental_ADS_080900_1059.pdf	74150 264c539a7da94e4c610417c42f276d55b45480b9	no	3

Warnings:	
Information:	
This is not an USPTO supplied ADS fillable form	
Total Files Size (in bytes):	182649

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/116,764

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 52 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 220 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1090

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/116,764	05/26/2011	Harald Philipp	080900.1059

CONFIRMATION NO. 6159

12323
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

POA ACCEPTANCE LETTER

OC00000048085471

Date Mailed: 06/10/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 05/26/2011.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/dgela/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/116,764	05/26/2011	Harald Philipp	080900.1059

CONFIRMATION NO. 6159

12323
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

FORMALITIES LETTER

OC000000048102200

Date Mailed: 06/10/2011

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings submitted to the Office are not electronically reproducible because portions of figures 15-16 are missing and/or blurry.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/ldvan/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/116,764	05/26/2011	3742	1090	080900.1059	20	3

CONFIRMATION NO. 6159

12323
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

FILING RECEIPT

OC000000048102199

Date Mailed: 06/10/2011

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Harald Philipp, Zug, SWITZERLAND;
Kevin Snoad, Chicester, UNITED KINGDOM;

Assignment For Published Patent Application

ATMEL CORPORATION, San Jose, CA

Power of Attorney: The patent practitioners associated with Customer Number 12323

Domestic Priority data as claimed by applicant

This application is a CON of 12/179,769 07/25/2008 PAT 7,952,366
which claims benefit of 60/952,053 07/26/2007

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 06/07/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/116,764**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

Proximity Sensor

Preliminary Class

219

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as

set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Harald Philipp
Application No.:	13/116764
Filed:	26 May 2011
Confirmation No.:	6159
Title:	Proximity Sensor

Response to Notice to File Corrected Application Papers

In response to the Notice to File Corrected Application Papers mailed 10 June 2011, Applicant submits the attached replacement sheets for Figures 15 and 16 of the drawings. The attached replacement drawings contain no new matter.

The Commissioner may charge any fee due and credit any overpayment for this Application to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,

BAKER BOTTS L.L.P.
Attorneys for Applicant

Travis W. Thomas
Reg. No.: 48,667

Date: 16 June 2011

Customer Number: 12323

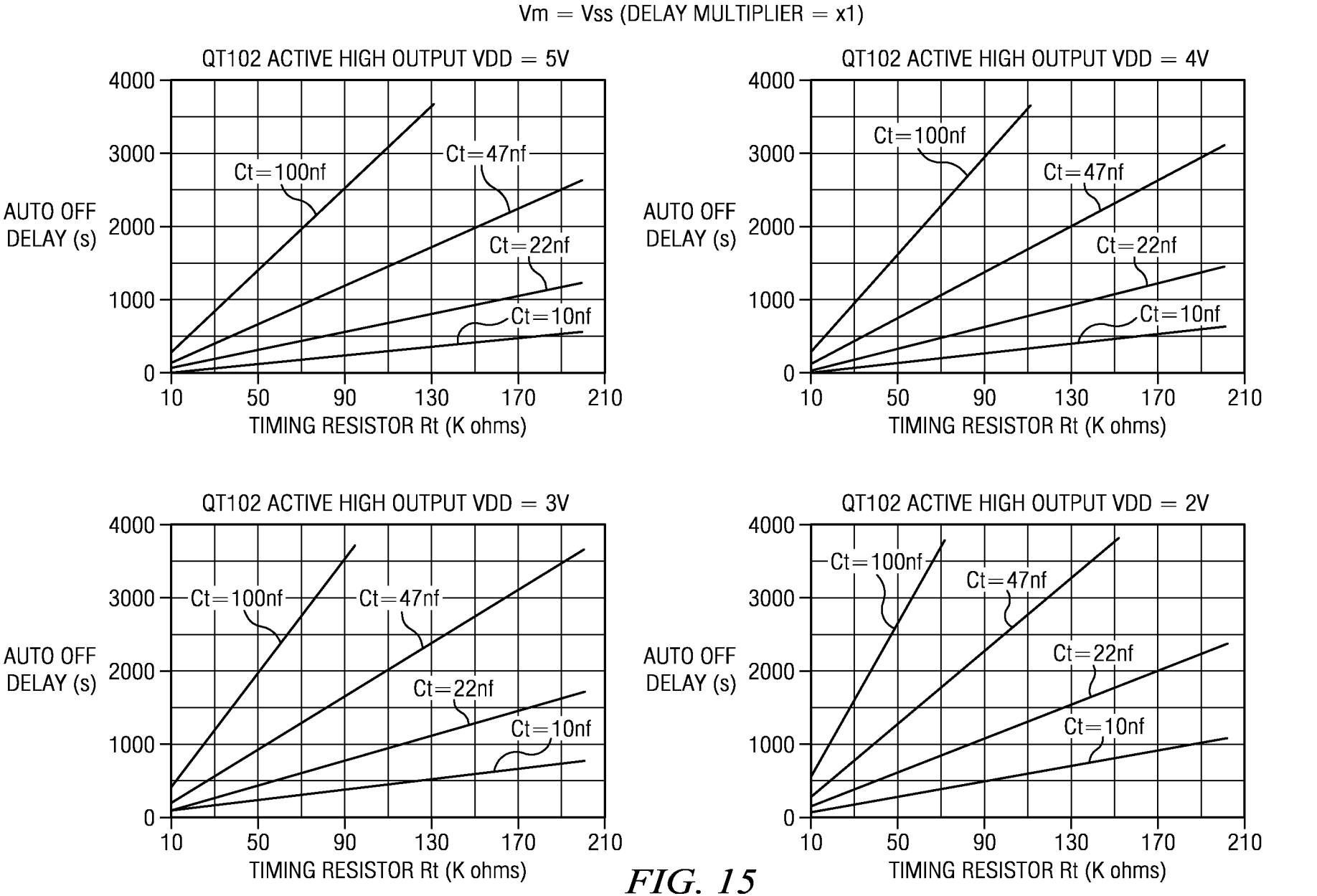

FIG. 15

Vm = Vss (DELAY MULTIPLIER = x1)

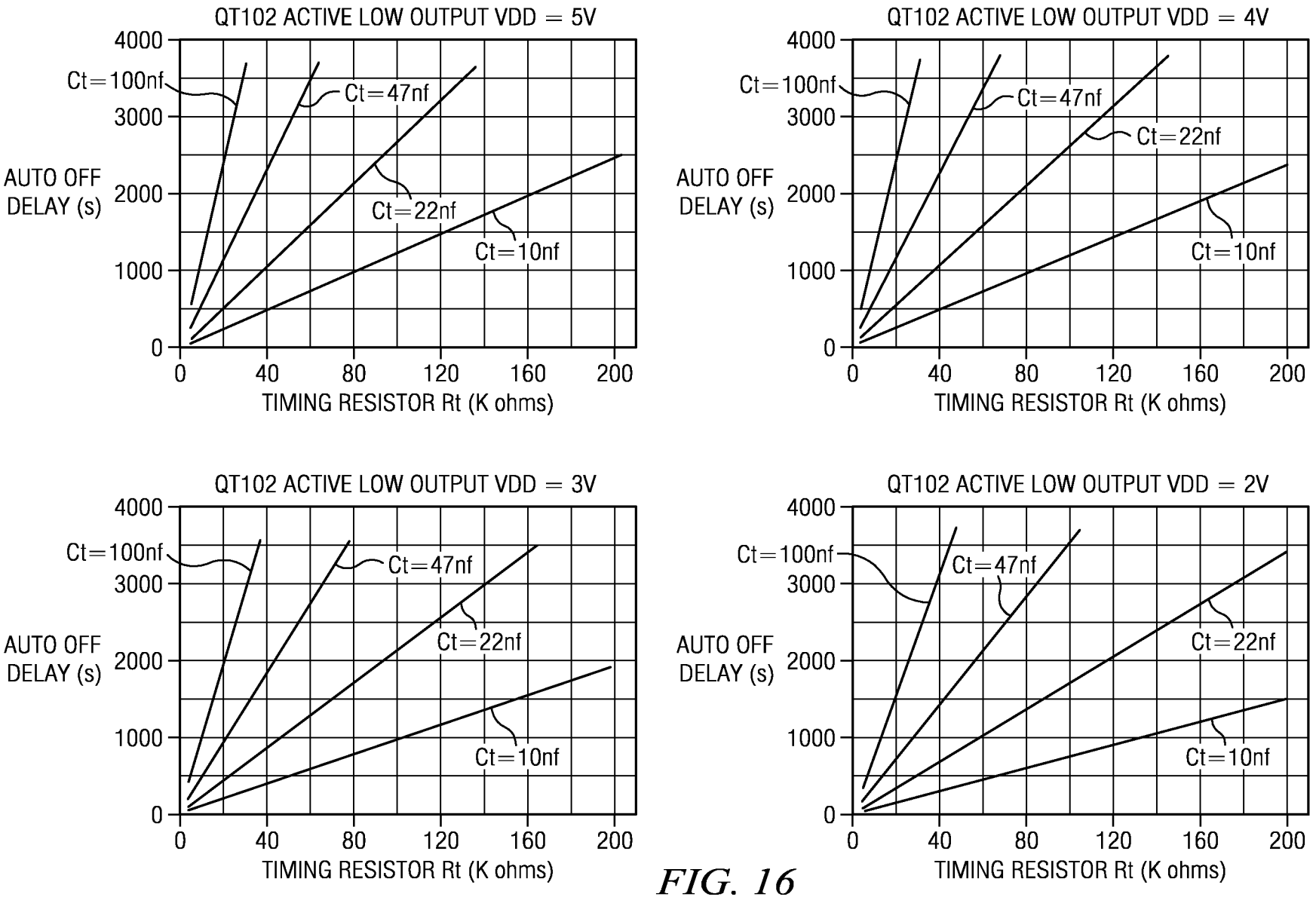

FIG. 16

Electronic Acknowledgement Receipt

EFS ID:	10324451
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Travis W. Thomas/Paula Hurley
Filer Authorized By:	Travis W. Thomas
Attorney Docket Number:	080900.1059
Receipt Date:	16-JUN-2011
Filing Date:	26-MAY-2011
Time Stamp:	18:15:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	Response_080900_1059.pdf	89424 427c518ad9b14c56520d5f1f3e72c01c52553dcc	no	1

Warnings:	
Information:	

2	Drawings-only black and white line drawings	Replacement_Figures_080900_1059.pdf	262262 9a2340a1e1e109786e3646886dface80fb9b4753	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	351686

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/116,764	05/26/2011	3742	1090	080900.1059P031213QRG-COA	20	3

CONFIRMATION NO. 6159

12323
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

UPDATED FILING RECEIPT

OC00000048387309

Date Mailed: 06/28/2011

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Harald Philipp, Zug, SWITZERLAND;
Kevin Snoad, Chicester, UNITED KINGDOM;

Assignment For Published Patent Application

ATMEL CORPORATION, San Jose, CA

Power of Attorney: The patent practitioners associated with Customer Number 12323

Domestic Priority data as claimed by applicant

This application is a CON of 12/179,769 07/25/2008 PAT 7,952,366
which claims benefit of 60/952,053 07/26/2007

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 06/07/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/116,764**

Projected Publication Date: 10/06/2011

Non-Publication Request: No

Early Publication Request: No

Title

Proximity Sensor

Preliminary Class

219

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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LICENSE FOR FOREIGN FILING UNDER

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/116,764

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 52 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 220 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1090

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/116,764	05/26/2011	Harald Philipp	080900.1059

CONFIRMATION NO. 6159

12323
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

PUBLICATION NOTICE

OC000000050234185

Title: Proximity Sensor

Publication No.US-2011-0242051-A1
Publication Date:10/06/2011

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** 13/116764		**First Named Inventor:** Harald Philipp
	Attorney Docket No: 080900.1059	**Art Unit:** Unassigned	**Filing Date:** 26 May 2011

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**FIRST NAMED INVENTOR**
	A	7,663,607	02-16-2010	Hotelling
	B	7,920,129	04-05-2011	Hotelling
	C	8,031,094	10-04-2011	Hotelling
	D	8,031,174	10-04-2011	Hamblin
	E	8,049,732	11-01-2011	Hotelling

UNPUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**FILING DATE**	**FIRST NAMED INVENTOR**
	F			
	G			
	H			
	I			

FOREIGN PATENT DOCUMENTS					
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**COUNTRY**	**TRANSLATION (YES OR NO)**
	J				
	K				

NON-PATENT LITERATURE (NPL)			
		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	**DATE**
	L		
	M		
	N		
	O		
	P		
	Q		
	R		

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

Electronic Acknowledgement Receipt

EFS ID:	11617288
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Jeffery D Baxter/Darla Rupert
Filer Authorized By:	Jeffery D Baxter
Attorney Docket Number:	080900.1059
Receipt Date:	14-DEC-2011
Filing Date:	26-MAY-2011
Time Stamp:	15:18:06
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1059ids.pdf	94600 cd0f6d0ad87d2c386c5cfe0374ec4b327be3442c	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Information Disclosure Statement (IDS) Form (SB08)	2	2
Warnings:			
Information:			
	Total Files Size (in bytes):	94600	

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Harald Philipp
Application No.:	13/116764
Filing Date:	26 May 2011
Confirmation No.:	6159
Group Art Unit:	Unknown
Title:	*Proximity Sensor*

Information Disclosure Statement

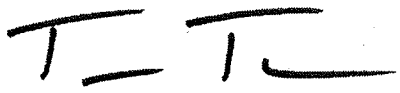
Applicant submits this Information Disclosure Statement (IDS) under 37 C.F.R. § 1.97(b)(3). Applicant respectfully requests the Examiner to consider and cite in the examination of this Application the documents listed in the attached Form PTO/SB/08. Under 37 C.F.R. § 1.98(a)(2)(ii), Applicant has not provided copies of U.S. patents or U.S. patent application publications.

Under 37 C.F.R. § 1.97(g), the filing of this IDS shall not be construed as a representation that a search has been made. Moreover, under 37 C.F.R. § 1.97(h), the filing of this IDS shall not be construed to be an admission that the information cited in this IDS is or is considered to be material to patentability as defined by 37 C.F.R. §1.56(b). Furthermore, the filing of this IDS shall not be construed to be an admission that any information cited in this IDS is or is considered to be prior art under 35 U.S.C. §§ 102-103.

The Commissioner may charge any fee due and credit any overpayment in this Patent Application to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,

BAKER BOTTS L.L.P.
Attorneys for Applicant



Travis W. Thomas
Reg. No. 48,667

Date: 14 December 2011

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** 13/116764		**First Named Inventor:** Harald Philipp
	Attorney Docket No: 080900.1059	**Art Unit:** 2858	**Filing Date:** 26 May 2011

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**FIRST NAMED INVENTOR**
	A	7,875,814	01-25-2011	Chen
	B	8,040,326	10-18-2011	Hotelling
	C	8,179,381	05-15-2012	Frey
	D	2009/0315854	12-24-2009	Matsuo

UNPUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**FILING DATE**	**FIRST NAMED INVENTOR**
	E			
	F			
	G			
	H			

FOREIGN PATENT DOCUMENTS					
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**COUNTRY**	**TRANSLATION (YES OR NO)**
	I				
	J				

NON-PATENT LITERATURE (NPL)			
		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	**DATE**
	K		
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U.S. PATENT AND TRADEMARK OFFICE

Electronic Acknowledgement Receipt

EFS ID:	13529791
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Travis W. Thomas/Paula Hurley
Filer Authorized By:	Travis W. Thomas
Attorney Docket Number:	080900.1059
Receipt Date:	18-AUG-2012
Filing Date:	26-MAY-2011
Time Stamp:	16:58:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS_080900_1059.pdf	94040 9061d9e40116169234 0c311b5d2b298813448d20	no	1

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	SB08_080900_1059.pdf	74158 676795ead41b53ccdb5ec410c8a559b44908a838	no	1

Warnings:	
Information:	
This is not an USPTO supplied IDS fillable form	
Total Files Size (in bytes):	168198

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New Applications Under 35 U.S.C. 111
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New International Application Filed with the USPTO as a Receiving Office
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Harald Philipp
Application No.:	13/116764
Filing Date:	26 May 2011
Confirmation No.:	6159
Group Art Unit:	2858
Title:	*Proximity Sensor*

Information Disclosure Statement

Applicant submits this Information Disclosure Statement (IDS) under 37 C.F.R. § 1.97(b)(3). Applicant respectfully requests the Examiner to consider and cite in the examination of this Application the documents listed in the attached Form PTO/SB/08. Under 37 C.F.R. § 1.98(a)(2)(ii), Applicant has not provided copies of U.S. patents or U.S. patent application publications.

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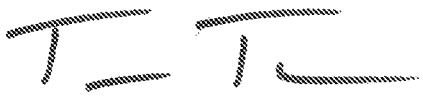
The Commissioner may charge any fee due and credit any overpayment in this Patent Application to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,

BAKER BOTTS L.L.P.
Attorneys for Applicant



Travis W. Thomas
Reg. No. 48,667

Date: 18 August 2012

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** 13/116764		**First Named Inventor:** Harald Philipp
	Attorney Docket No: 080900.1059	**Art Unit:** 2858	**Filing Date:** 05-26-2011

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**FIRST NAMED INVENTOR**
	A	2012/0242588	27 September 2012	Myers
	B	2012/0242592	27 September 2012	Rothkopf
	C	2012/0243151	27 September 2012	Lynch
	D	2012/0243719	27 September 2012	Franklin
UNPUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**FILING DATE**	**FIRST NAMED INVENTOR**
	E	61/454936	21 March 2011	Myers
	F	61/454950	21 March 2011	Lynch
	G	61/454894	21 March 2011	Rothkopf

FOREIGN PATENT DOCUMENTS					
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**COUNTRY**	**TRANSLATION (YES OR NO)**
	H	WO 2012/129247	27 September 2012	PCT	
	I				

NON-PATENT LITERATURE (NPL)			
		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	**DATE**
	J		
	K		
	L		
	M		
	N		
	O		
	P		

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 September 2012 (27.09.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/129247 A2

(51) International Patent Classification:
H04M 1/02 (2006.01) *G06F 1/16* (2006.01)

(21) International Application Number:
PCT/US2012/029844

(22) International Filing Date:
20 March 2012 (20.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

61/454,950	21 March 2011 (21.03.2011)	US
61/454,894	21 March 2011 (21.03.2011)	US
61/454,936	21 March 2011 (21.03.2011)	US
13/108,256	16 May 2011 (16.05.2011)	US
13/171,295	28 June 2011 (28.06.2011)	US
13/184,303	15 July 2011 (15.07.2011)	US
13/422,724	16 March 2012 (16.03.2012)	US

(71) Applicant *(for all designated States except US)*: **APPLE INC.** [US/US]; 1 Infinite Loop, M/S 36-2PAT, Cupertino, CA 95014 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ROTHKOPF, Fletcher, R.** [US/US]; 5 Infinite Loop, M/S 305-1PH, Cupertino, CA 95014 (US). **MYERS, Scott, A.** [US/US]; 5 Infinite Loop, MS 305-1PH, Cupertino, CA 95014 (US). **LYNCH, Stephen, Brian** [US/US]; 1 Infinite Loop, M/S 305-1DR, Cupertino, CA 95014 (US). **RAPPOPORT, Benjamin, M.** [US/US]; 1 Infinite Loop, M/S 305-2PD, Cupertino, CA 95014 (US). **FRANKLIN, Jermey, C.** [US/US]; 1 Infinite Loop, M/S 305-2PD, Cupertino, CA 95014 (US).

(74) Agent: **TREYZ, G., Victor**; TREYZ LAW GROUP, 870 Market Street, Suite 984, San Francisco, CA 94102 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,

[Continued on next page]

(54) Title: ELECTRONIC DEVICES WITH FLEXIBLE DISPLAYS

(57) Abstract: Electronic devices may be provided that contain flexible displays and internal components. An internal component may be positioned under the flexible display. The internal component may be an output device such as a speaker that transmits sound through the flexible display or an actuator that deforms the display in a way that is sensed by a user. The internal component may also be a microphone or pressure sensor that receives sound or pressure information through the flexible display. Structural components may be used to permanently or temporarily deform the flexible display to provide tactile feedback to a user of the device. Electronic devices may be provided with concave displays or convex displays formed from one or more flexible layers including a flexible display layer. Portions of the flexible display may be used as speaker membranes for display-based speaker structures.

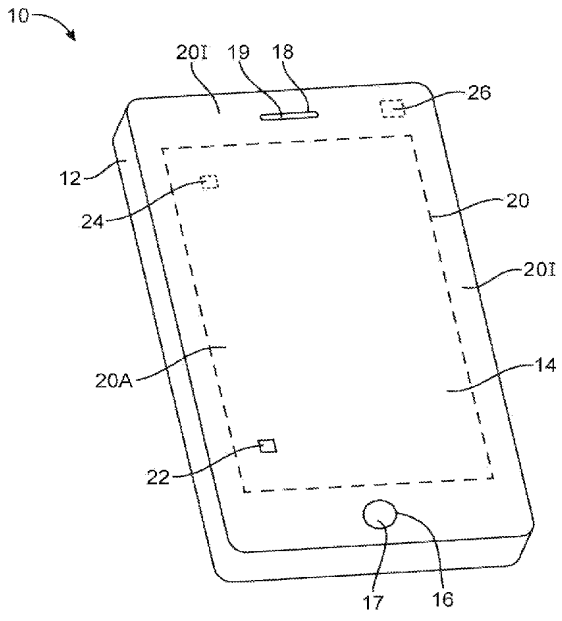


FIG. 1

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Electronic Devices With Flexible Displays

This application claims priority to United States patent application No. 13/171,295, filed June 28, 2011, United States patent application No. 13/108,256, filed May 16, 2011, United States patent application No. 13/184,303, filed July 15, 2011, United States patent application No. 13/422,724, filed March 16, 2012, provisional patent application No. 61/454,894, filed March 21, 2011, provisional patent application No. 61/454,936, filed, March 21, 2011, and provisional patent application No. 61/454,950, filed March 21, 2011 which are hereby incorporated by reference herein in their entirety.

Background

This relates generally to flexible displays, and more particularly, to electronic devices with flexible displays.

Electronic devices such as portable computers and cellular telephones are often provided with rigid displays made from rigid display structures. For example, a liquid crystal display (LCD) may be formed from a stack of rigid display structures such as a thin-film transistor layer with display pixels for providing visual feedback to a user, a color filter layer for providing the display

pixels with color, a touch screen panel for gathering touch input from a user, and a cover glass layer for protecting the display and internal components.

Conventional devices may also have input-output components such as buttons, microphones, speakers, and other components. Openings are commonly formed in the housing of a conventional device to accommodate operation of these input-output components. For example, openings may be formed in a device housing to accommodate speaker and microphone ports and openings may be formed in a display cover glass layer to accommodate a speaker port and menu button.

The inclusion of these openings to accommodate input-output components may not be desirable. For example, the presence of openings may be aesthetically unappealing, may raise the risk of damage from environmental exposure, and may reduce the amount of active display area that is available to display images for a user.

There is often very little real estate available for mounting these input-output components. For example, input-output components are often mounted under an inactive portion of a display or within the sidewalls of an electronic device housing.

The size and number of input-output components such as speakers may be limited by the amount of space available in these locations. For example, a conventional device may have a single speaker mounted under an inactive portion of a display. The size and quality of such a speaker may be limited by a lack of space in the inactive portion of the display. Additionally, mounting a speaker in the inactive portion of a display may add undesirable width to the inactive portion of the display.

Devices with planar cover glass layers may be prone

to scratches and damage when dropped on a surface. Users can minimize scratches and damage from drop events using a protective case. Protective cases may not, however, be convenient or aesthetically appealing for many users.

It is often desirable to produce portable devices of minimal size. Users of portable electronic devices may find a thinner device more desirable than a thicker device. Compact portable devices are sometimes provided with convex housing shapes. A convex housing shape may increase the internal volume of a device while preserving a sleek, thin look that is aesthetically pleasing to a user.

A portable compact device with a convex housing may have a display. In conventional arrangements, the display is flat, so only the portions of the device other than the display have a convex shape. This may limit the internal volume of the device and may detract from its appearance.

It would therefore be desirable to be able to provide improved electronic devices.

Summary

Electronic devices may be provided with flexible displays. The flexible displays may be composed of one or more flexible layers and may be mounted on top of or under a cover layer. For example, a flexible display may be mounted on top of a rigid support member or may be mounted on the underside of a rigid cover layer.

Electronic devices may also be provided with user interface components (input-output components) such as buttons, microphones, speakers, piezoelectric actuators (for receiving electrical input from a user or tactile feedback to users), or other actuators such as vibrators, pressure sensors, and other components. These components

may be mounted under portions of a flexible display.

During operation of the electronic device, the flexibility of the display may allow a user to interact with the component through the display. For example, sound waves from a speaker or localized vibrations from an actuator in an electronic device may pass through the flexible display. The flexible display may also allow an internal microphone, pressure sensor, or force sensor (or other internal components) to receive external input. For example, a user may deflect a flexible display using a finger or other external object, barometric pressure may be monitored through the flexible display, or sound waves may be received through the flexible display.

Components may receive input or may supply output through a physically deformed portion of the flexible display (e.g., a deformation that occurs when a user presses on the display to compress the component). In some configurations, a portion of the flexible display may serve as a membrane that forms part of a microphone, speaker, pressure sensor, or other electronic component.

The ability of a user to compress a component such as a button switch by deforming the flexible display may allow the area of a device available for visual display to be enlarged. For example, the active area of a flexible display may overlap a component such as a button or speaker.

If desired, a flexible display may be deformed by an internal component to provide audio or tactile feedback to a user. For example, structures inside an electronic device may be pressed against portions of a flexible display to temporarily create an outline for a virtual on-screen button or to temporarily create a grid of ridges that serve to delineate the locations of keys in a keyboard (keypad).

Electronic devices may be provided with concave displays. Peripheral edge portions of a concave display may be raised relative to depressed central portions of the concave display. This helps reduce scratches and other damage due to contact with the central portion of the display.

Concave displays may include one or more flexible display layers and may be mounted on top of or under a cover layer. For example, a flexible display layer may be mounted on top of a rigid support member or may be mounted on the underside of a rigid cover layer

Concave displays may also include touch-sensitive capabilities by stacking a touch sensor array layer on top of or under flexible display layers. Rigid concave displays may be formed from a flexible display layer, a touch-sensitive layer, and a rigid cover layer or rigid support structure.

Devices having concave displays formed from curved flexible display layers may help maximize the use of the internal volume of an electronic device.

Electronic devices may be provided with convex displays. The convex displays may include one or more flexible display layers and may be mounted on top of or under a cover layer with a curved shape. For example, a flexible display layer may be mounted on top of a rigid support member having a convex surface or may be mounted on the concave underside of a rigid convex display cover layer.

Convex displays may be provided with touch-sensitive capabilities by stacking a touch sensor array on top of or under flexible display layers. Rigid convex displays may be formed from a flexible display layer, a touch-sensitive layer, and a rigid cover layer or support structure.

Devices having convex displays formed from curved flexible display layers may help maximize the use of the internal volume of an electronic device.

A display cover such as a cover glass layer may be mounted over a flexible display. The flexible display may be an organic light-emitting diode display having a flexible substrate formed from one or more sheets of polymer. The flexible display may include a touch sensor layer having an array of capacitive touch sensor electrodes.

There may be one or more display-based speaker structures in the electronic device. The display-based speaker structures may be mounted under the flexible display. Portions of the flexible display may be used as speaker membranes for the display-based speaker structures.

The flexible display may have an active area that is configured to display images to a user. Speaker membranes may be formed from the active portion of the flexible display. The display-based speaker structures may be driven by transducers that receive an electrical audio signal input from circuitry in the electronic device. Piezoelectric transducers or transducers formed from coils and magnets may be used to drive the display-based speaker structures.

A stiffening structure may be used to stiffen a portion of a flexible display that is used as a speaker membrane. The stiffening structure may be formed from a layer of foam interposed between sheets of stiffening material. The stiffening structure may form a stiff and lightweight support structure that allows the speaker membrane to respond accurately to the transducer.

A suspension structure may be used to attach a display-based speaker structure to surrounding housing

structures. The suspension structure may form a pliant interface between the speaker structure and the surrounding housing structures. The suspension structure may allow the speaker structure to vibrate during speaker operation while inhibiting lateral motion of the speaker structure.

Speaker structures may be configured to achieve a desired frequency response. The electronic device housing in which a speaker structure is mounted may be provided with an acoustic port to tune speaker frequency response. The type of transducer that is used in a speaker may be selected to tune speaker frequency response. The size and placement of internal device components that affect speaker volume and speaker mass may also be selected to tune speaker frequency response.

An electronic device may be provided with an array of display-based speaker structures. The speaker membrane for each speaker structure may be stiffened with an associated stiffening structure. Each stiffened speaker membrane may be surrounded by a ring of flexible display that is configured to absorb lateral vibrations and thus prevent interference between neighboring speakers.

Further features of the invention, its nature and various advantages will be more apparent from the accompanying drawings and the following detailed description of the preferred embodiments.

Brief Description of the Drawings

FIG. 1 is a perspective view of an illustrative electronic device with a flexible display and internal components in accordance with an embodiment of the present invention.

FIG. 2 is a diagram of an illustrative set of

display layers that may be used to form a flexible display in accordance with an embodiment of the present invention.

FIG. 3 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of an internal user interface component in accordance with an embodiment of the present invention.

FIG. 4 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of a button in accordance with an embodiment of the present invention.

FIG. 5 is a cross-sectional side view of another embodiment of a portion of an illustrative electronic device in the vicinity of a button in accordance with an embodiment of the present invention.

FIG. 6 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of an audio component in accordance with an embodiment of the present invention.

FIG. 7 is a cross-sectional side view of another embodiment of a portion of an illustrative electronic device in the vicinity of an audio component in accordance with an embodiment of the present invention.

FIG. 8 is a cross-sectional side view of yet another embodiment of a portion of an illustrative electronic device in the vicinity of an audio component in accordance with an embodiment of the present invention.

FIG. 9 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of an actuator such as a piezoelectric actuator in accordance with an embodiment of the present invention.

FIG. 10 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of an internal structural component in accordance with an embodiment of the present invention.

FIG. 11 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of a combined internal interface component in accordance with an embodiment of the present invention.

FIG. 12 is a perspective view of a portion of an illustrative electronic device with a flexible display and a combined internal interface component in accordance with an embodiment of the present invention.

FIG. 13 is a perspective view of a portion of an illustrative electronic device with a flexible display and a combined internal interface component mounted to actuator stage in accordance with an embodiment of the present invention.

FIG. 14 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of an internal structural component mounted to an actuator stage in accordance with an embodiment of the present invention.

FIG. 15 is a cross-sectional side view of a portion of an illustrative electronic device with a cover and an internal structural component mounted to an actuator in accordance with an embodiment of the present invention.

FIG. 16 is a cross-sectional side view of a portion of an illustrative electronic device in the vicinity of a pressure sensor in accordance with an embodiment of the present invention.

FIG. 17 is a perspective view of an illustrative electronic device with a concave display and a bezel in accordance with an embodiment of the present invention.

FIG. 18 is a cross-sectional side view of an illustrative electronic device having a concave display with a flexible display layer that conforms to the concave shape of a support structure in accordance with an

embodiment of the present invention.

FIG. 19 is a cross-sectional side view of a portion of an illustrative electronic device having a cover layer and a flexible display layer joined by an adhesive layer in accordance with an embodiment of the present invention.

FIG. 20 is a cross-sectional side view of a portion of an illustrative electronic device having a flexible display layer, a flexible touch-sensitive layer, and a cover layer joined by adhesive layers in accordance with an embodiment of the present invention.

FIG. 21 is a cross-sectional side view of an illustrative electronic device having a concave display with a radius of curvature chosen to protect the device from a drop surface in accordance with an embodiment of the present invention.

FIG. 22 is a perspective view of an illustrative electronic device with a convex display and a bezel formed from a housing structure in accordance with an embodiment of the present invention.

FIG. 23 is a cross-sectional side view of an illustrative electronic device with a convex display and internal components in accordance with an embodiment of the present invention.

FIG. 24 is a cross-sectional side view of a portion of an illustrative electronic device having a convex display with a flexible display layer that conforms to a support structure in accordance with an embodiment of the present invention.

FIG. 25 is a cross-sectional side view of a portion of an illustrative electronic device having a convex cover layer and a flexible display layer joined by an adhesive layer in accordance with an embodiment of the present invention.

FIG. 26 is a cross-sectional side view of a portion of an illustrative electronic device having a flexible display layer, a touch-sensitive layer and a convex cover layer joined by adhesive layers in accordance with an embodiment of the present invention.

FIG. 27 is a cross-sectional perspective view of an illustrative electronic device having a convex display and a connector port arranged to use the internal volume of the device in accordance with an embodiment of the present invention.

FIG. 28 is a cross-sectional perspective view of an illustrative electronic device having a convex display and internal components in accordance with an embodiment of the present invention.

FIG. 29 is a cross-sectional side view of an illustrative electronic device substantially surrounded by a convex display in accordance with an embodiment of the present invention.

FIG. 30 is a diagram of an illustrative electronic device such as a portable computer having a display and one or more speaker structures in accordance with an embodiment of the present invention.

FIG. 31 is a diagram of an illustrative electronic device such as a cellular telephone or other handheld device having a display and one or more speaker structures in accordance with an embodiment of the present invention.

FIG. 32 is a diagram of an illustrative electronic device such as a tablet computer having a display and one or more speaker structures in accordance with an embodiment of the present invention.

FIG. 33 is a diagram of an illustrative electronic device such as a computer monitor with a built-in computer having a display and one or more speaker

structures in accordance with an embodiment of the present invention.

FIG. 34 is a diagram of an illustrative set of display layers that may be used to form a flexible display in accordance with an embodiment of the present invention.

FIG. 35 is a diagram of an illustrative set of layers that may be used to form an organic light-emitting diode display in accordance with an embodiment of the present invention.

FIG. 36 is a cross-sectional side view of a portion of an illustrative electronic device in which a flexible display forms part of a speaker structure in accordance with an embodiment of the present invention.

FIG. 37 is a cross-sectional side view of a portion of an illustrative electronic device in which a flexible display forms part of a speaker structure in accordance with an embodiment of the present invention.

FIG. 38 is a cross-sectional side view of a portion of an illustrative electronic device in which a flexible display forms part of a speaker structure in accordance with an embodiment of the present invention.

FIG. 39 is a perspective view of an illustrative electronic device of the type shown in FIG. 38 having a cover layer with speaker openings in accordance with an embodiment of the present invention.

FIG. 40 is a cross-sectional side view of a portion of an illustrative electronic device in which a flexible display is stiffened with a support structure in accordance with an embodiment of the present invention.

FIG. 41 is a cross-sectional side view of a portion of an illustrative electronic device having a curved flexible display with a curved support structure in accordance with an embodiment of the present invention.

FIG. 42 is a cross-sectional side view of a

portion of an illustrative electronic device in which a flexible display forms part of a single speaker structure in accordance with an embodiment of the present invention.

FIG. 43 is a cross-sectional side view of a portion of an illustrative electronic device in which a flexible display forms part of an array of speaker structures in accordance with an embodiment of the present invention.

FIG. 44 is a bottom view of an illustrative electronic device of the type shown in FIG. 43 having a flexible display that forms part of an array of speaker structures in accordance with an embodiment of the present invention.

Detailed Description

Electronic devices may be provided with flexible displays. A flexible display may include one or more flexible layers. If desired, the flexible display may include a display cover layer such as a flexible or rigid display cover layer.

In some configurations, an electronic device may be provided with a flexible display and user interface components that are positioned behind, abutted against or integrated into the flexible display. FIGS. 1-16 show examples of configurations in which user interface components may be positioned behind, abutted against or integrated into the flexible display.

In some configurations, an electronic device may be provided with a concave display having one or more flexible display layers. FIGS. 1, 2, and 17-21 show examples of configurations in which an electronic device may be provided with a concave display having one or more flexible display layers.

In some configurations, an electronic device may

be provided with a convex display having one or more flexible display layers. FIGS. 1, 2, and 22-29 show examples of configurations in which an electronic device may be provided with a convex display having one or more flexible display layers.

In some configurations, a portion of the flexible display may form a membrane structure of an electronic component such as a speaker, a microphone, a laser microphone or a pressure sensor. FIGS. 30-44 show examples of configurations in which a portion of the flexible display may form a membrane structure of an electronic component.

As shown in the examples of FIGS. 1-16, an electronic device may be provided with a flexible display and user interface components. User interface components may include buttons, switches, microphones, actuators such as solenoids, motors, and piezoelectric actuators, connector ports, touch screens, proximity sensors and other components for accepting input from, or transmitting information to, a user or the surrounding environment.

Flexible displays may be formed from flexible layers such as a flexible display layer (e.g., a flexible organic light-emitting diode array), a flexible touch-sensitive layer (e.g., a sheet of polymer with an array of transparent capacitor electrodes for a capacitive touch sensor), a flexible substrate layer, etc. These flexible layers may, if desired, be covered by a flexible or rigid cover layer (sometimes referred to as a cover glass) or may be supported by a support structure (e.g., a rigid support structure on the underside of the flexible layers). In electronic devices with flexible displays that are covered by rigid cover layers, the cover layers may be provided with openings that provide access to the flexible layers of the display in the vicinity of a user

interface device. For example, a cover glass layer may have an opening that allows a button member to move relative to the cover glass layer. As the button member moves within the opening, underlying portions of the flexible display may be deformed (e.g., to allow actuation of an associated switch).

To maximize the area of the portion of the flexible display that is available for displaying visual information to the user, user interface components may be positioned behind, abutted against or integrated into the flexible display. The deformable nature of the flexible display may allow a user to interact with the user interface components (input-output components) by moving the display into contact with the user interface components or by otherwise allowing the display to locally flex (e.g., to allow sound to pass through the flexible display or to allow a barometric pressure measurements of the exterior environment to be made by an internal pressure sensor). If desired, a portion of the flexible display may form a membrane portion of an electrical component. Components that may be provided with a membrane that is formed from a portion of a flexible display include microphones, laser microphones, pressure sensors, speakers, etc.

An illustrative electronic device of the type that may be provided with a flexible display is shown in FIG. 1.

Electronic device 10 may be a portable electronic device or other suitable electronic device. For example, electronic device 10 may be a laptop computer, a tablet computer, a somewhat smaller device such as a wrist-watch device, pendant device, or other wearable or miniature device, a cellular telephone, a media player, etc.

Device 10 may include a housing such as housing

12. Housing 12, which may sometimes be referred to as a case, may be formed of plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, etc.), other suitable materials, or a combination of these materials. In some situations, parts of housing 12 may be formed from dielectric or other low-conductivity material. In other situations, housing 12 or at least some of the structures that make up housing 12 may be formed from metal elements.

Device 10 may have a flexible display such as flexible display 14. Flexible display 14 may be formed from multiple layers of material. These layers may include a touch sensor layer such as a layer on which a pattern of indium tin oxide (ITO) electrodes or other suitable transparent electrodes have been deposited to form a capacitive touch sensor array. These layers may also include a layer that contains an array of display pixels. The touch sensor layer and the display layer may be formed using flexible sheets of polymer or other substrates having thicknesses of 10 microns to 0.5 mm or other suitable thicknesses (as an example).

The display pixel array may be, for example, an organic light-emitting diode (OLED) array. Other types of flexible display pixel arrays may also be formed (e.g., electronic ink displays, etc.). The use of OLED technology to form flexible display 14 is sometimes described herein as an example. This is, however, merely illustrative. Flexible display 14 may be formed using any suitable flexible display technology. The use of flexible displays that are based on OLED technology is merely illustrative.

In addition to these functional display layers (i.e., the OLED array and the optional touch sensor array), display 14 may include one or more structural

layers. For example, display 14 may be covered with a flexible or rigid cover layer and/or may be mounted on a support structure (e.g., a rigid support). Layers of adhesive may be used in attaching flexible display layers to each other and may be used in mounting flexible display layers to rigid and flexible structural layers.

In configurations for display 14 in which the cover layer for display 14 is flexible, input-output components that rely on the presence of flexible layers may be mounted at any suitable location under the display (e.g., along peripheral portions of the display, in a central portion of the display, etc.). In configurations for display 14 in which the flexible layers are covered by a rigid cover glass layer or other rigid cover layer, the rigid layer may be provided with one or more openings and the electronic components may be mounted under the openings. For example, a rigid cover layer may have openings such as a circular opening 16 for button 17 and a speaker port opening such as speaker port opening 18 (e.g., for an ear speaker for a user). Device 10 may also have other openings (e.g., openings in display 14 and/or housing 12 for accommodating volume buttons, ringer buttons, sleep buttons, and other buttons, openings for an audio jack, data port connectors, removable media slots, etc.).

In some embodiments, portions of flexible display 14 such as peripheral regions 20I may be inactive and portions of display 14 such as rectangular central portion 20A (bounded by dashed line 20) may correspond to the active part of display 14. In active display region 20A, an array of image pixels may be used to present text and images to a user of device 10. In active region 20A, display 14 may include touch sensitive components for input and interaction with a user of device 10. If

desired, regions such as regions 20I and 20A in FIG. 1 may both be provided with display pixels (i.e., all or substantially all of the entire front planar surface of a device such as device 10 may be covered with display pixels).

Device 10 may, if desired, have internal user interface components such as buttons 17 or speaker component 19 that occupy openings such as openings 16 and 18 respectively in an optional rigid cover layer of flexible display 14. Buttons 17 may be based on dome switches or other switch circuitry. Buttons 17 may include button members that form push buttons (e.g., momentary buttons), slider switches, rocker switches, etc. Device 10 may include internal structural components such as structural component 22 that add a raised structure to a portion of flexible display 14. Device 10 may include components such as interface components 24 and 26 that may be fully internal to device 10, but that receive input from the user or from the surrounding environment through physical interaction with flexible display 14. Interface components 22, 24, and 26 may be positioned in active region 20A or inactive region 20I of flexible display 14. Interface components 22, 24, and 26 may be positioned separately from one another or may be commonly located to form a combined component with structural and internal features. Interface components 24 and 26 may be positioned underneath flexible display 14 so that flexible display 14 must be deformed in order to contact components 24 or 26 or, if desired may be positioned to remain in constant contact with flexible display 14.

An exploded perspective view of an illustrative display is shown in FIG. 2. As shown in FIG. 2, flexible display 14 may be formed by stacking multiple layers including flexible display layer 14A, touch-sensitive

layer 14B, and cover layer 14C. Flexible display 14 may also include other layers of material such as adhesive layers, optical films, or other suitable layers. Flexible display layer 14 may include image pixels formed form light-emitting diodes (LEDs), organic LEDs (OLEDs), plasma cells, electronic ink elements, liquid crystal display (LCD) components, or other suitable image pixel structures compatible with flexible displays.

Touch-sensitive layer 14B may incorporate capacitive touch electrodes such as horizontal transparent electrodes 32 and vertical transparent electrodes 34. Touch-sensitive layer 14B may, in general, be configured to detect the location of one or more touches or near touches on touch-sensitive layer 14B based on capacitive, resistive, optical, acoustic, inductive, or mechanical measurements, or any phenomena that can be measured with respect to the occurrences of the one or more touches or near touches in proximity to touch sensitive layer 14B.

Software and/or hardware may be used to process the measurements of the detected touches to identify and track one or more gestures. A gesture may correspond to stationary or non-stationary, single or multiple, touches or near touches on touch-sensitive layer 14B. A gesture may be performed by moving one or more fingers or other objects in a particular manner on touch-sensitive layer 14B such as tapping, pressing, rocking, scrubbing, twisting, changing orientation, pressing with varying pressure and the like at essentially the same time, contiguously, or consecutively. A gesture may be characterized by, but is not limited to a pinching, sliding, swiping, rotating, flexing, dragging, or tapping motion between or with any other finger or fingers. A single gesture may be performed with one or more hands, by one or more users, or any combination thereof.

Cover layer 14C may be formed from plastic or glass (sometimes referred to as display cover glass) and may be flexible or rigid. If desired, the interior surface of peripheral inactive portions 20I of cover layer 14C may be provided with an opaque masking layer on such as black ink.

Touch-sensitive flexible display section 14AB may be formed from display pixel array layer 14A and optional touch sensor layer 14B.

FIG. 3 is a cross-sectional side view of a portion of flexible display 14 in the vicinity of internal user interface component 24. Flexible display 14 may be deformed away from its natural shape under pressure. For example, flexible display 14 may be deflected by pressure exerted by a user or by other external forces in direction 40. As shown in FIG. 3, pressure in direction 40 may cause flexible display 40 to deform as indicated by dashed lines 44. Internal component 24 may be configured to receive input due to deformation of flexible display 14. Internal component 24 may also provide a temporary return (restoring) pressure in direction 42.

Pressure in direction 42 may cause flexible display 14 to temporarily deform outward of device 10 as indicated by dashed lines 46. Pressure in direction 42 may, if desired, be formed by an internal actuator that deforms display 14 to provide a desired tactile sensation on the surface of display 14 to a user of device 10. Flexible display 14 may have a natural resiliency that, following deformation as indicated by dashed lines 44, causes flexible display to temporarily deform outward of device 10 as indicated by dashed lines 46 before returning to its natural shape. Internal component 24 may be a button, an actuator such as a motor, solenoid, vibrator, or piezoelectric actuator, a pressure sensor, an audio

component such as a microphone or speaker, or other component. Because display 14 is flexible, these components may operate effectively, even when covered by display 14. For example, audio components such as microphones and speakers may receive and transmit sound through flexible display 14. A barometric pressure sensor or a force sensor may also receive input through flexible display 14. Components such as actuators may be used to temporarily create raised ridges or other external features on the surface of the flexible display (e.g., to indicate to a user where an on-screen button or group of buttons is located). The portion of display 14 under which components 24 are mounted may be active (i.e., a portion of the display that contains OLED pixels or other display pixels) or inactive (i.e., a peripheral portion of the display outside of the active region).

FIG. 4 is a cross-sectional side view of a portion of device 10 in the vicinity of button 17 of device 10. As shown in FIG. 4, button 17 may have a button member such as button member 52 that reciprocates within opening 16 of cover layer 14C. When a user presses the exterior of button member 52 in direction 58, button member 52 may press against touch-sensitive flexible display section (layer) 14AB. Touch-sensitive flexible display section 14AB may be deformed to depress a dome switch such as dome switch 56 or other switch mechanism, thereby activating the switch (e.g., shorting internal switch terminals together to close the switch). Dome switches such as dome switch 56 may, if desired, be mounted to printed circuits such as printed circuit 54. Dome switch 56 may have a dome-shaped biasing member that pushes touch-sensitive flexible display section 14AB outward in direction 60 when the user releases pressure from button member 52. Dome switch 54 and printed circuit

54 may be recessed in a support structure such as support structure 50 behind flexible display 14. Other types of switches may used if desired, such as switches with spring-based biasing members or other biasing structures that bias button members such as button member 52. The use of a dome switch with a dome-shaped biasing structure is merely illustrative.

FIG. 5 is a cross-sectional side view of a portion of device 10 in the vicinity of button 17 of device 10. The illustrative embodiment of FIG. 5 differs from the illustrative embodiment of FIG. 4 in that cover layer 14C of flexible display 14 is not a rigid cover layer, but a flexible cover layer. In an embodiment in which flexible display 14 contains a flexible cover layer 14C, button 17 includes dome switch 56 and printed circuit 54. In the embodiment of FIG. 5, a user may press the exterior of flexible display 14 in direction 58. Flexible display 14 may be deformed to depress dome switch 56 or other switch mechanism, thereby activating the switch. As in FIG. 4, dome switches such as dome switch 56 may, if desired, be mounted to printed circuits such as printed circuit 54. Dome switch 56 may have a dome-shaped biasing member that pushes flexible display 14 outward in direction 60 when the user releases pressure from button member 52. Dome switch 54 and printed circuit 54 may be mounted in support structures 50 behind flexible display 14. Other types of switches may use spring-based biasing members or other biasing structures to bias button members such as button member 52. The use of a dome switch with a dome-shaped biasing structure is merely illustrative.

Providing device 10 with flexible display 14 without the need for an opening in flexible display 14 to access button 17 allows flexible display 14 to extend over button 17 without disruption. In both the FIG. 4 and FIG.

5 configurations, the portion of the flexible display that overlaps the button may be an active display portion or an inactive display portion. When an active display portion is configured so as to overlap buttons and other components, there is generally more area available for the active display portion. The presence of flexible display 14 over button 17 (or other components) may also reduce the risk of moisture or dirt entering into the interior of device 10.

FIG. 6 is a cross-sectional side view of a portion of device 10 in the vicinity of audio component 19. Audio component 19 may be recessed in a chassis 50 behind flexible display 14. Audio component 19 may be a speaker for providing sound to a user of device 10 or a microphone for receiving input from a user or the external environment. In the embodiment shown in FIG. 6, sound may be transmitted through flexible display 14 to a microphone or from a speaker. The portion of flexible display 14 that overlaps audio component 19 may be active or inactive. Arrangements in which component 19 is covered with part of the active area of display 14 may allow the size of active region 20A of flexible display 14 to be increased. The presence of flexible display 14 over audio component 19 may also reduce the risk of moisture or dirt entering into the interior of device 10.

FIG. 7 is a cross-sectional side view of a portion of device 10 in the vicinity of another embodiment of audio component 19. In the illustrative embodiment of FIG. 7, audio component 19 may be a speaker or microphone that contains a diaphragm such as diaphragm 70. Diaphragm 70 may be formed from a separate structure that is attached to the underside of flexible display 14 or may be formed from a part of flexible display 14. As in the embodiment shown in FIG. 6, audio component 19 may be

mounted within support structures 50. Audio component 19 may include a magnet such as magnet 74 and a coil such as coil 72 in which current may flow. If audio component 19 is a speaker, current may be driven through coil 72 to induce motion in diaphragm 70 and thereby emit sound through flexible display 14. If audio component 19 is a microphone, sound waves originating from the exterior of device 10 may induce vibrations in flexible display 14 which are transmitted to diaphragm 70 and ultimately to coil 72 in which current may be induced. The current produced in coil 72 may be used to transmit sound information to device 10. Diaphragm 70 may be a separate member in contact with flexible display 14 or may be an integral part of flexible display 14.

FIG. 8 is a cross-sectional side view of a portion of device 10 in the vicinity of another possible embodiment of audio component 19. As shown in FIG. 8, audio component 19 may be a laser microphone which uses vibrations in flexible display 14 induced by sound originating external to device 10 to produce an signal to be transmitted to device 10. As shown in FIG. 8, audio component 19 may be recessed in support structures 50. Audio component 19 may include a light emitting component such as laser component 80. Laser component 80 may emit a laser beam such as laser beam 84 in the direction of flexible display 14. Laser beam 84 may reflect off of flexible display 14 and a reflected laser beam such as reflected laser beam 86 may be absorbed by a laser absorbing component 82.

Laser beam 84 and reflected laser beam 86 may be used in combination with laser 80 and photosensitive element 82 to monitor variations in distance 88 from flexible display 14 to component 80 and component 82. Sound waves originating external to device 10 may induce

vibrations in flexible display 14 causing distance 88 to oscillate. The oscillations in distance 88 may be converted into sound-related information by device 10.

FIG. 9 is a cross-sectional side view of a portion of device 10 in the vicinity of a component such as component 22 of FIG. 1. In the embodiment shown in FIG. 9, component 22 may contain an actuator such as a piezoelectric (actuator 90). Piezoelectric actuators such as piezoelectric actuator 90 may vary in shape (e.g., thickness) in response to applied control voltages and may produce an output voltage when compressed (i.e., the piezoelectric element in actuator 90 may serve as a force sensor in addition to serving as a controllable actuator). A user of device 10 may exert force on flexible display 14 in direction 92. Flexible display 14 may be deformed to exert a mechanical pressure on piezoelectric element 90 or other force sensor, inducing a voltage which may be transmitted to device 10. Conversely, piezoelectric actuator 90 may be used to provide tactile feedback to a user of device 10. A voltage difference applied to the surfaces of piezoelectric actuator 90 may induce an expansion of piezoelectric actuator 90. Piezoelectric actuator 90 may then deform flexible display 90 in direction 94 providing tactile feedback to a user of device 10.

FIG. 10 is a cross-sectional side view of a portion of device 10 in the vicinity of structural component 22 of device 10. Structural component 22 may cause a permanent deformation such as deformation 102 in flexible display 14 to indicate the location of portion 101 of touch-sensitive layer 14B in display 14 to the user of device 10. Portion 101 may be, for example, a letter key or other button in a virtual keypad (keyboard) displayed on flexible display 14. A touch sensor array

associated with display 14 may be used to gather user input (i.e., the touch sensor array may be used to determine when a user has pressed the virtual key associated with portion 101). The location of portion 101 may also be indicated visually using associated display pixels in flexible display 14. At times, a user may desire to be able to locate portion 101 without having to look at flexible display 14. Deforming flexible display 14 in the vicinity of portion 101 using structural component 22 may allow a user to locate portion 101 without visual aid. Structural component 22 may be an isolated component indicating the location of a single portion 101 of touch-sensitive layer 14B or may be one of an array of components 22 indicating the locations of an array of portions 101 (e.g., the array of letter, number, and symbol keys in a virtual keypad displayed on display 14). Structural component 10 may be a separate component mounted to support structures 50 or may be an integral part of support structures 50.

FIG. 11 is a cross-sectional side view of a portion of device 10 in the vicinity of a hybrid component such as component 100. Component 100 may include both an internal interface component such as internal component 24 and a structural component such as structural component 22. Structural component 22 may cause a permanent deformation such as deformation 102 in flexible display 14 in the vicinity of internal component 24 to indicate the location of internal component 22 to the user of device 10. The presence of flexible display 14 between the user of device 10 and internal component 24 may obscure the location of internal interface component 24. The location of interface component 24 may be indicated visually using display pixels in flexible display 14. The deformation of flexible display 14 in the vicinity of interface component

24 using structural component 22 may also allow the user to locate interface component 24 without visual aid. Component 100 may be an isolated component indicating the location of a single interface component 24 of touch-sensitive layer 14B or may be one of an array of components 100 indicating the locations of an array of interface components 24.

FIG. 12 is a perspective view of an embodiment of device 10 in which internal component 24 is a button such as button 17. In the embodiment of FIG. 12, as in FIG. 11, component 100 includes internal component 24 and structural component 22 (shown in FIG. 11). As shown in FIG. 12, a ridge or other deformation such as deformation 102 in flexible display 14 may be used to indicate the location of button 17.

FIG. 13 is a cross-sectional side view of a portion of device 10 in the vicinity of another illustrative embodiment of a hybrid component such as component 100 which includes an internal interface component such as internal component 24 and a structural component such as structural component 22 mounted to an actuator such as actuator stage 110. Component 100 may be recessed in chassis 50. Actuator stage 110 may be electrically or mechanically raised in direction 112 to temporarily produce deformations such as deformations 102 in flexible display 14. Deformations 102 in flexible display 14 may indicate the location of internal interface device 24 to a user of device 10. Actuator stage 110 may be electrically or mechanically lowered in direction 114 to remove deformations 102 in flexible display 14 returning flexible display 14 to its original shape. Component 100 may be an isolated component indicating the location of a single interface component 24 of touch-sensitive layer 14B or may be one of an array of

components 100 indicating the locations of an array of respective interface components 24.

FIG. 14 is a cross-sectional side view of a portion of device 10 in the vicinity of another illustrative embodiment of a component such as structural component 22. In the arrangement of FIG. 14, structural component 22 is mounted an actuator such as actuator stage 110. Some modes of operating device 10 may require visual interaction with a user of device 10 (e.g., a mode involving the display of images or video). In these visual modes, the location of portion 101 of touch-sensitive layer 14B of flexible display 14 may be indicated visually using display pixels in flexible display 14.

In other modes of operation of device 10, a user of device 10 may wish to determine the location of portion 101 without visual aid. In the embodiment shown in FIG. 14, component 22 may be recessed in support structures 50. Actuator stage 110 may be electrically or mechanically raised in direction 112 to move structural component 22 into contact with flexible display 14 to temporarily produce deformations such as deformations 102 in flexible display 14. Deformations 102 may indicate the location of portion 101 to a user of device 10. When no longer needed for tactile interaction (e.g., upon switching to a video display mode), actuator 110 may be electrically or mechanically moved in direction 114 to lower structural component 22 and remove deformations 102 in flexible display 14.

FIG. 15 is a cross-sectional side view of an embodiment of device 10 in which device 10 includes housing 12 and cover member 122. Cover member 122 may be formed of plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, etc.), other

suitable materials, or a combination of these materials. Cover member 122 may be a single structure or may include multiple cover structures. In order to facilitate lifting of cover 122 by a user of device 10, structural component 22 may be coupled to an actuator 130 which may be used to lift structural component 122 in direction 134. When lifted, structural component 134 may cause a deformation such as deformation 102 in flexible display 14. Flexible display 14 may exert a pressure on cover member 122, lifting cover member 122 in direction 134 allowing the user to grip cover member 122 in order to lift cover member 122 to an open position such as open position 140. Actuator 130 may then be used to lower structural component 22 in direction 132 in order to allow flexible display 14 to return to its original shape. Actuator 130 may be activated in response to a control signal produced by the user using actuator switch 124 or by a control signal from other suitable control circuitry.

FIG. 16 is a cross-sectional side view of a portion of device 10 in the vicinity of another illustrative embodiment of internal interface component 24. In the embodiment shown in FIG. 16, interface component 24 may be a pressure sensor that includes a pressure sensing module 140. Pressure sensing module 140 may be coupled between a contact member such as contact member 142 (which is in contact with flexible display 14) and electrical contacts 144. Pressure may be exerted on flexible display 14 (e.g., by a user of device 10 or due to atmospheric pressure changes in the surrounding environment of device 10). Pressure exerted on flexible display 14 may be transmitted to pressure sensing module 140 by contact member 142. Pressure information may be transmitted to device 10 through electrical contacts 144. Pressure sensing module 140 may sense pressure changes

using piezoelectric, capacitive, inductive, resistive, optical or other mechanisms. Providing device 10 with flexible display 14 allows flexible display 14 to extend over interface component 24, increasing the area of active region 20A of flexible display 14. The presence of flexible display 14 over interface component 24 may also reduce the risk of moisture or dirt entering into the interior of device 10.

In accordance with an embodiment, an electronic device is provided that includes a flexible display and an internal component, where the flexible display may be deformed by an action external to the device and deformation of the flexible display creates a response from the internal component.

In accordance with another embodiment, the flexible display includes a flexible display layer and a touch-sensitive layer.

In accordance with another embodiment, the flexible display layer of the flexible display includes an active display region and the internal component is covered with a portion of the active display region of the flexible display.

In accordance with another embodiment, the internal component includes a button and deformation of the flexible display compresses the button.

In accordance with another embodiment, the flexible display further includes a rigid cover layer having at least one opening.

In accordance with another embodiment, the opening includes a hole in the rigid cover layer, the button further includes a button member in the opening, the button member moves within the hole in the rigid cover layer, and the movement of the button member in the opening causes deformation of the flexible display.

In accordance with another embodiment, the internal component includes a pressure sensor and deformation of the flexible display exerts a mechanical pressure on the pressure sensor.

In accordance with another embodiment, the pressure sensor includes a piezoelectric actuator and the mechanical pressure induces a voltage on the piezoelectric actuator.

In accordance with another embodiment, the internal component includes a laser microphone for detecting a sound originating external to the electronic device and detecting the sound includes, with a laser, detecting deformation of the flexible display.

In accordance with an embodiment, an electronic device is provided that includes a flexible display and an audio component that transmits or receives sound through the flexible display.

In accordance with another embodiment, the flexible display includes an active display region and the audio component is mounted behind the active display region of the flexible display.

In accordance with another embodiment, the flexible display includes a flexible display layer and a touch-sensitive layer.

In accordance with another embodiment, the audio component includes a diaphragm and the diaphragm is mounted in contact with the flexible display.

In accordance with another embodiment, an electronic device is provides that includes a housing, a flexible display mounted on the housing, and a first internal component mounted under a portion of the flexible display, where the first internal component is configured to deform the portion of the flexible display.

In accordance with another embodiment, the first

internal component includes a piezoelectric actuator, where a voltage applied to the piezoelectric actuator causes an expansion of the piezoelectric actuator and the portion of the flexible display deforms in response to the expansion of the piezoelectric actuator.

In accordance with another embodiment, the first internal component includes a structural component, where the portion of the flexible display deforms in response to physical contact with the structural component and deformation of the portion of the flexible display causes the portion of the flexible display to conform to a surface of the structural component.

In accordance with another embodiment, the electronic device further includes a second internal component mounted under the portion of the flexible display, where the portion of the flexible display that conforms to the surface of the structural component indicates the location of the second internal component.

In accordance with another embodiment, the second internal component includes a button, where the portion of the flexible display is configured to be further deformed by an action external to the electronic device and further deformation of the portion of the flexible display compresses the button.

In accordance with another embodiment, the first internal component further includes an actuator, where the structural component is mounted on the actuator, where raising the actuator moves the structural component into contact with the portion of the flexible display, and where lowering the actuator moves the structural component out of contact with the flexible display.

In accordance with another embodiment, the flexible display includes a touch-sensitive layer, where deformation of the portion of the flexible display

conforming to the surface of the structural component indicates the location of a portion of the touch-sensitive layer of the flexible display.

In accordance with another embodiment, the electronic device further includes a second internal component mounted on the actuator and deformation of the portion of the flexible display conforming to the surface of the structural component indicates the location of the second internal component.

In accordance with another embodiment, the electronic device further includes a cover member and an actuator switch coupled to the actuator, where deformation of the flexible display exerts a pressure on the cover member and the pressure on the cover member lifts the cover member.

The foregoing is merely illustrative of the principles of this invention and various modifications can be made by those skilled in the art without departing from the scope and spirit of the invention.

As shown in the examples of FIGS. 1, 2 and 17-21, an electronic device may be provided with a concave display. The concave display may include a flexible display layer that has been bent to curve the display.

Concave displays may be formed from flexible layers such as a flexible display layer (e.g., a flexible organic light-emitting diode array), a flexible touch-sensitive layer (e.g., a sheet of polymer with an array of transparent capacitor electrodes for a capacitive touch sensor), a flexible substrate layer, etc. These flexible layers may, if desired, be covered by a flexible or rigid cover layer (sometimes referred to as a cover glass) or may be supported by a support structure (e.g., a rigid support structure on the underside of the flexible layers). In electronic devices with concave displays that

are covered by rigid cover layers, the cover layers may be provided with openings that provide access to the flexible layers of the display. For example, a cover glass layer may have an opening that allows a button member to move relative to the cover glass layer. As the button member moves within the opening, underlying portions of the flexible display may be deformed (e.g., to allow actuation of an associated switch).

Electronic devices may also be provided with user interface components (input-output components) such as buttons, microphones, speakers, piezoelectric actuators or (for receiving electrical input from a user or tactile feedback to users), other actuators such as vibrators, pressure sensors, and other components. These components may be mounted under portions of a flexible display.

User interface components may be mounted under the flexible display or may be integrated into the flexible display. The deformable nature of the flexible display may allow a user to interact with the user interface components (input-output components) by moving the display into contact with the user interface components or by otherwise allowing the display to locally flex (e.g., to allow sound to pass through the flexible display or to allow barometric pressure measurements of the exterior environment to be made by an internal pressure sensor). If desired, a portion of the flexible display may form a membrane portion of an electrical component. Components that may be provided with a membrane that is formed from a portion of a flexible display include microphones, laser microphones, pressure sensors, speakers, etc.

Concave displays formed from flexible and rigid layers that all have concave shapes (i.e., displays formed from a collection of layers in which no layer of the

display is planar) may provide reduced vulnerability to damage during a drop event in which an electronic device strikes the ground or other external objects while maximizing the internal volume of the device that is available to hold electrical and mechanical device components.

An illustrative electronic device of the type that may be provided with a concave display is shown in FIG. 1. Electronic device 10 may be a portable electronic device or other suitable electronic device. For example, electronic device 10 may be a laptop computer, a tablet computer, a somewhat smaller device such as a wrist-watch device, pendant device, or other wearable or miniature device, a cellular telephone, a media player, etc.

Device 10 may include a housing such as housing 12. Housing 12, which may sometimes be referred to as a case, may be formed of plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, etc.), other suitable materials, or a combination of these materials. In some situations, parts of housing 12 may be formed from dielectric or other low-conductivity material. In other situations, housing 12 or at least some of the structures that make up housing 12 may be formed from metal elements.

Device 10 may have a concave display such as concave display 14. Concave display 14 may be formed from multiple layers of material. These layers may include a touch sensor layer such as a layer on which a pattern of indium tin oxide (ITO) electrodes or other suitable transparent electrodes have been deposited to form a capacitive touch sensor array or a touch sensor layer formed using other touch technologies (e.g., resistive touch, acoustic touch, optical touch, etc.). These layers may also include a layer that contains an array of display

pixels. The touch sensor layer and the display layer may be formed using flexible sheets of polymer or other substrates having thicknesses of 10 microns to 0.5 mm or other suitable thicknesses (as an example).

The display pixel array may be, for example, an organic light-emitting diode (OLED) array containing rows and columns of OLED display pixels. Other types of flexible display pixel arrays may also be formed (e.g., electronic ink displays, etc.). The use of OLED technology to form flexible display 14 is sometimes described herein as an example. This is, however, merely illustrative. Flexible display 14 may be formed using any suitable flexible display technology. The use of flexible displays that are based on OLED technology is merely illustrative.

In addition to these functional display layers (i.e., the OLED array and the optional touch sensor array), display 14 may include one or more structural layers. For example, display 14 may be covered with a flexible or rigid cover layer and/or may be mounted on a support structure (e.g., a rigid support). Layers of adhesive may be used in attaching flexible display layers to each other and may be used in mounting flexible display layers to rigid and flexible structural layers.

In configurations for display 14 in which the cover layer for display 14 is flexible, input-output components that rely on the presence of flexible layers may be mounted at any suitable location under the display (e.g., along peripheral portions of the display, in a central portion of the display, etc.). In configurations for display 14 in which the flexible layers are covered by a rigid cover glass layer or other rigid cover layer, the rigid layer may be provided with one or more openings and the electronic components may be mounted under the

openings. For example, a rigid cover layer may have openings such as a circular opening 16 for button 17 and a speaker port opening such as speaker port opening 18 (e.g., for an ear speaker for a user). Device 10 may also have other openings (e.g., openings in display 14 and/or housing 12 for accommodating volume buttons, ringer buttons, sleep buttons, and other buttons, openings for an audio jack, data port connectors, removable media slots, etc.).

In some embodiments, portions of concave display 14 such as peripheral regions 20I may be inactive and portions of display 14 such as rectangular central portion 20A (bounded by dashed line 20) may correspond to the active part of display 14. In active display region 20A, an array of image pixels may be used to present text and images to a user of device 10. In active region 20A, display 14 may include touch sensitive components for input and interaction with a user of device 10. If desired, regions such as regions 20I and 20A in FIG. 1 may both be provided with display pixels (i.e., all or substantially all of the entire front planar surface of a device such as device 10 may be covered with display pixels).

Device 10 may, if desired, have internal user interface components such as buttons 17 or speaker component 19 that occupy openings such as openings 16 and 18 respectively in an optional rigid cover layer of concave display 14. Buttons 17 may be based on dome switches or other switch circuitry. Buttons 17 may include button members that form push buttons (e.g., momentary buttons), slider switches, rocker switches, etc. Device 10 may include internal structural components such as structural component 22 that add a raised structure to a portion of concave display 14. Device 10 may include

components such as interface components 24 and 26 that may be fully internal to device 10, but that receive input from the user or from the surrounding environment through physical interaction with concave display 14. Interface components 22, 24, and 26 may be positioned in active region 20A or inactive region 20I of concave display 14. Interface components 22, 24, and 26 may be positioned separately from one another or may be commonly located to form a combined component with structural and internal features. Interface components 24 and 26 may be positioned underneath concave display 14 so that concave display 14 must be deformed in order to contact components 24 or 26 or, if desired may be positioned to remain in constant contact with concave display 14.

An exploded perspective view of an illustrative display is shown in FIG. 2. As shown in FIG. 2, concave display 14 may be formed by stacking multiple layers including flexible display layer 14A, touch-sensitive layer 14B, and cover layer 14C. Display 14 may also include other layers of material such as adhesive layers, optical films, or other suitable layers. Flexible display layer 14 may include image pixels formed form light-emitting diodes (LEDs), organic LEDs (OLEDs), plasma cells, electronic ink elements, liquid crystal display (LCD) components, or other suitable image pixel structures compatible with flexible displays.

Touch-sensitive layer 14B may incorporate capacitive touch electrodes such as horizontal transparent electrodes 32 and vertical transparent electrodes 34. Touch-sensitive layer 14B may, in general, be configured to detect the location of one or more touches or near touches on touch-sensitive layer 14B based on capacitive sensors, resistive sensors, optical sensors, acoustic sensors, inductive sensors, or force sensors.

Software and/or hardware may be used to process the measurements of the detected touches to identify and track one or more gestures. A gesture may correspond to stationary or non-stationary, single or multiple, touches or near touches on touch-sensitive layer 14B. A gesture may be performed by moving one or more fingers or other objects in a particular manner on touch-sensitive layer 14B such as tapping, pressing, rocking, scrubbing, twisting, changing orientation, pressing with varying pressure and the like at essentially the same time, contiguously, or consecutively. A gesture may be characterized by, but is not limited to a pinching, sliding, swiping, rotating, flexing, dragging, or tapping motion between or with any other finger or fingers. A single gesture may be performed with one or more hands, by one or more users, or any combination thereof.

Cover layer 14C may be formed from plastic or glass (sometimes referred to as display cover glass) and may be flexible or rigid. If desired, the interior surface of peripheral inactive portions 20I of cover layer 14C may be provided with an opaque masking layer on such as black ink.

Touch-sensitive flexible display section 14AB may be formed from display pixel array layer 14A and optional touch sensor layer 14B.

FIG. 17 is perspective view of an illustrative embodiment of device 10 with concave display 14 in which device 10 is provided with a bezel such as bezel 200 surrounding the periphery of concave display 14. In the illustrative embodiment shown in FIG. 17, housing 12 of device 10 has an opening 204 that may provide access to a data port. The surface of bezel 200 may be formed in-plane with the surface of display 14 (i.e., so that bezel 200 and display 14 form a single smooth surface) or may be

formed at a right angle to the walls of housing 12 (as examples). Bezel 200 may be a separate bezel member or may be formed as a portion of housing 12. As shown in FIG. 17, top and bottom portions 202 of bezel 200 may have a concave (curved) shape that matches the cross-sectional curved shape of concave display 14.

FIG. 18 is a cross-sectional side view of an illustrative embodiment of device 10 in which concave display 14 is formed by mounting flexible display layer 14A to a concave support structure such as support structure 210 (e.g., a rigid support structure having at least a concave external surface such as a metal, glass, or plastic support structure) using a layer of adhesive material such as adhesive layer 212. As shown in FIG. 18, the internal volume of device 10, defined by housing 12, bezel 202 and concave display 14 may include volume 216 above a plane (indicated by dashed line 214) defined by the deepest point in the curvature of display 14. This is because the inner surface of support structure 210 is convex (in the FIG. 18 example). Volume 216 provides space in addition to rectangular volume 218 in which internal components such as component 220 (e.g., printed circuit boards, antennas or other components) may be positioned. The ability to bend flexible display 14 into the concave shape of FIG. 18 may therefore help maximize the interior space that is available within device 10 to mount device components.

FIG. 19 is a cross-sectional side view of a portion of device 10. In the illustrative embodiment of FIG. 19, concave display 14 is formed from flexible display layer 14A, adhesive layer 212, and rigid cover layer 14C (e.g., a layer of rigid plastic or a layer of rigid cover glass having a concave external surface and a convex inner surface to which flexible display layer 14A

conforms). Concave display 14 may be formed adjacent to bezel portion 200 of housing 12 or may be joined to housing 12 by an additional mounting member. The concave shape of cover layer 14C of display 14 may provide reduced susceptibility to damage if device 10 is dropped. Forming flexible display layer 14A in a shape that matches the concave shape of cover layer 14C (i.e., so that layer 14A conforms to the convex inner surface of layer 14C) may provide additional internal volume 216 to device 10.

FIG. 20 is a cross-sectional side view of a portion of another embodiment of device 10. In the illustrative embodiment of FIG. 20, concave display 14 is formed from flexible display layer 14A attached to optional touch-sensitive layer 14B by adhesive layer 212. Touch-sensitive layer 14B may further be attached to rigid cover layer 14C (e.g., a glass or plastic layer) using adhesive layer 230 such that all layers (212, 14B, 230, and 14C) of display 14 conform to the concave shape of cover layer 14C. Concave display 14 may be directly adjacent to bezel portion 200 of housing 12 or may be joined to housing 212 by an additional mounting member. The concave shape of all layers (14A, 212, 14B, 230, and 14C) of display 14 may provide reduced susceptibility to damage in the event that device 10 is dropped and may provide additional internal volume 216.

FIG. 21 is a cross-sectional side view of device 10 and a common drop surface such as drop surface 240 (e.g., sidewalk concrete, asphalt, tile, or any other surface) on which device 10 may be dropped. Drop surface 240 may have a surface roughness due to surface features such as surface features 242. Surface features 242 may have a characteristic height such as height 244 (e.g., 1-2 mm for a concrete surface). As shown in FIG. 21, device 10 may be provided with concave display 14. Concave

display 14 may be provided with a curvature defined by maximum depth 248 defined by the distance from the outermost surface of device 10, indicated by dashed line 246 and the deepest point in the curvature of display 14 (indicated by dashed line 214). The outermost surface of device 10 may be defined by bezel 200, or, in the absence of bezel 200, may be defined by juncture point 250 at which the peripheral edges of display 14 meet housing 12.

Maximum depth 248 may be chosen to be larger than characteristic size 244 of surface features 242 of common drop surface 240. Providing device 10 with a concave display having curvature chosen to provide a maximum depth (depth 248) that is larger than characteristic height 244 may significantly reduce the risk of damage (e.g., scratches or other damage) to device 10 during a drop event.

Providing concave display 14 with flexible display layer 14A capable of conforming to the shape of cover layer 14C allows all layers of display 14 to be conformed to same concave shape. Providing device 10 with concave display 14 in which all layers of concave display 14 conform to the same concave shape may reduce the susceptibility of device 10 to damage when dropped on common drop surface 240 while providing additional internal volume 216 in which internal components may be positioned.

Electronic devices may be provided with concave displays that reduce the risk of damage in the event of a drop while maximizing the internal volume of the device. Concave displays may be formed from one or more flexible layers including a flexible display layer. The flexible display layer may be mounted to a rigid support structure or a rigid cover layer. Flexible display layers that conform to the curved shape of a rigid cover structure

provide additional internal volume in which internal components of the device may be positioned.

In accordance with an embodiment, an electronic device is provided that includes a housing and a concave display mounted in the housing, where the concave display has a rigid internal support structure having a concave surface and a flexible display layer attached to the rigid internal support structure that conforms to the concave surface of the rigid support structure.

In accordance with another embodiment, the concave display further includes a first adhesive layer and the first adhesive layer attaches the flexible display layer to the concave surface of the rigid internal support structure.

In accordance with another embodiment, the concave display further includes a touch-sensitive layer.

In accordance with another embodiment, the concave display further includes first and second adhesive layers, where the first adhesive layer attaches the flexible display layer to the touch-sensitive layer and where the second adhesive layer attaches the flexible display layer to the rigid internal support structure.

In accordance with another embodiment, the housing includes a bezel and the bezel surrounds a periphery of the concave display.

In accordance with another embodiment, the rigid internal support structure has a convex inner surface and the electronic device further includes at least one internal component mounted adjacent to the convex inner surface.

In accordance with another embodiment, the rigid internal support structure has at least one opening.

In accordance with another embodiment, the at least one opening includes a hole in the rigid internal

support structure and the at least one internal component is mounted in the hole in the rigid internal support structure.

In accordance with another embodiment, an electronic device is provided that includes a housing and a concave display mounted in the housing, where the concave display includes a rigid cover layer having at least one concave outer surface and at least one corresponding convex inner surface and includes a flexible display layer, where the flexible display layer conforms to the convex inner surface of the rigid cover layer.

In accordance with another embodiment, the flexible display layer includes image pixels formed from organic light-emitting diodes.

In accordance with another embodiment, the concave display further includes a first adhesive layer, where the first adhesive layer attaches the flexible display layer to the convex inner surface of the rigid cover layer.

In accordance with another embodiment, the rigid cover layer has at least one opening, where the electronic device further includes an internal component and where the internal component is mounted adjacent to the flexible display layer under the at least one opening in the rigid cover layer.

In accordance with another embodiment, the internal component includes a speaker and the speaker transmits sound through the flexible display layer.

In accordance with another embodiment, the internal component includes a button, where the electronic device further includes a button member in the at least one opening in the rigid cover layer, where the button member moves within the at least one opening in the rigid cover layer, and where the movement of the button member

compresses the button.

In accordance with another embodiment, an electronic device is provided that includes an electronic device housing and a concave display mounted in the electronic device housing, where the concave display includes a rigid cover layer having a concave outer surface and a convex inner surface, a flexible display layer, and a touch-sensitive layer, where the flexible display layer and the touch-sensitive layer each conform to the convex inner surface of the rigid cover layer.

In accordance with another embodiment, the concave display further includes first and second adhesive layers, where the flexible display layer is attached to the touch-sensitive layer with the first adhesive layer and where the touch-sensitive layer is attached to the convex inner surface of the rigid cover layer with the second adhesive layer.

In accordance with another embodiment, the electronic device further includes at least one internal component mounted adjacent to the flexible display layer of the concave display.

In accordance with another embodiment, the rigid cover layer of the convex display has at least one opening, where the at least one internal component is an audio component, and where the audio component is mounted under the at least one opening in the rigid cover layer.

In accordance with another embodiment, the concave outer surface of the concave display has a curvature and peripheral edges, where the curvature has a deepest point, where the deepest point and at least some of the peripheral edges define a maximum depth associated with the curvature of the concave display and where the maximum depth of the concave display is between 0.5 millimeter and 20 millimeters.

In accordance with another embodiment, the electronic device further includes an internal component, where the internal component is mounted at a distance from the peripheral edges of the concave outer surface, and where the distance is smaller than the maximum depth.

The foregoing is merely illustrative of the principles of this invention and various modifications can be made by those skilled in the art without departing from the scope and spirit of the invention.

As shown in the examples of FIGS. 1, 2 and 22-29, an electronic device may be provided with a convex display. The convex display may include a flexible display layer that has been bent to form a curved surface.

Convex displays may be formed from flexible layers such as a flexible display layer (e.g., a flexible organic light-emitting diode array), a flexible touch-sensitive layer (e.g., a sheet of polymer with an array of transparent capacitor electrodes for a capacitive touch sensor), a flexible substrate layer, etc. These flexible layers may, if desired, be covered by a flexible or rigid cover layer (sometimes referred to as a cover glass) or may be supported by a support structure (e.g., a rigid support structure on the underside of the flexible layers). In electronic devices with convex displays partially covered by rigid cover layers, the cover layers may be provided with openings that provide access to the flexible layers of the display. For example, a cover glass layer may have an opening that allows a button member to move relative to the cover glass layer. As the button member moves within the opening, underlying portions of the flexible display may be deformed (e.g., to allow actuation of an associated switch).

Electronic devices may also be provided with user interface components (input-output components) such

as buttons, microphones, speakers, piezoelectric actuators or (for receiving electrical input from a user or tactile feedback to users), other actuators such as vibrators, pressure sensors, and other components. These components may be mounted under portions of a flexible display.

User interface components may be mounted under the flexible display or may be integrated into the flexible display. The deformable nature of the flexible display may allow a user to interact with the user interface components (input-output components) by moving the display into contact with the user interface components or by otherwise allowing the display to locally flex (e.g., to allow sound to pass through the flexible display or to allow a barometric pressure measurements of the exterior environment to be made by an internal pressure sensor). If desired, a portion of the flexible display may form a membrane portion of an electrical component. Components that may be provided with a membrane that is formed from a portion of a flexible display include microphones, laser microphones, pressure sensors, speakers, etc.

Convex displays formed from flexible and rigid layers that all have convex shapes i.e., displays formed from a collection of layers in which no layer of the display is planar) may provide an aesthetically desirable external appearance while maximizing the internal volume of the device that is available to hold electrical and mechanical device components.

An illustrative electronic device of the type that may be provided with a convex display is shown in FIG. 1.

Electronic device 10 may be a portable electronic device or other suitable electronic device. For example, electronic device 10 may be a laptop computer, a tablet

computer, a somewhat smaller device such as a wrist-watch device, pendant device, or other wearable or miniature device, a cellular telephone, a media player, etc.

Device 10 may include a housing such as housing 12. Housing 12, which may sometimes be referred to as a case, may be formed of plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, etc.), other suitable materials, or a combination of these materials. In some situations, parts of housing 12 may be formed from dielectric or other low-conductivity material. In other situations, housing 12 or at least some of the structures that make up housing 12 may be formed from metal elements.

Device 10 may have a convex display such as convex display 14. Convex display 14 may be formed from multiple layers of material. These layers may include a touch sensor layer such as a layer on which a pattern of indium tin oxide (ITO) electrodes or other suitable transparent electrodes have been deposited to form a capacitive touch sensor array or a touch sensor layer formed using other touch technologies (e.g., resistive touch, acoustic touch, optical touch, etc.). These layers may also include layer that contains an array of display pixels. The touch sensor layer and the display layer may be formed using flexible sheets of polymer or other substrates having thicknesses of 10 microns to 0.5 mm or other suitable thicknesses (as an example).

The display pixel array may be, for example, an organic light-emitting diode (OLED) array containing rows and columns of OLED display pixels. Other types of flexible display pixel arrays may also be formed (e.g., electronic ink displays, etc.). The use of OLED technology to form flexible display 14 is sometimes described herein as an example. This is, however, merely

illustrative. Flexible display 14 may be formed using any suitable flexible display technology. The use of flexible displays that are based on OLED technology is merely illustrative.

In addition to these functional display layers (i.e., the OLED array and the optional touch sensor array), display 14 may include one or more structural layers. For example, display 14 may be covered with a flexible or rigid cover layer and/or may be mounted on a support structure (e.g., a rigid support). Layers of adhesive may be used in attaching flexible display layers to each other and may be used in mounting flexible display layers to rigid and flexible structural layers.

In configurations for display 14 in which the cover layer for display 14 is flexible, input-output components that rely on the presence of flexible layers may be mounted at any suitable location under the display (e.g., along peripheral portions of the display, in a central portion of the display, etc.). In configurations for display 14 in which the flexible layers are covered by a rigid cover glass layer or other rigid cover layer, the rigid layer may be provided with one or more openings and the electronic components may be mounted under the openings. For example, a rigid cover layer may have openings such as a circular opening 16 for button 17 and a speaker port opening such as speaker port opening 18 (e.g., for an ear speaker for a user). Device 10 may also have other openings (e.g., openings in display 14 and/or housing 12 for accommodating volume buttons, ringer buttons, sleep buttons, and other buttons, openings for an audio jack, data port connectors, removable media slots, etc.).

In some embodiments, portions of convex display 14 such as peripheral regions 20I may be inactive and

portions of display 14 such as rectangular central portion 20A (bounded by dashed line 20) may correspond to the active part of display 14. In active display region 20A, an array of image pixels may be used to present text and images to a user of device 10. In active region 20A, display 14 may include touch sensitive components for input and interaction with a user of device 10. If desired, regions such as regions 20I and 20A in FIG. 1 may both be provided with display pixels (i.e., all or substantially all of the entire front planar surface of a device such as device 10 may be covered with display pixels).

Device 10 may, if desired, have internal user interface components such as buttons 17 or speaker component 19 that occupy openings such as openings 16 and 18 respectively in an optional rigid cover layer of convex display 14. Buttons 17 may be based on dome switches or other switch circuitry. Buttons 17 may include button members that form push buttons (e.g., momentary buttons), slider switches, rocker switches, etc. Device 10 may include internal structural components such as structural component 22 that add a raised structure to a portion of convex display 14. Device 10 may include components such as interface components 24 and 26 that may be fully internal to device 10, but that receive input from the user or from the surrounding environment through physical interaction with convex display 14. Interface components 22, 24, and 26 may be positioned in active region 20A or inactive region 20I of convex display 14. Interface components 22, 24, and 26 may be positioned separately from one another or may be commonly located to form a combined component with structural and internal features. Interface components 24 and 26 may be positioned underneath convex display 14 so that convex display 14

must be deformed in order to contact components 24 or 26 or, if desired may be positioned to remain in constant contact with convex display 14.

An exploded perspective view of an illustrative display is shown in FIG. 2. As shown in FIG. 2, convex display 14 may be formed by stacking multiple layers including flexible display layer 14A, touch-sensitive layer 14B, and cover layer 14C. Display 14 may also include other layers of material such as adhesive layers, optical films, or other suitable layers. Flexible display layer 14 may include image pixels formed form light-emitting diodes (LEDs), organic LEDs (OLEDs), plasma cells, electronic ink elements, liquid crystal display (LCD) components, or other suitable image pixel structures compatible with flexible displays.

Touch-sensitive layer 14B may incorporate capacitive touch electrodes such as horizontal transparent electrodes 32 and vertical transparent electrodes 34. Touch-sensitive layer 14B may, in general, be configured to detect the location of one or more touches or near touches on touch-sensitive layer 14B based on capacitive sensors, resistive sensors, optical sensors, acoustic sensors, inductive sensors, or force sensors.

Software and/or hardware may be used to process the measurements of the detected touches to identify and track one or more gestures. A gesture may correspond to stationary or non-stationary, single or multiple, touches or near touches on touch-sensitive layer 14B. A gesture may be performed by moving one or more fingers or other objects in a particular manner on touch-sensitive layer 14B such as tapping, pressing, rocking, scrubbing, twisting, changing orientation, pressing with varying pressure and the like at essentially the same time, contiguously, or consecutively. A gesture may be

characterized by, but is not limited to a pinching, sliding, swiping, rotating, flexing, dragging, or tapping motion between or with any other finger or fingers. A single gesture may be performed with one or more hands, by one or more users, or any combination thereof.

Cover layer 14C may be formed from plastic or glass (sometimes referred to as display cover glass) and may be flexible or rigid. If desired, the interior surface of peripheral inactive portions 20I of cover layer 14C may be provided with an opaque masking layer on such as black ink.

Touch-sensitive flexible display section 14AB may be formed from display pixel array layer 14A and optional touch sensor layer 14B.

FIG. 22 is perspective view of an exemplary embodiment of device 10 with convex display 14 and convex housing 12 in which housing 12 has an opening 300 that may provide access to, e.g., an audio port. A portion of housing 12 may form a bezel such as bezel 304. Bezel 304 may be formed so that bezel 304 and display 14 form a common smooth surface or may be formed raised above or depressed below the outer surface of display 14. Bezel 304 may be a separate bezel member or may be formed as a portion of housing 12. As shown in FIG. 22, top and bottom portions 306 of bezel 200 may have a convex (curved) shape that matches the cross-sectional curved shape of convex display 14.

FIG. 23 is a cross-sectional side view of an illustrative embodiment of device 10 taken along line 302 of FIG. 22 and viewed in direction 303. As shown in FIG. 23, device 10 has a convex shape formed by convex housing 12 and convex display 14. Device 10 may also include internal components such as battery 310 and components 312. The convex shape of housing 12 and display 14 of

device 10 may provide device 10 with a thin appearance while providing an interior space that is able to accommodate internal components such as battery 310.

FIG. 24 is a cross-sectional side view of an illustrative embodiment of device 10 in which convex display 14 is formed by mounting flexible display layer 14A to a convex support structure such as support structure 320 (e.g., a rigid support structure having at least a convex external surface such as a metal, glass, or plastic support structure) using a layer of adhesive material such as adhesive layer 322. As shown in FIG. 24, the internal volume of device 10, defined by housing 12 and convex display 14 may include volume 326 above plane 324 (defined by inner edges 328 of display 14) and below inner surface 330 of display 14. This is because inner surface 330 of support structure 320 is concave (in the FIG. 24 example). Volume 326 provides space which may be used for placement of internal components such as component 332 (e.g., printed circuit boards, antennas or other components). The ability to bend flexible display layer 14A into the convex shape of FIG. 24 that matches the convex outer surface of support structure 320 may therefore help maximize the interior space that is available within device 10 to mount device components.

FIG. 25 is a cross-sectional side view of a portion of device 10. In the illustrative embodiment of FIG. 25, convex display 14 is formed from flexible display layer 14A, adhesive layer 322, and rigid cover layer 14C (e.g., a layer of rigid plastic or a layer of rigid cover glass having a convex external surface and a concave inner surface to which flexible display layer 14A conforms). Convex display 14 may be formed adjacent to bezel portion housing 12 or may be joined to housing 12 by an additional mounting member. Providing device 10 with a layer such as

flexible display layer 14A that conforms to the convex shape of cover layer 14C (i.e., so that layer 14A conforms to the concave inner surface of layer 14C) may provide additional internal volume 326 between plane 324 (defined by inner edges 328 of display 14) and inner surface 330 of display 14.

FIG. 26 is a cross-sectional side view of a portion of another embodiment of device 10. In the illustrative embodiment of FIG. 26, convex display 14 is formed from flexible display layer 14A attached to optional touch-sensitive layer 14B by adhesive layer 322. Touch-sensitive layer 14B may further be attached to rigid cover layer 14C (e.g., a glass or plastic layer) using adhesive layer 340 such that all layers (322, 14B, 340, and 14C) of display 14 conform to the convex shape of cover layer 14C (i.e., so that layers 14A and 14B conform to the concave inner surface of cover layer 14C). Convex display 14 may be formed adjacent to housing 12 or may be joined to housing 212 by an additional mounting member. The convex shape of all layers (14A, 322, 14B, 340, and 14C) may combine with convex housing 12 to provide a thin appearance for device 10 and may provide additional internal volume 326 between plane 324 (defined by inner edges 328 of display 14) and inner surface 330 of display 14.

FIG. 27 is a cross-sectional perspective view of an illustrative electronic device 10 in the vicinity of a connecting structure such as connecting structure 350 (e.g. an audio port or other female connector). As shown in FIG. 27, audio port 350 may have electrical contacts 352 for mating with contacts 356 of a connector such as mating connector 354 (e.g., a mating audio plug or other male connector). In the embodiment of FIG. 27, a portion of audio port 350 may occupy a portion of internal volume

326 above plane 324 (defined by inner edges 328 of display 14). The convex shape of display 14 of device 10 may provide a thin appearance and may provide additional internal volume 326 between plane 324 (defined by inner edges 328 of display 14) and inner surface 330 of display 14 in which a portion of mating connectors such as connector 350 may be mounted.

FIG. 28 is a cross-sectional side view of an illustrative electronic device 10 in the vicinity of a stack of components 360 such as printed circuit boards (PCBs), sensors, switches, connectors, battery structures, or other electronic components. In the embodiment shown in FIG. 28, some components 360 may be mounted partially or completely in a portion of internal volume 326 above plane 324 (defined by inner edges 328 of display 14). The convex shape of display 14 of device 10 may provide a thin appearance and may provide additional internal volume 326 between plane 324 (defined by inner edges 328 of display 14) and inner surface 330 of display 14 in which PCBs and other components 360 may be mounted. The example of FIG. 29 in which components 360 are mounted in volume 326 is merely illustrative. Other components or structures may occupy volume 326, if desired.

FIG. 29 is a cross-sectional side view of an illustrative electronic device in which display 14 of device 10 completely surrounds device 10. As shown in FIG. 29, device 10 may have convex front (upper) and rear (lower) surfaces that are joined along curved sidewalls. Display 14 may cover the front, rear, and sidewall surfaces of device 10 so as to completely surround electrical components 360 (e.g., printed circuit boards, integrated circuits, switches, sensors, etc.). Edges 372 may be joined by a joining member such as joining member 370. Member 370 may be a separate member formed of

plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, etc.), other suitable materials, or a combination of these materials, or may be formed from an adhesive material.

In the example of FIG. 29, display 14 may be formed by stacking multiple layers including flexible display layer 14A, touch-sensitive layer 14B, and cover layer 14C. Display 14 may also include other layers of material such as adhesive layers, optical films, or other suitable layers. As an example, display 14 may be formed by mounting flexible display layer 14A to a rigid convex support structure having one or more convex outer surfaces and one or more associated concave inner surfaces that completely surrounds device 10. In another configuration, display 14 may be formed from flexible display layer 14A, adhesive layer 322, and rigid cover layer 14C (e.g., a rigid cover layer with one or more convex outer surfaces and one or more associated concave inner surfaces). In another possible configuration, convex display 14 may be formed by attaching flexible display layer 14A to optional touch-sensitive layer 14B using adhesive layer 322. Touch-sensitive layer 14B may further be attached to rigid cover layer 14C (e.g., a glass or plastic layer) using adhesive layer 340 so that all layers (322, 14B, 340, and 14C) of display 14 conform to the convex shape of cover layer 14C. These examples are merely illustrative and other configurations of display 14 may be used.

The convex shape of display 14 of device 10 may provide a thin appearance for device 10 and may help to maximize the internal volume of the device in which components such as battery 310, PCBs 360 or other components such as component 312 may be mounted. Surrounding device 10 completely with convex display 14 may allow the area of a device available for visual

display to be enlarged.

The foregoing is merely illustrative of the principles of this invention and various modifications can be made by those skilled in the art without departing from the scope and spirit of the invention.

Electronic devices may be provided with convex displays. A convex display may be used to maximize the internal volume of a device. Convex displays may be formed from one or more flexible layers. A flexible display layer may be mounted to a rigid support structure or a rigid cover layer. Flexible display layers that conform to the curved shape of a rigid structure may provide additional internal volume in which internal components of the device may be positioned.

In accordance with another embodiment, an electronic device is provided including a housing and a display mounted in the housing, where the display has a flexible display layer that conforms to a convex outer surface of a rigid support structure.

In accordance with another embodiment, the display further includes an adhesive layer and the adhesive layer attaches the flexible display layer to the convex outer surface of the rigid support structure.

In accordance with another embodiment, the display further includes a touch-sensitive layer.

In accordance with another embodiment, the display further includes first and second adhesive layers, where the first adhesive layer attaches the flexible display layer to the touch-sensitive layer and the second adhesive layer attaches the flexible display layer to the convex outer surface of the rigid support structure.

In accordance with another embodiment, the flexible display layer includes image pixels formed from organic light-emitting diodes.

In accordance with another embodiment, the housing has at least one opening, where the opening is associated with a connector port and the electronic device further includes a connector structure mounted in the connector port.

In accordance with another embodiment, an electronic device is provided that includes a housing and a display mounted in the housing, where the display includes a rigid cover layer having at least one convex outer surface and having at least one associated concave inner surface and includes a flexible display layer that conforms to the concave inner surface.

In accordance with another embodiment, the display further includes an adhesive layer and the adhesive layer bonds the flexible display layer to the concave inner surface of the rigid cover layer.

In accordance with another embodiment, the rigid cover layer includes glass.

In accordance with another embodiment, the flexible display layer includes image pixels formed from organic light-emitting diodes.

In accordance with another embodiment, the flexible display layer includes image pixels formed from organic light-emitting diodes.

In accordance with another embodiment, the display further includes a touch sensor layer that conforms to the concave inner surface.

In accordance with another embodiment, the concave display further includes first and second adhesive layers, where the first adhesive layer attaches the flexible display layer to the touch sensor layer and the second adhesive layer attaches the touch sensor layer to the concave inner surface of the display.

In accordance with another embodiment, the touch

sensor layer includes indium-tin-oxide electrodes.

In accordance with another embodiment, the electronic device further includes an internal component, where the concave inner surface of the display provides an additional internal volume for the electronic device and where the internal component is mounted at least partially in the additional internal volume.

In accordance with another embodiment, an electronic device is provided having at least a front surface and a rear surface and including electronic components interposed between the front and rear surfaces and a display that substantially covers at least the front and rear surfaces and that surrounds the electronic components, where the display includes a rigid cover layer having at least one inner surface and a flexible display layer that is bent to conform to the inner surface.

In accordance with another embodiment, the display further includes a touch-sensitive layer attached to at least a portion of the flexible display layer.

In accordance with another embodiment, the inner surface includes a concave inner surface and the electronic device further includes a connector structure and a housing having an opening, where the connector structure is mounted in the opening to form a connector port.

In accordance with another embodiment, the electronic device has at least two sidewall surfaces and the display substantially covers the two sidewall surfaces.

In accordance with another embodiment, the display has at least two edges and the edges of the display are joined by a joining member.

The foregoing is merely illustrative of the principles of this invention and various modifications can

be made by those skilled in the art without departing from the scope and spirit of the invention. The foregoing embodiments may be implemented individually or in any combination.

As shown in the examples of FIGS. 30-44, an electronic device may be provided with a flexible display and other user interface components. The user interface components may include buttons, switches, microphones, actuators such as solenoids, motors, and piezoelectric actuators, connector ports, touch screens, proximity sensors and other components for accepting input from, or transmitting information to, a user of the electronic device.

Flexible displays may be formed from flexible layers such as a flexible display layer (e.g., a flexible organic light-emitting diode array), a flexible touch-sensitive layer (e.g., a sheet of polymer with an array of transparent capacitor electrodes for a capacitive touch sensor), a flexible substrate layer, etc. These flexible layers may, if desired, be covered by a flexible or rigid cover layer (sometimes referred to as a cover glass) or may be supported by a support structure (e.g., a rigid support structure on the underside of the flexible layers). In electronic devices with flexible displays that are covered by rigid cover layers, the cover layers may be provided with openings that provide access to the flexible layers of the display in the vicinity of a user interface device. For example, a cover glass layer may have an opening that allows a button member to move relative to the cover glass layer. As another example, a cover glass layer may have one or more speaker openings through which sound may pass.

To maximize the area of the portion of the flexible display that is available for displaying visual

information to the user, user interface components may be positioned behind, abutted against, or integrated into the flexible display. The deformable nature of the flexible display may allow a user to interact with the user interface components (input-output components) by moving the display into contact with the user interface components or by otherwise allowing the display to locally flex (e.g., to allow sound to pass through the flexible display or to allow barometric pressure measurements of the exterior environment to be made by an internal pressure sensor).

If desired, a portion of the flexible display may form a membrane structure for an electrical component. For example, a portion of the flexible display may form a speaker membrane for a speaker component. Components that may be provided with a membrane structure formed from a portion of a flexible display include speakers, microphones, laser microphones, pressure sensors, etc.

An illustrative electronic device of the type that may be provided with a flexible display is shown in FIG. 30. Electronic device 10 may be a computer such as a computer that is integrated into a display. For example, electronic device 10 may be a computer monitor, a laptop computer, a tablet computer, a somewhat smaller portable device such as a wrist-watch device, pendant device, or other wearable or miniature device, a cellular telephone, a media player, a tablet computer, a gaming device, a speaker device, a navigation device, a computer monitor, a television, or other electronic equipment.

Device 10 may include a housing such as housing 412. Housing 412, which may sometimes be referred to as a case, may be formed of plastic, glass, ceramics, fiber composites, metal (e.g., stainless steel, aluminum, etc.), other suitable materials, or a combination of these

materials. In some situations, parts of housing 412 may be formed from dielectric or other low-conductivity material. In other situations, housing 412 or at least some of the structures that make up housing 412 may be formed from metal elements.

Housing 412 may be formed using a unibody configuration in which some or all of housing 412 is machined or molded as a single structure or may be formed using multiple structures (e.g., an internal frame structure, one or more structures that form exterior housing surfaces, etc.).

As shown in FIG. 30, housing 412 may have multiple parts. For example, housing 412 may have upper portion 412A and lower portion 412B. Upper portion 412A may be coupled to lower portion 412B using a hinge that allows portion 412A to rotate about rotational axis 416 relative to portion 412B. A keyboard such as keyboard 418 and a touch pad such as touch pad 420 may be mounted in housing portion 412B.

Device 10 may have a flexible display such as flexible display 414. Flexible display 414 may be formed from multiple layers of material. These layers may include a touch sensor layer such as a layer on which a pattern of indium tin oxide (ITO) electrodes or other suitable transparent electrodes have been deposited to form a capacitive touch sensor array. These layers may also include a display layer that contains an array of display pixels. The touch sensor layer and the display layer may be formed using flexible sheets of polymer (e.g., polyimide) or other substrates having thicknesses of 10 microns to 0.5 mm, having thicknesses of less than 0.2 mm, or having other suitable thicknesses (as examples).

The display pixel array may be an organic light-

emitting diode (OLED) array, for example. Other types of flexible display pixel arrays may also be formed (e.g., electrowetting displays, electrophoretic displays, flexible liquid crystal displays, flexible electrochromic displays, etc.). The use of OLED technology to form flexible display 414 is sometimes described herein as an example. This is, however, merely illustrative. In general, any suitable type of flexible display technology may be used in forming display 414.

In addition to these functional display layers (i.e., the OLED array and the optional touch sensor array), display 414 may include one or more structural layers. For example, display 414 may be covered with a flexible or rigid cover layer and/or may be mounted on a support structure (e.g., a rigid support). If desired, layers of adhesive may be used to attach flexible display layers to each other and/or to mount flexible display layers to rigid and flexible structural layers.

In some embodiments, display 414 may have an active area such as active area AA and an inactive area such as area IA. In active display region AA, an array of image pixels may be used to present text and images to a user of device 10. In active region AA, display 414 may include touch sensitive components for input and interaction with a user of device 10. If desired, both central portion AA and peripheral portion IA may be provided with display pixels (i.e., all or substantially all of the entire front planar surface of upper housing portion 412A may be provided with display pixels).

In the example of FIG. 31, device 10 has been implemented using a housing that is sufficiently small to fit within a user's hand (e.g., device 10 of FIG. 31 may be a handheld electronic device such as a cellular telephone). As show in FIG. 31, device 10 may include a

display such as display 414 mounted on the front of housing 412. Display 414 may be substantially filled with active display pixels or may have an inactive portion such as inactive portion IA that surrounds an active portion such as active portion AA. Display 414 may have openings (e.g., openings in inactive region IA or active region AA of display 414) such as an opening to accommodate button 422 and an opening to accommodate speaker port 424.

FIG. 32 is a perspective view of electronic device 10 in a configuration in which electronic device 10 has been implemented in the form of a tablet computer. As shown in FIG. 32, display 414 may be mounted on the upper (front) surface of housing 412. An opening may be formed in display 414 to accommodate button 422 (e.g., an opening may be formed in inactive region IA surrounding active region AA).

FIG. 33 is a perspective view of electronic device 10 in a configuration in which electronic device 10 has been implemented in the form of a television or in the form of a computer integrated into a computer monitor. As shown in FIG. 33, display 414 may be mounted on the front surface of housing 412. Stand 426 may be used to support housing 412. Display 414 may include an inactive region such as inactive region IA that surrounds active region AA.

An exploded perspective view of an illustrative display is shown in FIG. 34. As shown in FIG. 34, flexible display 414 may be formed by stacking multiple layers including flexible display layer 414A and touch-sensitive layer 414B. An optional cover layer such as cover layer 462 may be formed over flexible display 414. Cover layer 462 may be a layer of glass, plastic, or other protective display layer.

Flexible display 414 may also include other

layers of material such as adhesive layers, optical films, sealant layers, or other suitable layers. Flexible display layer 414A may include image pixels formed from light-emitting diodes (LEDs), organic LEDs (OLEDs), plasma cells, electrowetting display elements, electrophoretic display elements, liquid crystal display (LCD) components, or other suitable image pixel structures compatible with flexible displays.

Touch-sensitive layer 414B may incorporate capacitive touch electrodes such as horizontal transparent electrodes 432 and vertical transparent electrodes 434. Touch-sensitive layer 414B may, in general, be configured to detect the location of one or more touches or near touches on touch-sensitive layer 414B based on capacitive, resistive, optical, acoustic, inductive, or mechanical measurements, or any phenomena that can be measured with respect to the occurrences of the one or more touches or near touches in proximity to touch sensitive layer 414B.

Flexible display 414 may be formed from display pixel array layer 414A and optional touch sensor layer 414B. In the example of FIG. 34, touch-sensitive layer 414B is interposed between cover layer 462 and flexible display layer 414A. This arrangement is merely illustrative. If desired, flexible display layer 414A may be interposed between cover layer 462 and touch-sensitive layer 414B (e.g., flexible display layer 414A may be arranged on top of touch-sensitive layer 414B). If desired, touch-sensitive layer 414B and flexible display layer 414A may be integrated as a single layer. For example, capacitive touch electrodes such as electrodes 432 and 434 and display pixels such as display pixels 430 may be formed on a common substrate, if desired.

FIG. 35 is a cross-sectional side view of a

portion of flexible display layer 414A. As shown in FIG. 35, flexible display layer 414A may contain multiple sublayers. For example, display layer 414A may include a substrate layer such as substrate layer 415. Substrate layer 415 may be formed from a flexible or rigid dielectric such as glass, ceramic, or plastic. As an example, substrate layer 415 may be formed from one or more flexible sheets of polymer (e.g., polyimide). Substrate layer 415 may have a thickness of 10 microns to 0.5 mm, may have a thickness of less than 0.2 mm, or may have other suitable thickness (as examples).

A thin-film transistor (TFT) layer such as TFT layer 417 may include a layer of thin-film transistor structures (e.g., polysilicon transistors and/or amorphous silicon transistors) formed on substrate layer 415.

An organic emissive layer such as OLED layer 419 may be formed over TFT layer 417. OLED layer 419 may include a light-emitting material such as an array of organic light-emitting diode structures that are used to form display pixels such as display pixels 430 of FIG. 34.

A sealant layer such as sealant layer 421 may be formed over OLED layer 419 to protect the structures of OLED layer 419 and TFT layer 417. Sealant layer 421 may be formed from one or more layers of polymer (e.g., one or more layers of polymer that are deposited onto OLED layer 419), metal foil (e.g., a layer of metal foil that is laminated, sputtered, evaporated, or otherwise applied onto OLED layer 419), or other suitable coating or conformal covering.

Electronic device 10 may be provided with one or more speaker structures for providing sound to a user of electronic device 10. FIG. 36 is a cross-sectional side view of a portion of electronic device 10 in the vicinity of a speaker structure such as speaker structure 448.

Sound produced by speaker structure 448 may be transmitted through flexible display 414 to the exterior of device 10. Flexible display 414 may be used as a speaker membrane structure for speaker 448. Portions such as portion 414M that serve as a speaker membrane for speaker 448 may be located in an active or inactive portion of display 414. Arrangements in which speaker membrane 414M forms an active display area may allow the size of the active region of flexible display 414 to be increased relative to its inactive region.

As shown in FIG. 36, speaker structure 448 may be driven by a transducer such as transducer 450. Transducer 450 may be configured to receive electrical audio signal input from circuitry in device 10 and to convert the electrical signal into sound. In the example of FIG. 36, transducer 450 is formed from a magnet such as magnet 440 surrounded by coils such as coils 442. Magnet 440 may be a permanent magnet formed from ferrite material, ceramic material, iron alloy material, rare earth material, other suitable material, or a combination of these materials. Coils 442 may be formed from copper, aluminum, silver, other suitable materials, etc. If desired, there may be one or more sets of coils surrounding magnet 440.

When current passes through coils 442, a magnetic field is produced. This allows coils 442 to act as a variable electromagnet with a magnetic field that interacts with the constant magnetic field produced by permanent magnet 440. For example, the negative pole of the electromagnet may be repelled by the negative pole of permanent magnet 440. The magnetic force created by this repulsion will force magnet 440 away from coils 442. When the current flowing through coils 442 changes direction, the polarity of the variable electromagnet reverses.

Magnet 440 may be pushed back and forth rapidly (along the z-axis) as the current in coils 442 alternates directions.

Portions of flexible display 414 such as portion 414M may form a speaker membrane for speaker 448. As magnet 440 moves back and forth along the z-axis, attached speaker membrane 414M will in turn vibrate the air in front of speaker membrane 414M, creating sound waves.

In some arrangements, an optional support structure such as support structure 446 (sometimes referred to as a stiffening structure or stiffener) may be interposed between transducer 450 and speaker membrane 414M. Support structure 446 may be used to stiffen speaker membrane portion 414M of display 414. Support structure 446 may be formed from a metal plate, from specialized composite structures (e.g., a layer of foam interposed between layers of stiffener, etc.), from other support materials or stiffening structures, or from a combination of these materials. Using a support structure such as support structure 446 may allow speaker membrane 414M to respond more accurately to the movement of magnet 440. In arrangements where optional support structure 446 is not used, magnet 440 may be configured to stiffen portion 414M of display 414 that serves as a speaker membrane structure.

There may be one or more speaker structures 448 in device 10. Some or all of speaker structures 448 in device 10 may have speaker membranes that are formed from flexible display 414. If desired, some, all, or substantially all of flexible display 414 may be used as a speaker membrane for one speaker, for two speakers, for three speakers, or for more than three speakers.

A suspension structure such as suspension structure 454 may be used to attach portions of flexible display 414 to a rigid support structure such as housing

412. Suspension structure 454 may prevent speaker membrane 414M from moving laterally along the x-axis and/or the y-axis, but may allow free motion of speaker membrane 414M along the z-axis as speaker 448 produces sound. Suspension structure 454 may be formed from an elastomeric material, foam material, resin coated material, other suitable materials, or a combination of these materials. As shown in the example of FIG. 36, suspension structure 454 may form a pliant interface between speaker membrane 414M and housing sidewalls 412S. This is merely illustrative. If desired, suspension structure 454 may form a pliant interface between speaker membrane 414M and any suitable surrounding housing structure or any suitable rigid support structure.

If desired, other suspension structures may be incorporated into speaker structure 448. For example, there may be one or more suspension structures attached to magnet 440. This type of suspension structure may provide a restoring force that returns magnet 440 to an equilibrium position after being displaced by magnetic forces.

The desired range of frequencies produced by speaker 448 may depend on several factors. For example, the desired range of frequencies produced by speaker 448 may depend on the type of electronic device in which speaker 448 is implemented, may depend on the location of speaker 448 in device 10, may depend on the other speaker structures that are being used in combination with speaker structure 448, etc. Design choices may be made to obtain a desired frequency response from speaker 448. For example, materials used in forming speaker 448 may be selected based on the desired frequency response.

The type of enclosure that surrounds speaker 448 may also be selected based on the desired frequency

response. For example, the enclosure that surrounds the speaker may be ported. As shown in FIG. 36, housing 412 may optionally be provided with an opening or port such as acoustic port 452 (sometimes referred to as a funnel, horn, vent, hole, etc.). Port 452 may be used to equalize the pressure between the inside of housing 412 and the outside of housing 412. This may in turn augment the sound waves produced by speaker 448. A ported enclosure such as the ported enclosure shown in the example of FIG. 36 may increase the magnitude of low-frequency sound waves produced by speaker 448 (e.g., a speaker with a ported enclosure may have a higher bass output than a speaker with a sealed enclosure).

As shown in FIG. 36, port 452 may have a portion such as portion 452P that protrudes into the enclosure. The size and shape of protruding portion 452P may be customized to obtain a desired frequency response. For example, protruding portion 452P of port 452 may have a "horn" shape, in which the diameter of opening 452 varies along the length of portion 452P. Protruding portion 452P may have a curved shape, if desired. In general, protruding portion 452P may have any suitable shape, and opening 452 may have any suitable size. The characteristics of port 452 will depend on the desired frequency response of speaker 448, the structure of device 10, etc., and may be modified accordingly. The example shown in FIG. 36 is merely illustrative.

If desired, speaker 448 may be provided with a sealed enclosure that does not have a port. The example of FIG. 36 in which housing 412 is provided with port 452 is merely illustrative. The type of enclosure into which speaker 448 is implemented (e.g., a sealed enclosure, a ported enclosure, etc.) will depend on the desired frequency response of speaker 448, the structure of device

10, etc., and may be modified accordingly.

Electronic device 10 may have internal components or structures such as internal component 456. Internal components such as internal component 456 may optionally be used to tune the resonant frequency of speaker 448. Internal component 456 may be a battery or other internal structure. If desired, optional component 456 may be omitted or may otherwise not be used to tune the resonant frequency of speaker 448.

If desired, housing 412 may have one or more raised edges such as optional raised portion 412'. Raised portion 412' may have an upper surface that lies above the upper surface of display 414 (e.g., the upper surface of raised portion 412' may protrude above the upper surface of flexible display 414 in vertical dimension z). Optional raised housing 412' may allow a user to hold device 10 in hand without disrupting the speaker functionality of display 414. Raised portion 412' of housing 412 may surround the entire periphery of display 414, or may be located on one side of display 414, on two sides of display 414, on three sides of display 414, or on all four sides of display 414. Raised portion 412' may be formed as an integral part of housing 412 or may be formed as a separate structure in contact with housing 412.

FIG. 37 is a cross-sectional side view of a portion of electronic device 10 in the vicinity of another possible embodiment of speaker structure 448. As shown in FIG. 37, speaker structure 448 may be driven by a transducer such as transducer 450. In the example of FIG. 37, transducer 450 may be formed from one or more central sets of coils 442 surrounded by a magnet such as magnet 440. In some arrangements, inner portion 444 of coils 442 may also contain a magnet structure (e.g., coils 442 may surround a magnet structure). Magnet structures that are

formed within inner portion 444 of coils 442 may be formed as an integral part of outer magnet 440 (e.g., may be joined above and/or below coils 442) or may be a separate magnet structure. If desired, inner portion 444 of coils 442 may be free of magnet structures.

As with the transducer of FIG. 36, transducer 450 of FIG. 37 may be configured to receive electrical audio signal input from circuitry in device 10 and to convert the electrical signal into sound. As current passes through coils 442, a magnetic field is produced. The magnetic field produced by coils 442 interacts with the constant magnetic field produced by permanent magnet 440. The interaction of the electromagnet with the constant magnetic field will create a magnetic force between coils 442 and magnet 440 (e.g., an attractive or repulsive force). When the current flowing through coils 442 changes direction, the polarity of the variable electromagnet (and thus the direction of magnetic force) is reversed. Coils 442 may be pushed back and forth (along the z-axis) by the varying magnetic force as the current in coils 442 alternates directions.

As coils 442 move back and forth, attached speaker membrane 414M will in turn vibrate the air in front of speaker membrane 414M, creating sound waves. Support structure 446 may be used to stiffen speaker membrane 414M so that membrane portion 414M of flexible display 414 responds accurately to the movement of transducer 450.

In the example of FIG. 37, speaker 448 may be provided with a sealed enclosure that does not have a port. This is merely illustrative. Any suitable type of enclosure (e.g., a sealed enclosure, a ported enclosure, etc.) may be used. The type of enclosure into which speaker 448 is implemented will depend on the desired

frequency response of speaker 448, the structure of device 10, etc., and may be modified accordingly.

FIG. 38 is a cross-sectional side view of a portion of device 10 in the vicinity of another possible embodiment of speaker structure 448. In the example of FIG. 38, speaker 448 is supported by a rigid structure within device 10 such as rigid structure 466. Rigid structure 466 may be formed from housing structures or internal components, or may be a dedicated structure used to form a frame (sometimes referred to as a chassis or "basket") or other rigid support structure for speaker 448. Suspension structure 454 may be used to form a pliant interface between speaker 448 and rigid structure 466. As with the suspension structure of FIGS. 7 and 8 (in which suspension structure 454 is attached to housing sidewalls 412S), suspension structure 454 of FIG. 38 may prevent speaker membrane portions 414M of display 414 from moving laterally along the x-axis and/or the y-axis, but may allow free motion of speaker membrane 414M along the z-axis as speaker 448 produces sound. Suspension structure 454 may be attached to any suitable portion of speaker 448 (e.g., support structure 446, magnet 440, speaker membrane portion 414M, etc.)

The type of arrangement shown in FIG. 38 may be beneficial for configurations in which speaker 448 is not in the vicinity of housing sidewalls 412S or in other configurations in which speaker 448 is not attached to housing 412. For example, speaker 448 may be located in the central portion of a large display. In this type of configuration, a rigid structure such as rigid structure 466 of FIG. 38 may be used to support speaker 448, if desired.

There may be one or more speakers 448 in device 10. Multiple speakers 448 may be attached to a common

rigid structure 466 or each speaker 448 may be attached to a separate rigid structure 466.

If desired, a cover layer such as optional cover layer 462 may be formed over flexible display 414. Cover layer 462 may be formed from glass, plastic, or other suitable material. Cover layer 462 may allow a user to hold device 10 in hand without disrupting the speaker functionality of display 414. Cover layer 462 may also serve to protect display 414 and other parts of device 10 while still allowing speaker membrane 414M to move freely along the z-axis as speaker 448 produces sound. Cover layer 462 may be in contact with display 414 or there may be a gap 463 interposed between cover layer 462 and display 414. Gap 463 may be filled with air or may include a layer of material such as a layer of sealant (as an example).

One or more holes such as holes 464 (sometimes referred to as openings or speaker openings) may be formed in cover layer 462 so that sound may pass from speaker 448 to the exterior of device 10.

A perspective view of device 10 showing how holes 464 may be formed in cover layer 462 is shown in FIG. 39. As shown in FIG. 39, holes 464 may be formed in a "speaker grill" fashion in which an array of openings is formed in front of one or more speakers. Holes 464 may be formed in cover layer 462 in any suitable location. For example, holes 464 may be formed in localized areas of cover layer 462 that overlap a speaker structure, or holes 464 may be formed in a uniform array that covers some, all, or substantially all of the front surface of display 414. Holes 464 may have any suitable size. For example, holes 464 may have a diameter between .25 mm and .5 mm, between .5 mm and 1 mm, between 1 mm and 1.5 mm, more than 1.5 mm, less than 1.5 mm, etc. The size, shape, and

number of openings 464 formed in cover layer 462 may depend on the type and number of speakers 448 in device 10.

FIG. 40 is a cross-sectional side view of device 10 in the vicinity of support structure 446. Support structure 446 may be used to stiffen portions of flexible display 414. As discussed in connection with FIG. 36, stiffening structure 446 may be formed from a metal plate, from fiber-based composite materials, from laminated layers of one or more materials, or from other suitable materials. As shown in the example of FIG. 40, stiffening structure 446 may be formed from a layer of foam 474 interposed between first and second stiffening sheets 472. Sheets 472 may be formed from polymer, metal, glass, ceramic, fiber-based composites, or other suitable materials. This type of structure may provide a stiff and lightweight support structure for display 414. If desired, support structure 446 may be used to stiffen speaker membrane portions 414M of display 414, may be used to stiffen other portions of display 414, or may be used to stiffen all or substantially all of display 414.

Support structure 446 may be shaped in any desired fashion. For example, support structure 446 may be curved, may be planar, or may have a combination of curved and planar portions.

FIG. 41 is a cross-sectional side view of device 10 in the vicinity of curved support structure 446. As shown in FIG. 41, flexible display 414 may conform to the shape of stiffening structure 446. In the example of FIG. 41 stiffening structure 446 has a curved shape so that flexible display 414 is concave. This is, however, merely illustrative. In general, stiffening structure 446 and the attached portion of display 414 may have any suitable shape. For example, stiffening structure 446 may have a

curved shape so that flexible display 414 is convex. The example of FIG. 41 in which display 414 has a concave shape may be suitable for configurations in which display 414 forms a speaker membrane for speaker 448. A concave shaped speaker membrane may improve the quality of sound produced by speaker 448. Speakers with convex membranes may also be used.

FIG. 42 is a cross-sectional side view of device 10 in the vicinity of a single speaker structure. As shown in FIG. 42, portion 414M of flexible display 414 may form a speaker membrane for speaker structure 448. Transducer 450 for speaker 448 may be any suitable type of transducer (e.g., one or more sets of coils surrounded by a magnet, one or more sets of coils surrounding a magnet, a piezoelectric transducer, a microphone transducer, a sensor, an actuator, etc.). Speaker 448 may be the only speaker in device 10 or may be one of a plurality of speakers in device 10. Display-based speaker structure 448 may be used in conjunction with speaker structures that are not display-based. For example, there may be other speakers in device 10 which do not use display 414 as a speaker membrane. Speaker structure 448 of FIG. 42 may use all or substantially all of display 414 as a speaker membrane (e.g., the entire front face of device 10 may be occupied by a speaker), or may use only a portion of display 414 as a speaker membrane.

In the example of FIG. 43, an array of transducers 450 may be used to form a plurality of display-based speakers 448. Display-based speaker structures 448 may be used in conjunction with speaker structures that are not display-based. Each display-based speaker 448 may have an associated transducer 450. Each associated transducer 450 may be any suitable type of transducer (e.g., one or more sets of coils surrounded by

a magnet, one or more sets of coils surrounding a magnet, a piezoelectric transducer, a microphone transducer, a sensor, an actuator, etc.). The type of transducer 450 used may be different for each speaker 448 (e.g., the array of speakers 448 in FIG. 43 may include different types of transducers, if desired). Providing speakers 448 with different types of transducers, different structures, and different characteristics may give device 10 the ability to produce sound with a wider range of frequencies.

FIG. 44 is a bottom view of a portion of device 10 showing how an array of display-based speakers such as the array shown in FIG. 43 may be implemented in device 10. In the example of FIG. 44, support structure 446 is formed on the underside of display 414. Support structure 446 may be used to stiffen speaker membrane portions 414M of display 414 (e.g., support structure 446 may be interposed between transducer 450 and display 414). Support structure 446 may also be used to stiffen portions of display 414 between adjacent speakers 448.

Each speaker 448 may be surrounded by a ring 414' of flexible display 414 that is not stiffened by support structure 446. Flexible ring-shaped portions 414' of flexible display 414 may provide a barrier structure around each speaker 448 that prevents interference between adjacent speakers 448. For example, as speaker membrane 414M vibrates, ring 414' (which is surrounded by support structure 446) may absorb vibrations moving laterally in display 414 (e.g., in directions along the x-axis and/or y-axis). This may allow adjacent speakers 448 to operate independently without being disrupted by the vibrations of a neighboring speaker.

If desired, speakers 448 may include a variety of speaker types. Examples of speaker types that may be

used for speakers 448 include subwoofers, woofers, mid-range speakers, tweeters, supertweeters, etc. If desired, different channels of audio input may be routed to each speaker. For example, speakers 448 may include a center channel speaker, a left channel speaker, a right channel speaker, a surround channel speaker, etc. Any suitable characteristic of speakers 448 (e.g., size, type, location, input channel, etc.) may be modified to achieve a desired frequency response and/or to accommodate the structure of device 10.

Electronic devices that contain flexible displays and one or more display-based speaker structures may be provided. The speaker structures may be positioned under the flexible display. Portions of the flexible display may be used as speaker membranes for the speaker structures. The speaker structures may be driven by transducers that convert electrical audio signal input into sound. Piezoelectric transducers or transducers formed from coils and magnets may be used to drive the speaker structures. Speaker membranes may be formed from active display areas of the flexible display. Some, all, or substantially all of the flexible display may be used as a speaker membrane for one or more display-based speaker structures. An optional cover layer may be provided with speaker openings so that sound may pass from the display-based speaker structures to the exterior of the device.

In accordance with another embodiment, an electronic device is provided including a flexible display and a speaker structure having a speaker membrane, where the speaker membrane is formed from a portion of the flexible display.

In accordance with another embodiment, the electronic device further includes a stiffening structure

configured to stiffen the portion of the flexible display that forms the speaker membrane.

In accordance with another embodiment, the stiffening structure includes a layer of foam.

In accordance with another embodiment, the stiffening structure includes first and second stiffening sheets that are attached to opposing first and second sides of the layer of foam.

In accordance with another embodiment, the flexible display includes an active portion configured to display images and the speaker membrane is formed from the active portion of the flexible display.

In accordance with another embodiment, the electronic device further includes a rigid structure and a suspension structure configured to attach portions of the speaker structure to the rigid structure.

In accordance with another embodiment, the electronic device further includes an electronic device housing in which the flexible display is mounted, where the rigid structure is formed at least partly from the electronic device housing.

In accordance with another embodiment, the electronic device further includes a cover layer formed over the flexible display, where the cover layer includes at least one opening formed over the speaker membrane.

In accordance with another embodiment, the electronic device further includes an electronic device housing in which the flexible display is mounted, where the electronic device housing has at least one acoustic port.

In accordance with another embodiment, the flexible display includes an organic light-emitting diode display having a substrate formed from a flexible sheet of polymer.

In accordance with another embodiment an electronic device is provided including a flexible display and a plurality of speaker structures, where portions of the flexible display form speaker membranes for the plurality of speaker structures.

In accordance with another embodiment, the electronic device further includes a plurality of stiffening structures configured to stiffen the portions of the flexible display that form the speaker membranes.

In accordance with another embodiment, the flexible display includes a set of stiffened regions, where each of the stiffened regions in the set of stiffened regions forms part of a respective one of the speaker structures, flexible regions, where each of the flexible regions surrounds a respective one of the stiffened regions in the set of stiffened regions, and a surrounding stiffened region, where each of the flexible regions is surrounded by portions of the surrounding stiffened region.

In accordance with another embodiment, the speaker structures include a left channel speaker and a right channel speaker.

In accordance with another embodiment, the electronic device further includes transducers configured to drive the speaker structures, where each transducer includes coils and a magnet.

In accordance with another embodiment, the electronic device further includes piezoelectric transducers configured to drive the speaker structures.

In accordance with another embodiment, the flexible display includes an organic light-emitting diode display having a substrate formed from a flexible sheet of polymer.

In accordance with another embodiment, a

portable electronic device is provided, including a housing, a flexible organic light-emitting diode display mounted in the housing, where the flexible organic light-emitting diode display has a substrate formed from a flexible sheet of polymer, and at least one speaker having a speaker membrane formed from a portion of the flexible sheet of polymer.

In accordance with another embodiment, the portable electronic device further includes a stiffening structure interposed between the at least one speaker and the speaker membrane, where the stiffening structure includes a composite material.

In accordance with another embodiment, the speaker membrane has a concave shape.

In accordance with another embodiment, the housing includes a rectangular housing with four peripheral edges and the flexible organic light-emitting diode display and the speaker membrane extend between the four peripheral edges.

The foregoing is merely illustrative of the principles of this invention and various modifications can be made by those skilled in the art without departing from the scope and spirit of the invention. The foregoing embodiments may be implemented individually or in any combination.

What is Claimed is:

1. An electronic device, comprising:

a flexible display; and

an internal component, wherein the flexible display may be deformed by an action external to the device, and wherein deformation of the flexible display creates a response from the internal component.

2. The electronic device defined in claim 1 wherein the flexible display comprises:

a flexible display layer; and

a touch-sensitive layer.

3. The electronic device defined in claim 2 wherein the flexible display layer of the flexible display includes an active display region, and wherein the internal component is covered with a portion of the active display region of the flexible display.

4. The electronic device defined in claim 3 wherein the internal component comprises a button, and wherein deformation of the flexible display compresses the button.

5. The electronic device defined in claim 4 wherein the flexible display further comprises a rigid cover layer having at least one opening.

6. The electronic device defined in claim 5 wherein the opening comprises a hole in the rigid cover layer, wherein the button further comprises a button member in the opening, wherein the button member moves within the hole in the rigid cover layer, and wherein the

movement of the button member in the opening causes deformation of the flexible display.

7. The electronic device defined in claim 3 wherein the internal component comprises a pressure sensor, and wherein deformation of the flexible display exerts a mechanical pressure on the pressure sensor.

8. The electronic device defined in claim 7 wherein the pressure sensor comprises a piezoelectric actuator, and wherein the mechanical pressure induces a voltage on the piezoelectric actuator.

9. The electronic device defined in claim 3 wherein the internal component comprises a laser microphone for detecting a sound originating external to the electronic device, and wherein detecting the sound comprises with a laser, detecting deformation of the flexible display.

10. An electronic device, comprising:

a flexible display; and

an audio component that transmits or receives sound through the flexible display.

11. The electronic device defined in claim 10 wherein the flexible display includes an active display region, and wherein the audio component is mounted behind the active display region of the flexible display.

12. The electronic device defined in claim 11 wherein the flexible display comprises:

a flexible display layer; and

a touch-sensitive layer.

13. The electronic device defined in claim 11 wherein the audio component comprises a diaphragm, and wherein the diaphragm is mounted in contact with the flexible display.

14. An electronic device, comprising:

a housing;

a flexible display mounted on the housing; and

a first internal component mounted under a portion of the flexible display, wherein the first internal component is configured to deform the portion of the flexible display.

15. The electronic device defined in claim 14 wherein the first internal component comprises a piezoelectric actuator, wherein a voltage applied to the piezoelectric actuator causes an expansion of the piezoelectric actuator, and wherein the portion of the flexible display deforms in response to the expansion of the piezoelectric actuator.

16. The electronic device defined in claim 14 wherein the first internal component comprises a structural component, wherein the portion of the flexible display deforms in response to physical contact with the structural component, and wherein deformation of the portion of the flexible display causes the portion of the flexible display to conform to a surface of the structural component.

17. The electronic device defined in claim 16 further comprising a second internal component mounted

under the portion of the flexible display, wherein the portion of the flexible display that conforms to the surface of the structural component indicates the location of the second internal component.

18. The electronic device defined in claim 17 wherein the second internal component comprises a button, wherein the portion of the flexible display is configured to be further deformed by an action external to the electronic device, and wherein further deformation of the portion of the flexible display compresses the button.

19. The electronic device defined in claim 16 wherein the first internal component further comprises an actuator, wherein the structural component is mounted on the actuator, wherein raising the actuator moves the structural component into contact with the portion of the flexible display, and wherein lowering the actuator moves the structural component out of contact with the flexible display.

20. The electronic device defined in claim 19 wherein the flexible display comprises a touch-sensitive layer and wherein deformation of the portion of the flexible display conforming to the surface of the structural component indicates the location of a portion of the touch-sensitive layer of the flexible display.

21. The electronic device defined in claim 19 further comprising a second internal component mounted on the actuator, and wherein deformation of the portion of the flexible display conforming to the surface of the structural component indicates the location of the second internal component.

22. The electronic device defined in claim 19 further comprising:

a cover member; and

an actuator switch coupled to the actuator, wherein deformation of the flexible display exerts a pressure on the cover member, and wherein the pressure on the cover member lifts the cover member.

23. An electronic device, comprising:

a housing; and

a concave display mounted in the housing, wherein the concave display has a rigid internal support structure having a concave surface and a flexible display layer attached to the rigid internal support structure that conforms to the concave surface of the rigid support structure.

24. The electronic device defined in claim 23 wherein the concave display further comprises a first adhesive layer, and wherein the first adhesive layer attaches the flexible display layer to the concave surface of the rigid internal support structure.

25. The electronic device defined in claim 23 wherein the concave display further comprises a touch-sensitive layer.

26. The electronic device defined in claim 25 wherein the concave display further comprises first and second adhesive layers, wherein the first adhesive layer attaches the flexible display layer to the touch-sensitive layer, and wherein the second adhesive layer attaches the flexible display layer to the rigid internal support

structure.

27. The electronic device defined in claim 23 wherein the housing comprises a bezel, and wherein the bezel surrounds a periphery of the concave display.

28. The electronic device defined in claim 26 wherein the rigid internal support structure has a convex inner surface and wherein the electronic device further comprises at least one internal component mounted adjacent to the convex inner surface.

29. The electronic device defined in claim 28, wherein the rigid internal support structure has at least one opening.

30. The electronic device defined in claim 29 wherein the at least one opening comprises a hole in the rigid internal support structure, and wherein the at least one internal component is mounted in the hole in the rigid internal support structure.

31. An electronic device, comprising:

a housing; and

a concave display mounted in the housing, wherein the concave display includes a rigid cover layer having at least one concave outer surface and at least one corresponding convex inner surface and includes a flexible display layer, wherein the flexible display layer conforms to the convex inner surface of the rigid cover layer.

32. The electronic device defined in claim 31 wherein the flexible display layer comprises image pixels formed from organic light-emitting diodes.

33. The electronic device defined in claim 31 wherein the concave display further comprises a first adhesive layer, and wherein the first adhesive layer attaches the flexible display layer to the convex inner surface of the rigid cover layer.

34. The electronic device defined in claim 33 wherein the rigid cover layer has at least one opening, wherein the electronic device further comprises an internal component, and wherein the internal component is mounted adjacent to the flexible display layer under the at least one opening in the rigid cover layer.

35. The electronic device defined in claim 34 wherein the internal component comprises a speaker and wherein the speaker transmits sound through the flexible display layer.

36. The electronic device defined in claim 34 wherein the internal component comprises a button, wherein the electronic device further comprises a button member in the at least one opening in the rigid cover layer, wherein the button member moves within the at least one opening in the rigid cover layer, and wherein the movement of the button member compresses the button.

37. An electronic device, comprising:

an electronic device housing; and

a concave display mounted in the electronic device housing, wherein the concave display comprises a rigid cover layer having a concave outer surface and a convex inner surface, a flexible display layer, and a touch-sensitive layer, wherein the flexible display layer

and the touch-sensitive layer each conform to the convex inner surface of the rigid cover layer.

38. The electronic device defined in claim 37 wherein the concave display further comprises first and second adhesive layers, wherein the flexible display layer is attached to the touch-sensitive layer with the first adhesive layer, and wherein the touch-sensitive layer is attached to the convex inner surface of the rigid cover layer with the second adhesive layer.

39. The electronic device defined in claim 38 further comprising at least one internal component mounted adjacent to the flexible display layer of the concave display.

40. The electronic device defined in claim 39 wherein the rigid cover layer of the convex display has at least one opening, wherein the at least one internal component is an audio component, and wherein the audio component is mounted under the at least one opening in the rigid cover layer.

41. The electronic device defined in claim 38 wherein the concave outer surface of the concave display has a curvature and peripheral edges, wherein the curvature has a deepest point, wherein the deepest point and at least some of the peripheral edges define a maximum depth associated with the curvature of the concave display and wherein the maximum depth of the concave display is between 0.5 millimeter and 20 millimeters.

42. The electronic device defined in claim 41 further comprising an internal component, wherein the

internal component is mounted at a distance from the peripheral edges of the concave outer surface, and wherein the distance is smaller than the maximum depth.

43. An electronic device, comprising:

a housing; and

a display mounted in the housing, wherein the display has a flexible display layer that conforms to a convex outer surface of a rigid support structure.

44. The electronic device defined in claim 43 wherein the display further comprises an adhesive layer, and wherein the adhesive layer attaches the flexible display layer to the convex outer surface of the rigid support structure.

45. The electronic device defined in claim 43 wherein the display further comprises a touch-sensitive layer.

46. The electronic device defined in claim 45 wherein the display further comprises first and second adhesive layers, wherein the first adhesive layer attaches the flexible display layer to the touch-sensitive layer, and wherein the second adhesive layer attaches the flexible display layer to the convex outer surface of the rigid support structure.

47. The electronic device defined in claim 46 wherein the flexible display layer comprises image pixels formed from organic light-emitting diodes.

48. The electronic device defined in claim 46, wherein the housing has at least one opening, wherein the

opening is associated with a connector port, the electronic device further comprising a connector structure mounted in the connector port.

49. An electronic device, comprising:

a housing; and

a display mounted in the housing, wherein the display includes a rigid cover layer having at least one convex outer surface and having at least one associated concave inner surface and includes a flexible display layer that conforms to the concave inner surface.

50. The electronic device defined in claim 49 wherein the display further comprises an adhesive layer, and wherein the adhesive layer bonds the flexible display layer to the concave inner surface of the rigid cover layer.

51. The electronic device defined in claim 49 wherein the rigid cover layer comprises glass.

52. The electronic device defined in claim 51 wherein the flexible display layer comprises image pixels formed from organic light-emitting diodes.

53. The electronic device defined in claim 49 wherein the flexible display layer comprises image pixels formed from organic light-emitting diodes.

54. The electronic device defined in claim 49 wherein the display further comprises a touch sensor layer that conforms to the concave inner surface.

55. The electronic device defined in claim 54

wherein the concave display further comprises first and second adhesive layers, wherein the first adhesive layer attaches the flexible display layer to the touch sensor layer, and wherein the second adhesive layer attaches the touch sensor layer to the concave inner surface of the display.

56. The electronic device defined in claim 55 wherein touch sensor layer comprises indium-tin-oxide electrodes.

57. The electronic device defined in claim 49 further comprising an internal component, wherein the concave inner surface of the display provides an additional internal volume for the electronic device, and wherein the internal component is mounted at least partially in the additional internal volume.

58. An electronic device having at least a front surface and a rear surface, comprising:

electronic components interposed between the front and rear surfaces; and

a display that substantially covers at least the front and rear surfaces and that surrounds the electronic components, wherein the display comprises a rigid cover layer having at least one inner surface and a flexible display layer that is bent to conform to the inner surface.

59. The electronic device defined in claim 58 wherein the display further comprises a touch-sensitive layer attached to at least a portion of the flexible display layer.

60. The electronic device defined in claim 58 wherein the inner surface comprises a concave inner surface, the electronic device further comprising a connector structure and a housing having an opening, wherein the connector structure is mounted in the opening to form a connector port.

61. The electronic device defined in claim 58 wherein the electronic device has at least two sidewall surfaces, and wherein the display substantially covers the two sidewall surfaces.

62. The electronic device defined in claim 61 wherein the display has at least two edges, and wherein the edges of the display are joined by a joining member.

63. An electronic device, comprising:

a flexible display; and

a speaker structure having a speaker membrane, wherein the speaker membrane is formed from a portion of the flexible display.

64. The electronic device defined in claim 63, further comprising:

a stiffening structure configured to stiffen the portion of the flexible display that forms the speaker membrane.

65. The electronic device defined in claim 64 wherein the stiffening structure comprises a layer of foam.

66. The electronic device defined in claim 65 wherein the stiffening structure comprises first and

second stiffening sheets that are attached to opposing first and second sides of the layer of foam.

67. The electronic device defined in claim 63 wherein the flexible display comprises an active portion configured to display images and wherein the speaker membrane is formed from the active portion of the flexible display.

68. The electronic device defined in claim 63, further comprising:

a rigid structure; and

a suspension structure configured to attach portions of the speaker structure to the rigid structure.

69. The electronic device defined in claim 68, further comprising:

an electronic device housing in which the flexible display is mounted, wherein the rigid structure is formed at least partly from the electronic device housing.

70. The electronic device defined in claim 63, further comprising:

a cover layer formed over the flexible display, wherein the cover layer comprises at least one opening formed over the speaker membrane.

71. The electronic device defined in claim 63 further comprising an electronic device housing in which the flexible display is mounted, wherein the electronic device housing has at least one acoustic port.

72. The electronic device defined in claim 63

wherein the flexible display comprises an organic light-emitting diode display having a substrate formed from a flexible sheet of polymer.

73. An electronic device, comprising:

a flexible display; and

a plurality of speaker structures, wherein portions of the flexible display form speaker membranes for the plurality of speaker structures.

74. The electronic device defined in claim 73, further comprising:

a plurality of stiffening structures configured to stiffen the portions of the flexible display that form the speaker membranes.

75. The electronic device defined in claim 73 wherein the flexible display comprises:

a set of stiffened regions, wherein each of the stiffened regions in the set of stiffened regions forms part of a respective one of the speaker structures;

flexible regions, wherein each of the flexible regions surrounds a respective one of the stiffened regions in the set of stiffened regions; and

a surrounding stiffened region, wherein each of the flexible regions is surrounded by portions of the surrounding stiffened region.

76. The electronic device defined in claim 73 wherein the speaker structures comprise a left channel speaker and a right channel speaker.

77. The electronic device defined in claim 73, further comprising:

transducers configured to drive the speaker structures, wherein each transducer comprises coils and a magnet.

78. The electronic device defined in claim 73 further comprising piezoelectric transducers configured to drive the speaker structures.

79. The electronic device defined in claim 73 wherein the flexible display comprises an organic light-emitting diode display having a substrate formed from a flexible sheet of polymer.

80. A portable electronic device, comprising:

a housing;

a flexible organic light-emitting diode display mounted in the housing, wherein the flexible organic light-emitting diode display has a substrate formed from a flexible sheet of polymer; and

at least one speaker having a speaker membrane formed from a portion of the flexible sheet of polymer.

81. The portable electronic device defined in claim 80, further comprising:

a stiffening structure interposed between the at least one speaker and the speaker membrane, wherein the stiffening structure comprises a composite material.

82. The portable electronic device defined in claim 80 wherein the speaker membrane has a concave shape.

83. The portable electronic device defined in claim 80 wherein the housing comprises a rectangular

housing with four peripheral edges and wherein the flexible organic light-emitting diode display and the speaker membrane extend between the four peripheral edges.

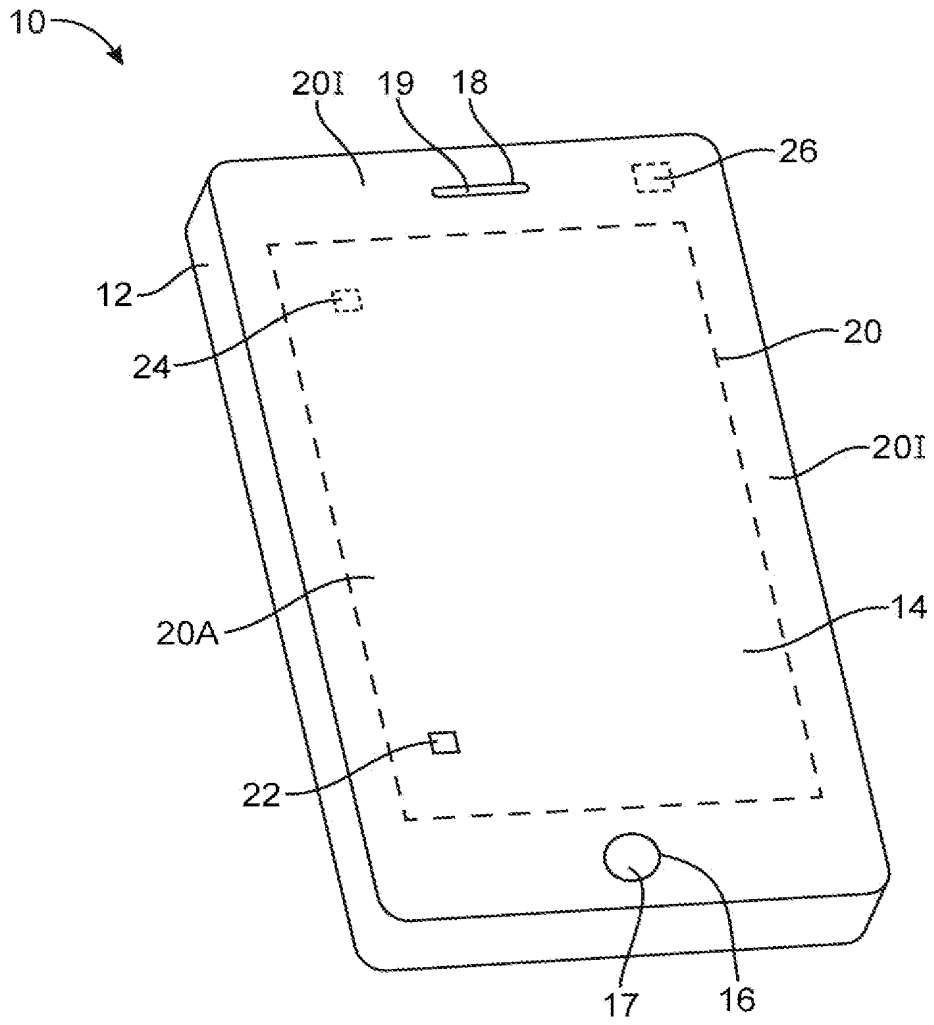


FIG. 1

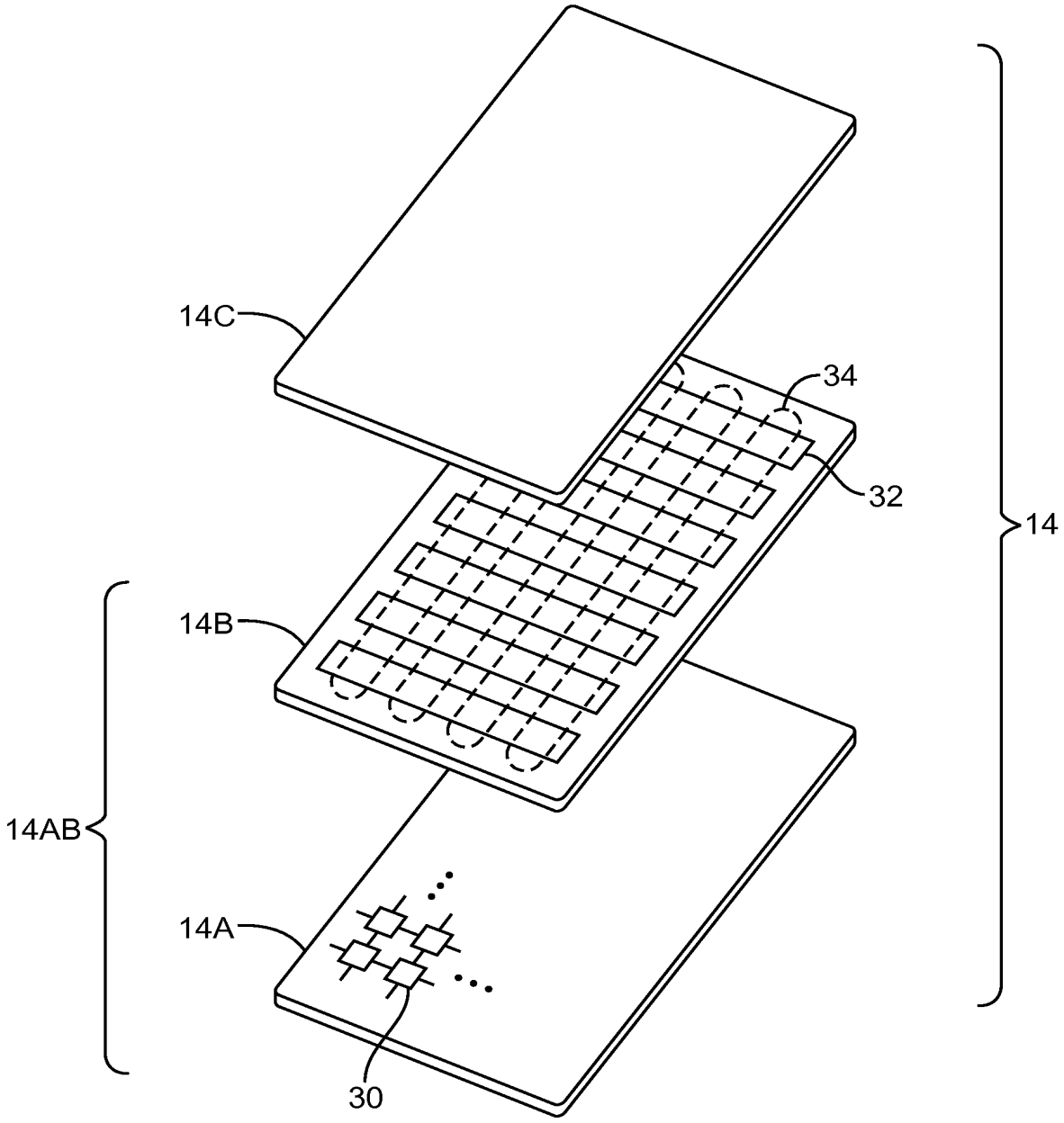


FIG. 2

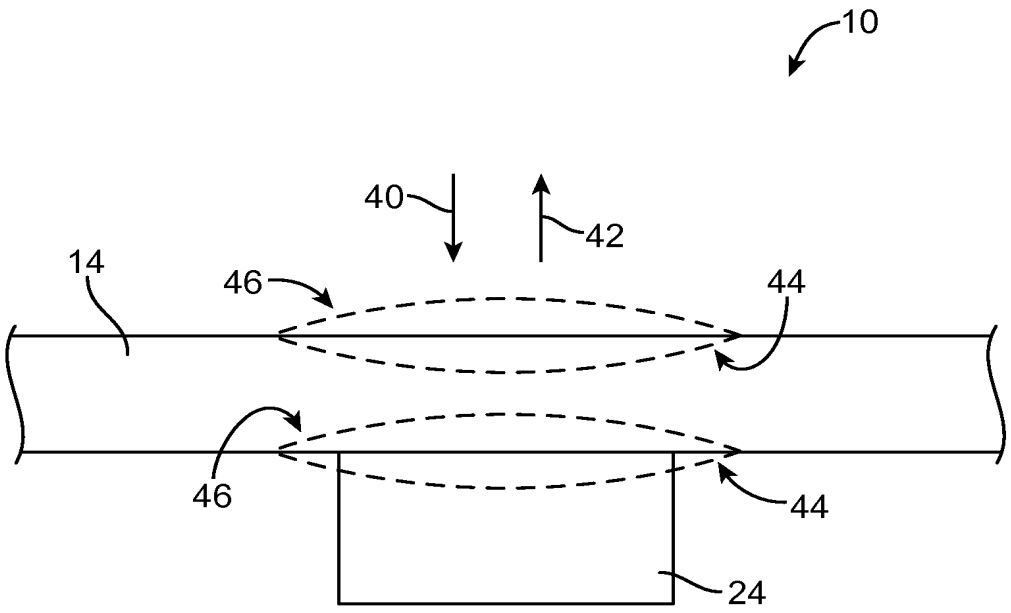


FIG. 3

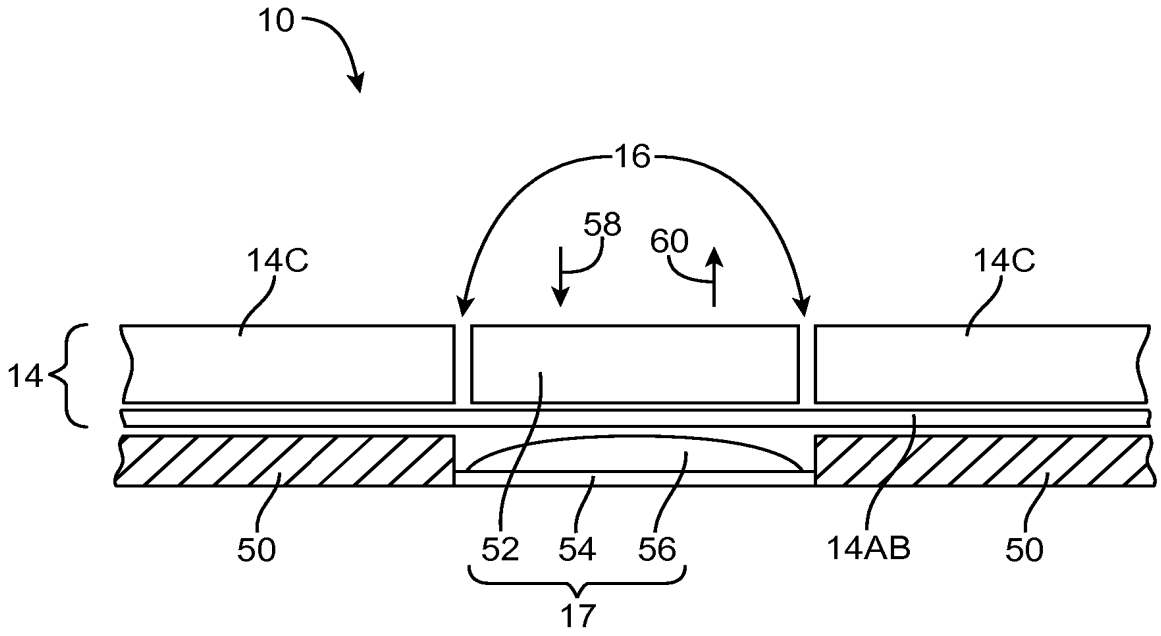


FIG. 4

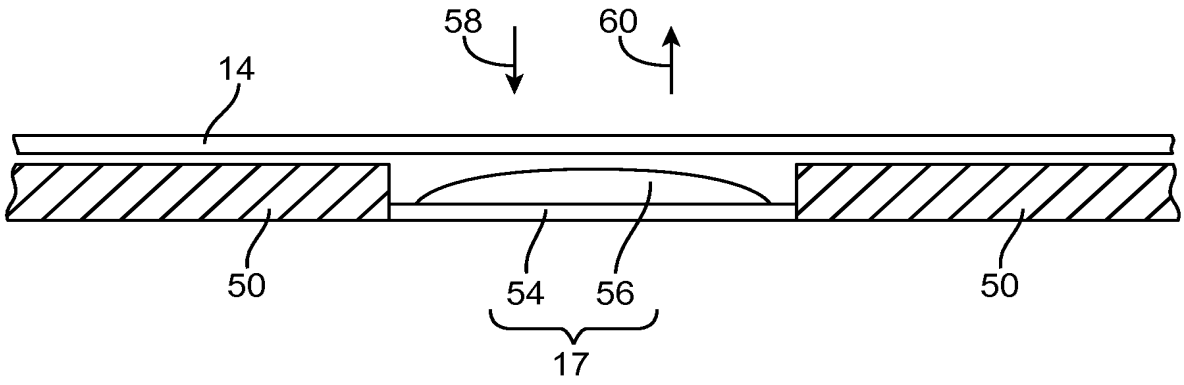


FIG. 5

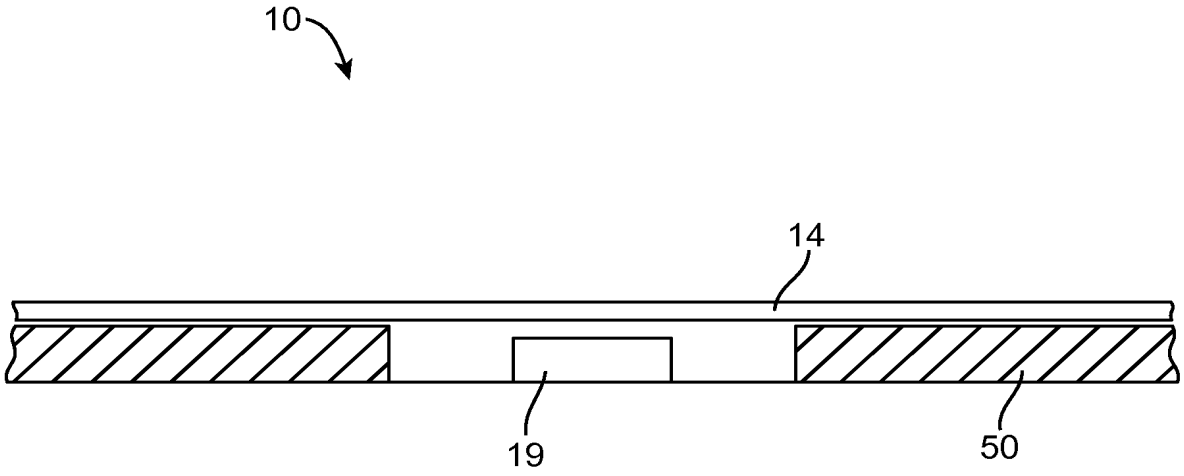


FIG. 6

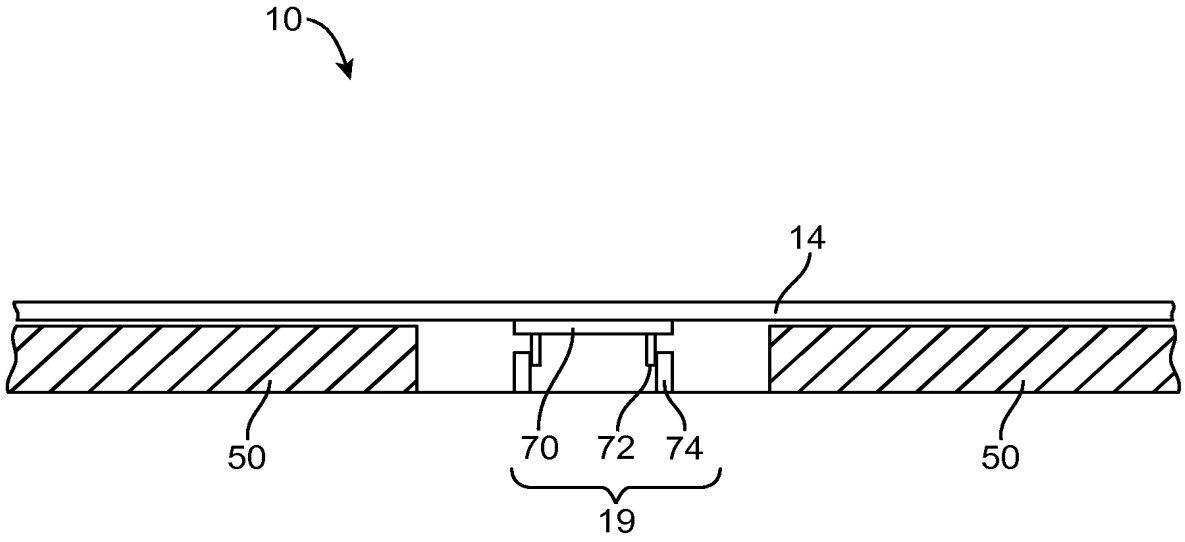


FIG. 7

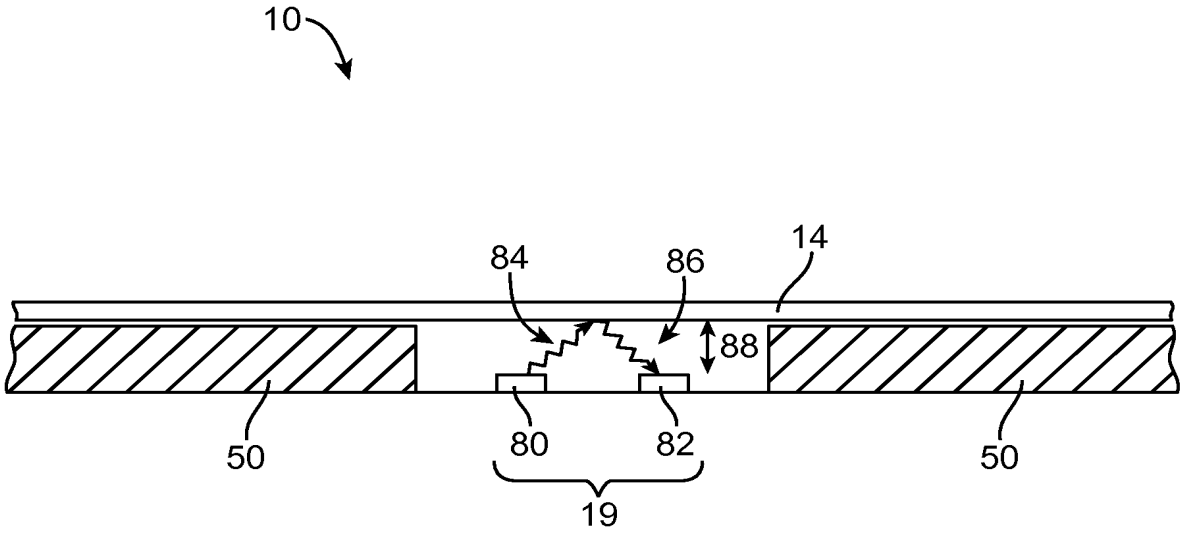


FIG. 8

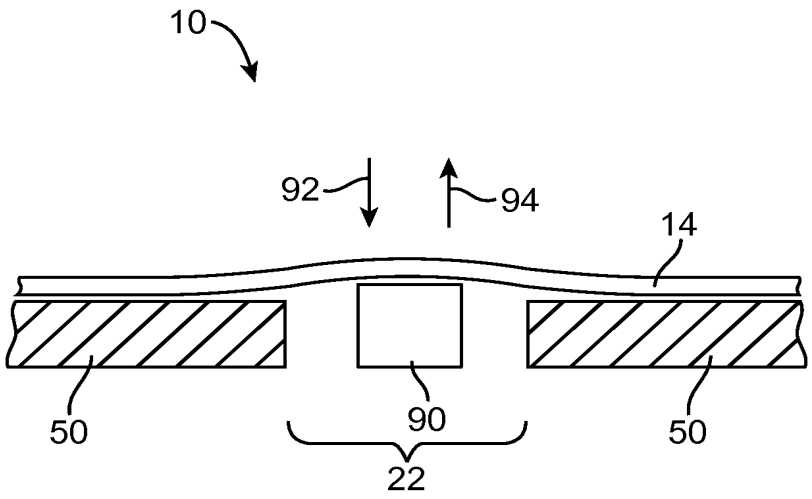


FIG. 9

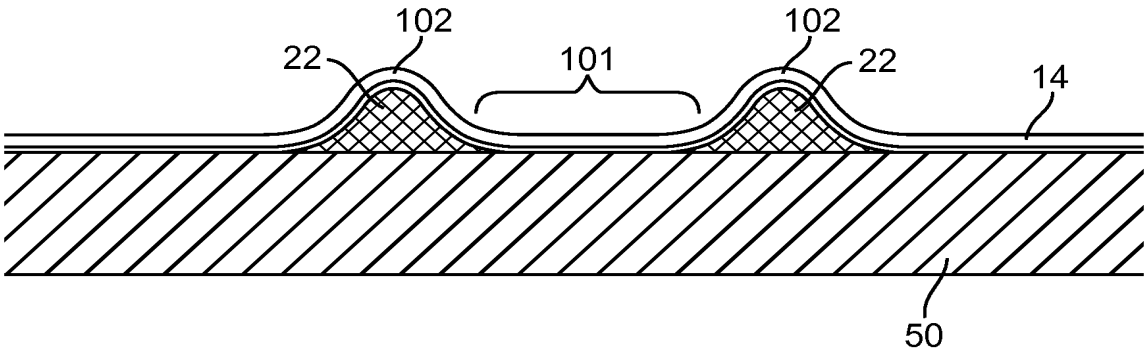


FIG. 10

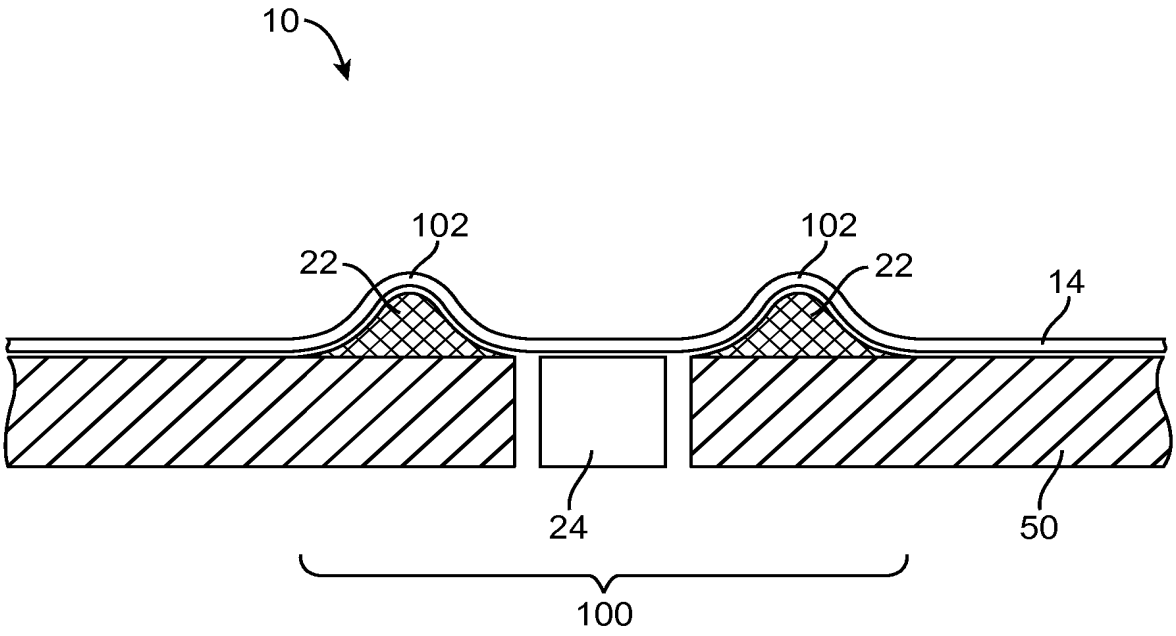


FIG. 11

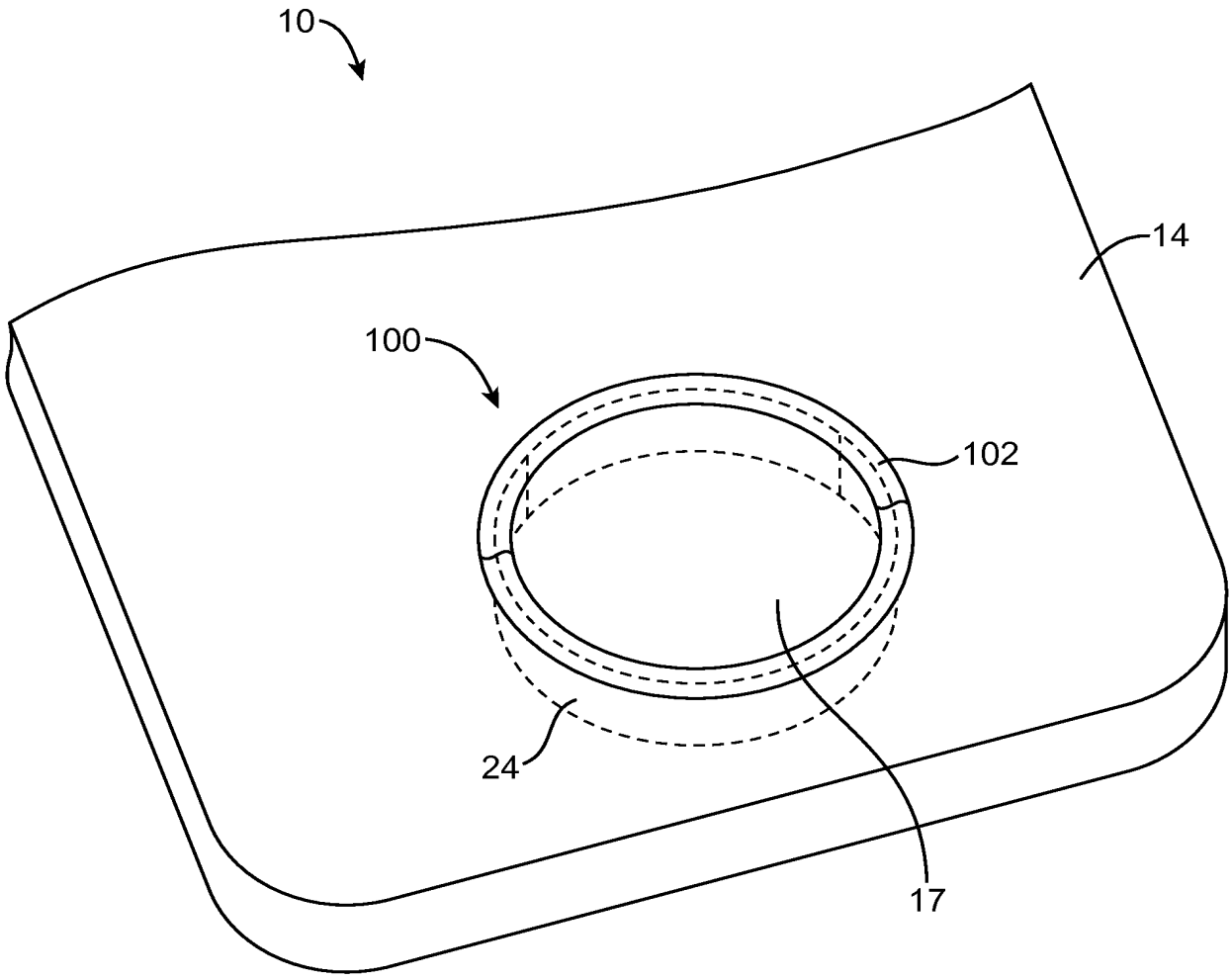


FIG. 12

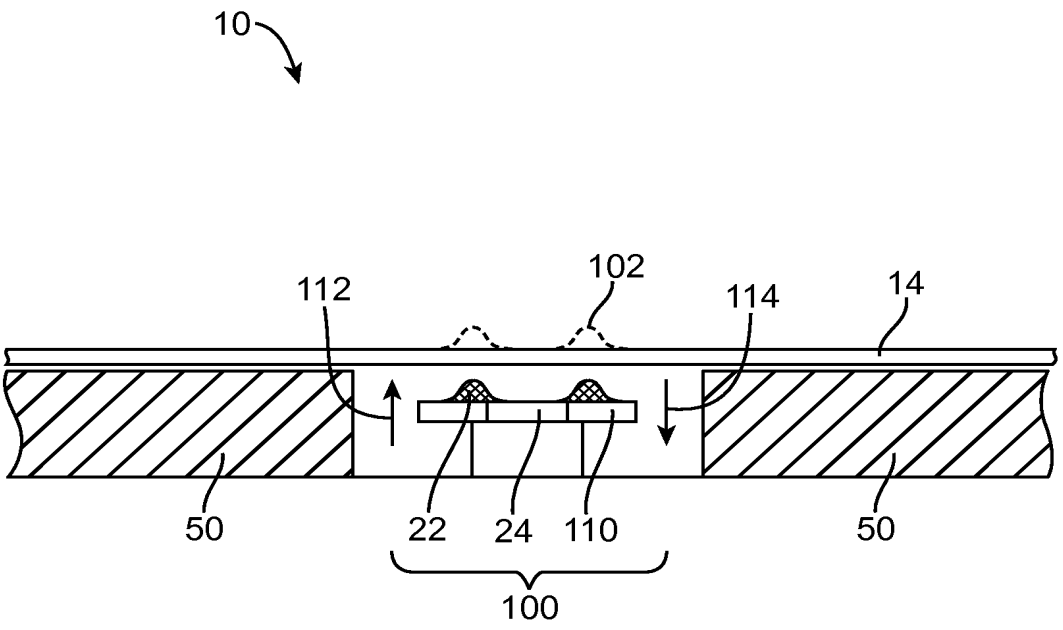


FIG. 13

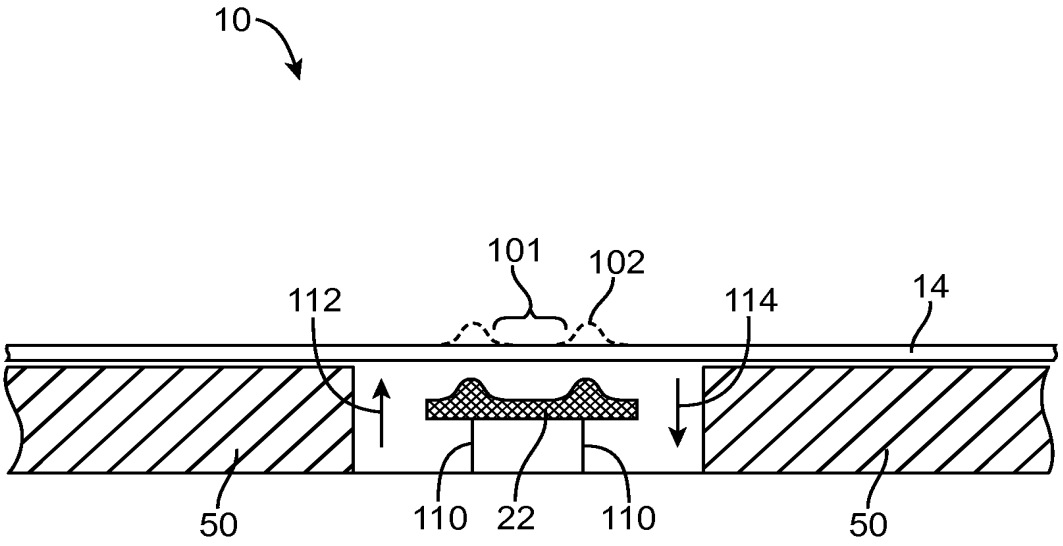


FIG. 14

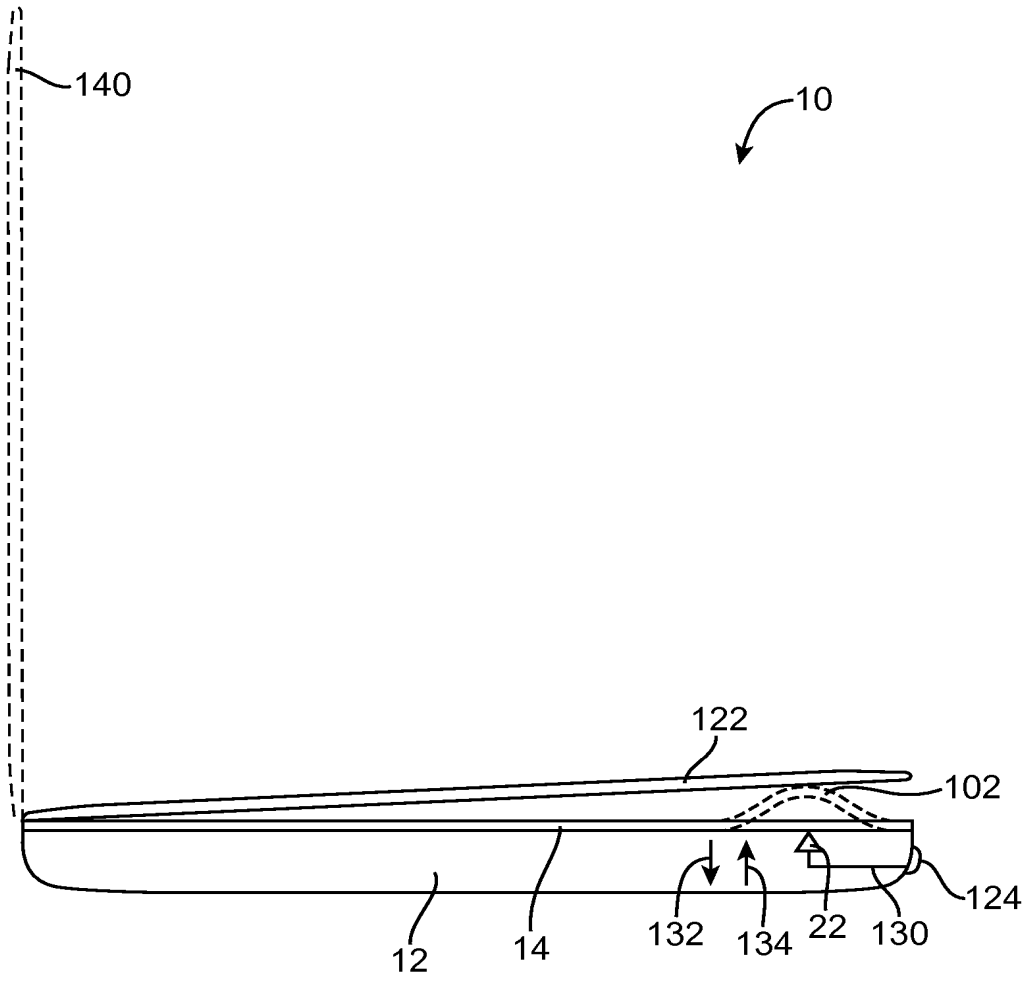


FIG. 15

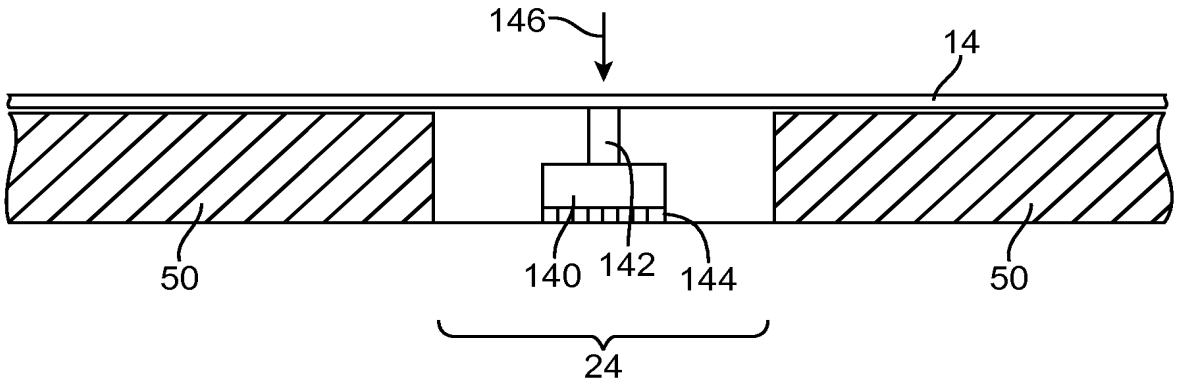


FIG. 16

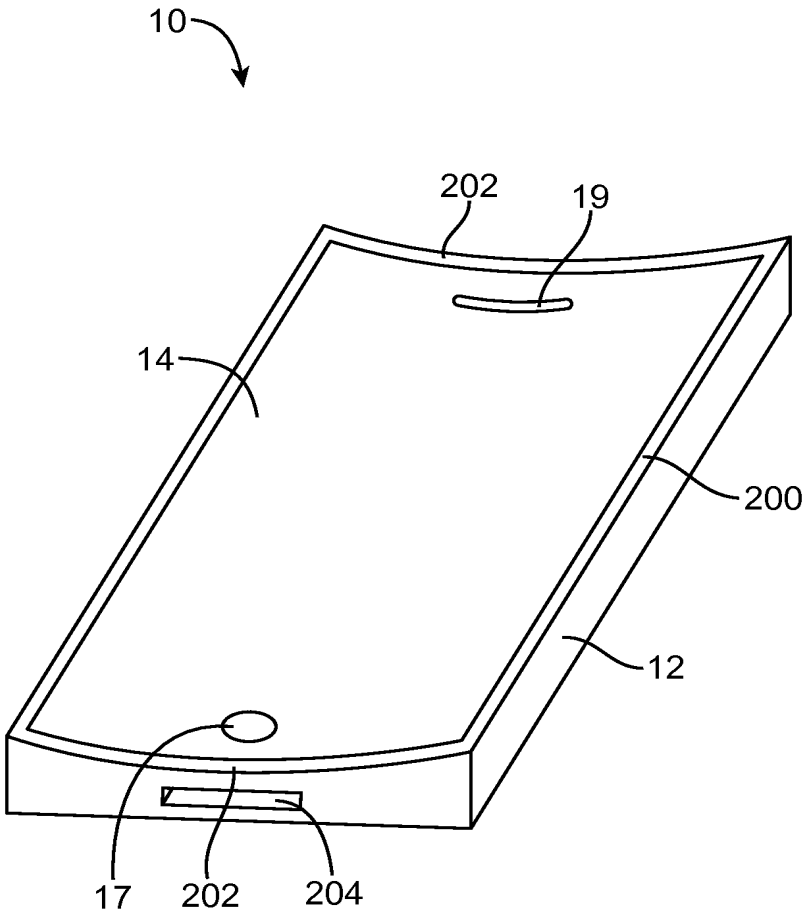


FIG. 17

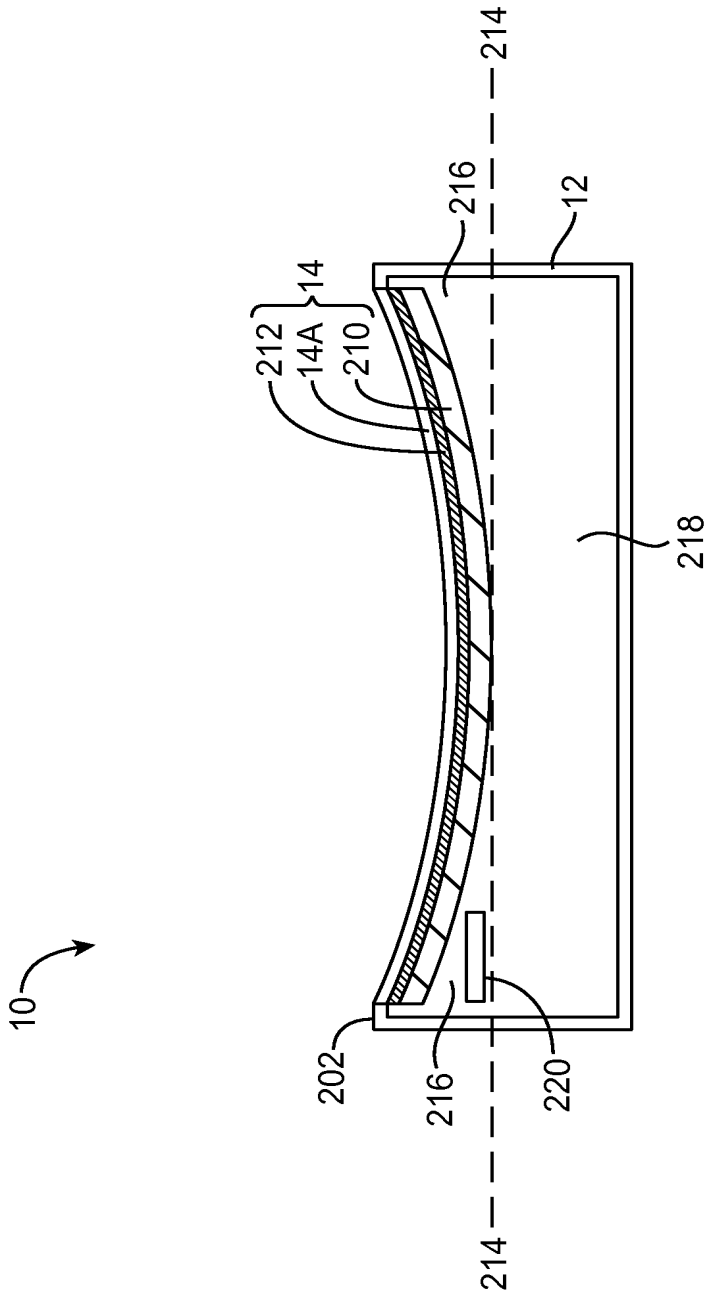


FIG. 18

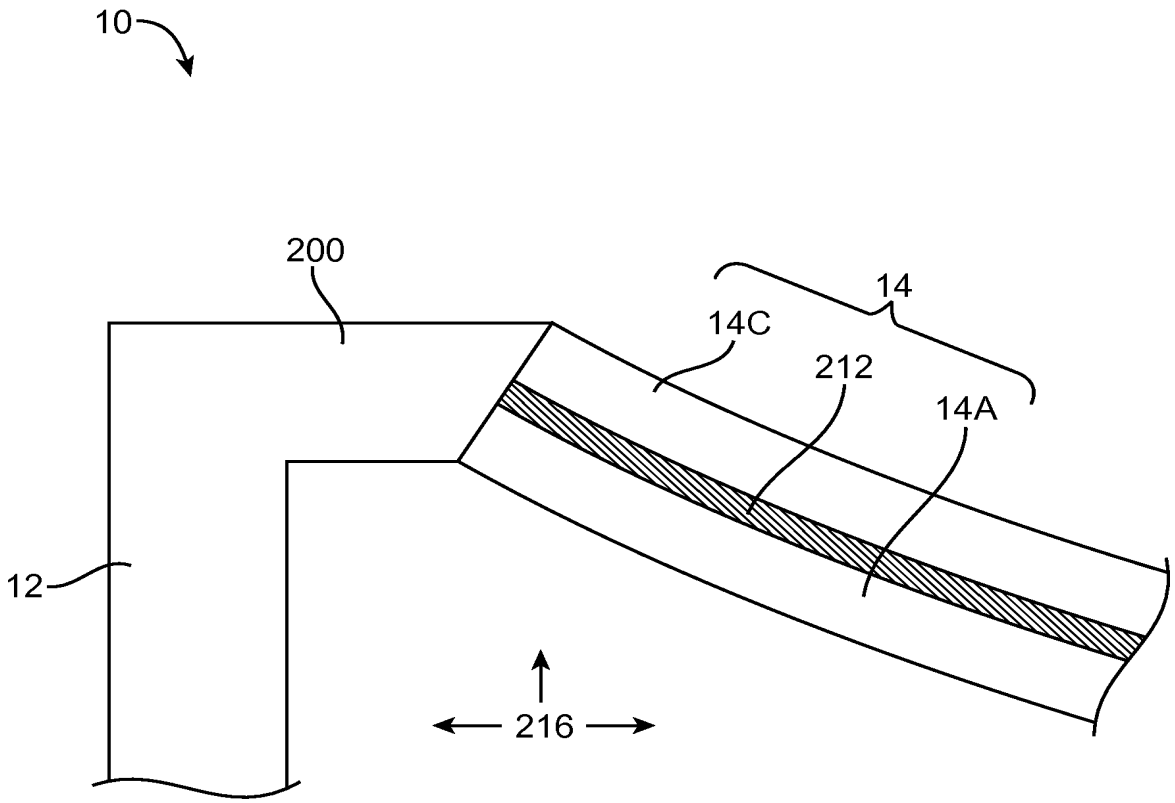


FIG. 19

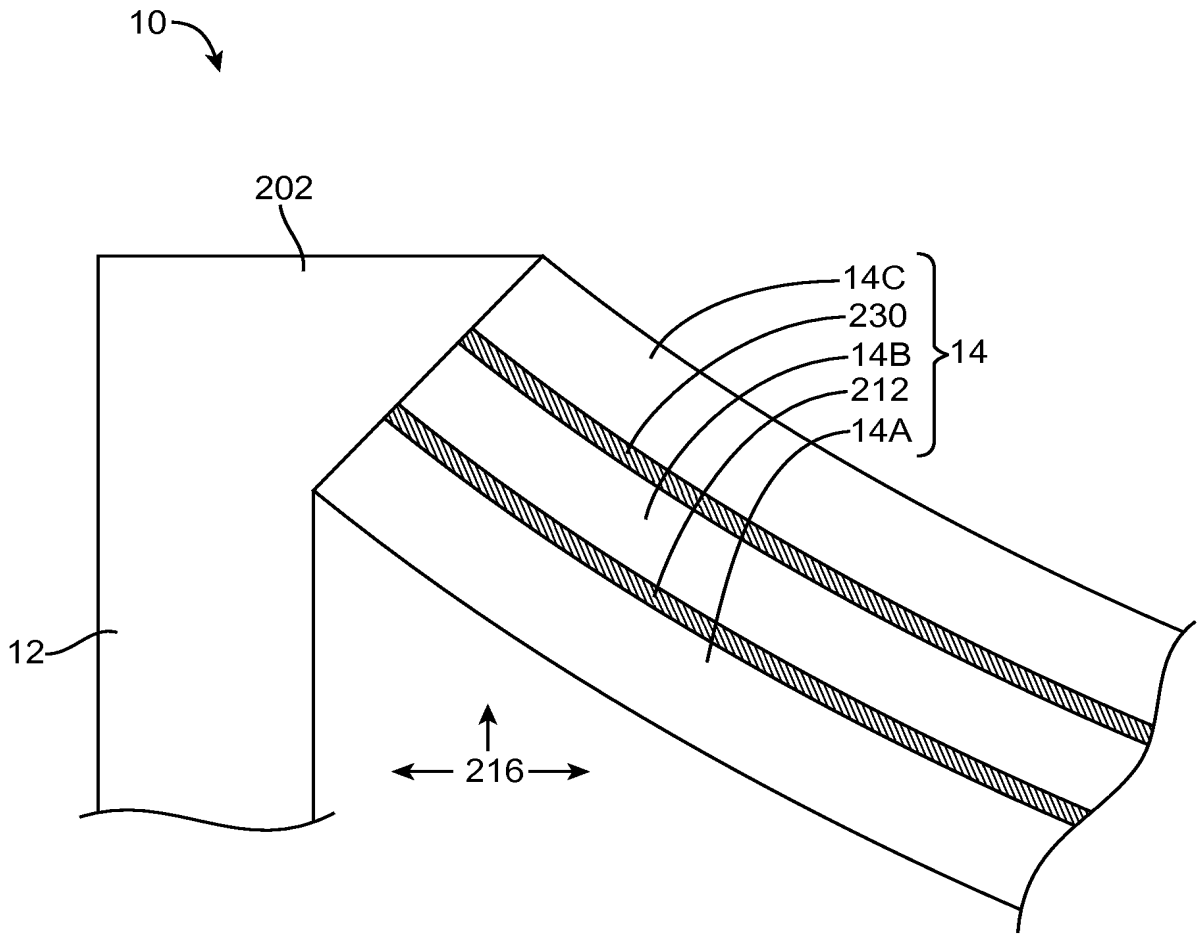


FIG. 20

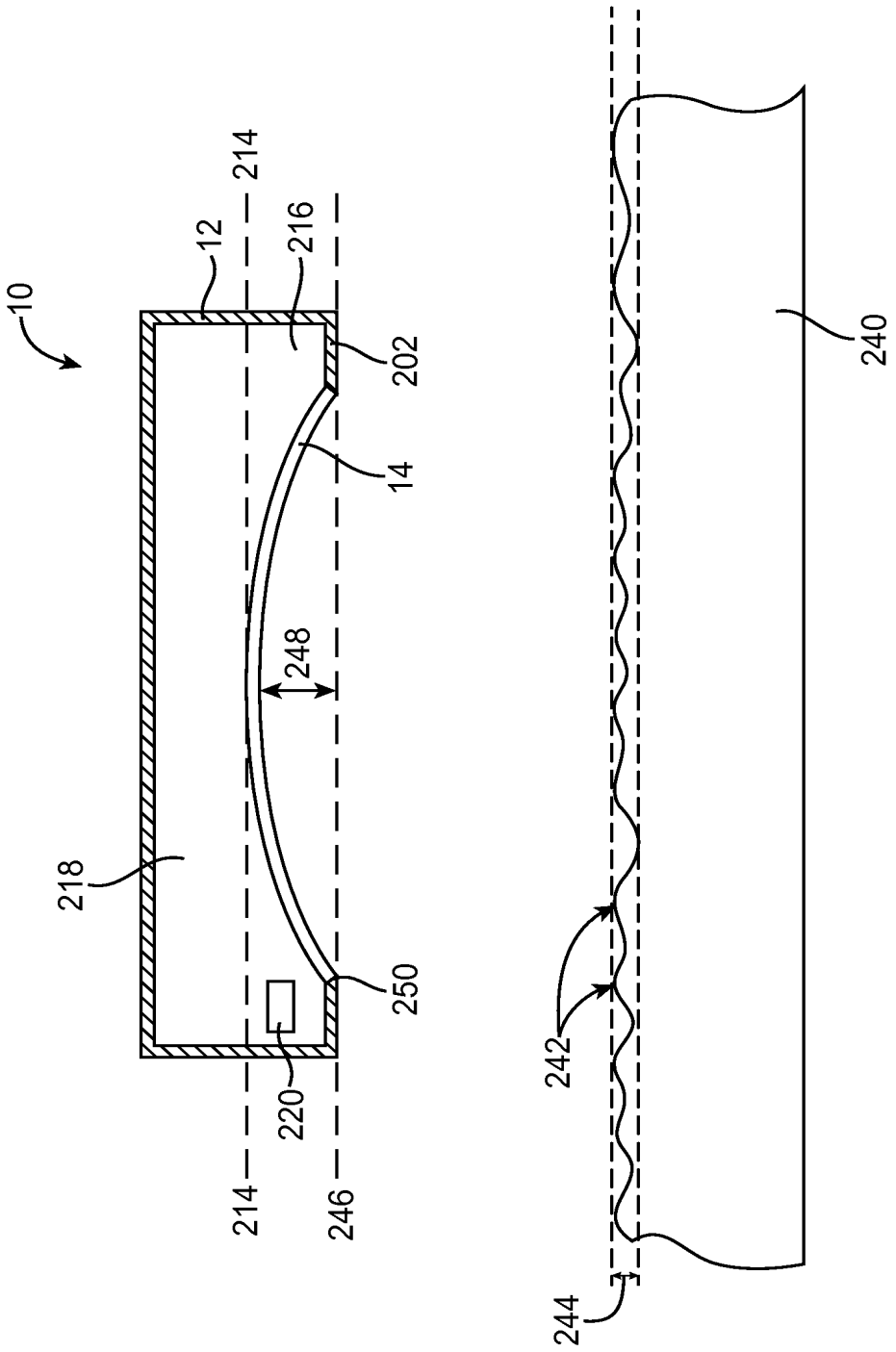


FIG. 21

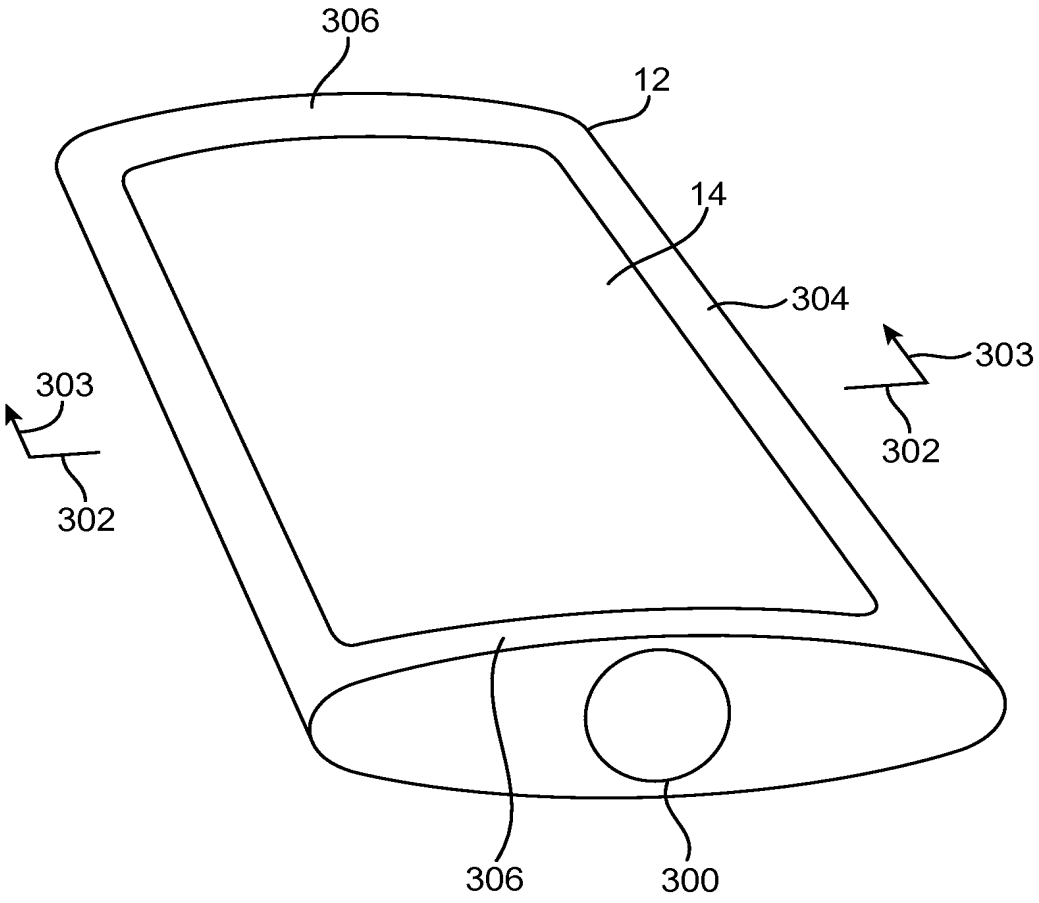
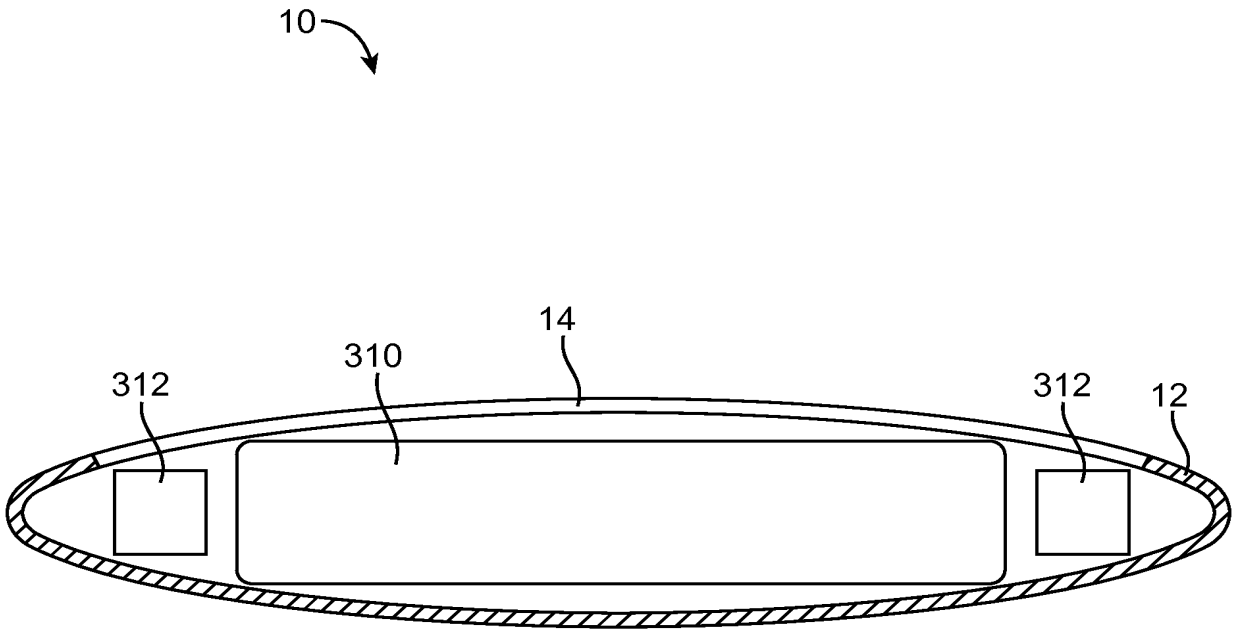


FIG. 22



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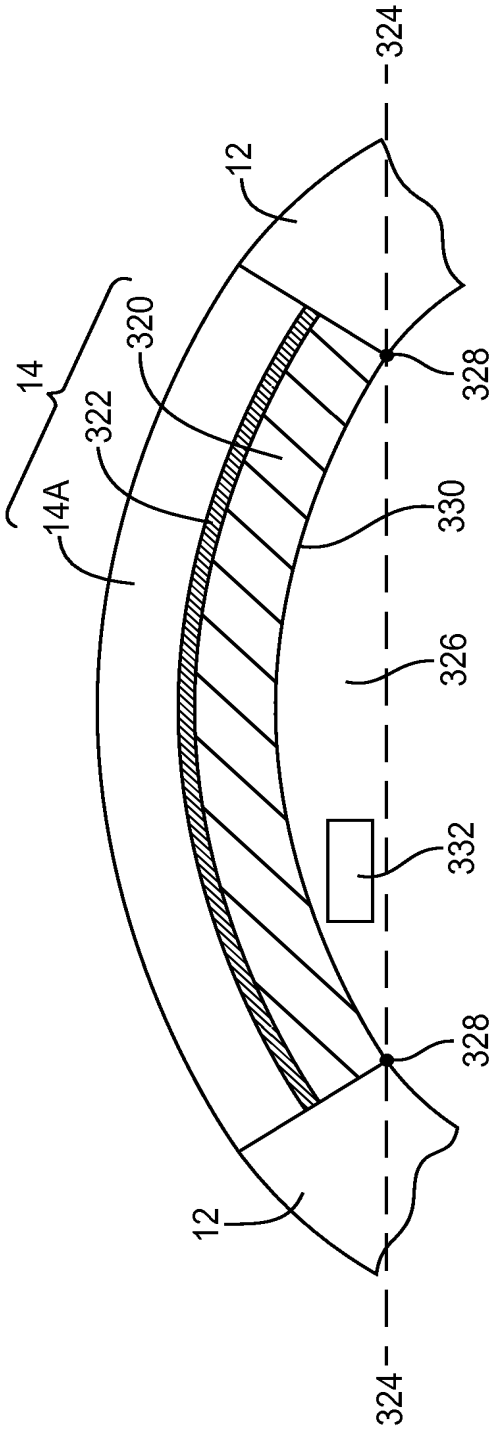

FIG. 24

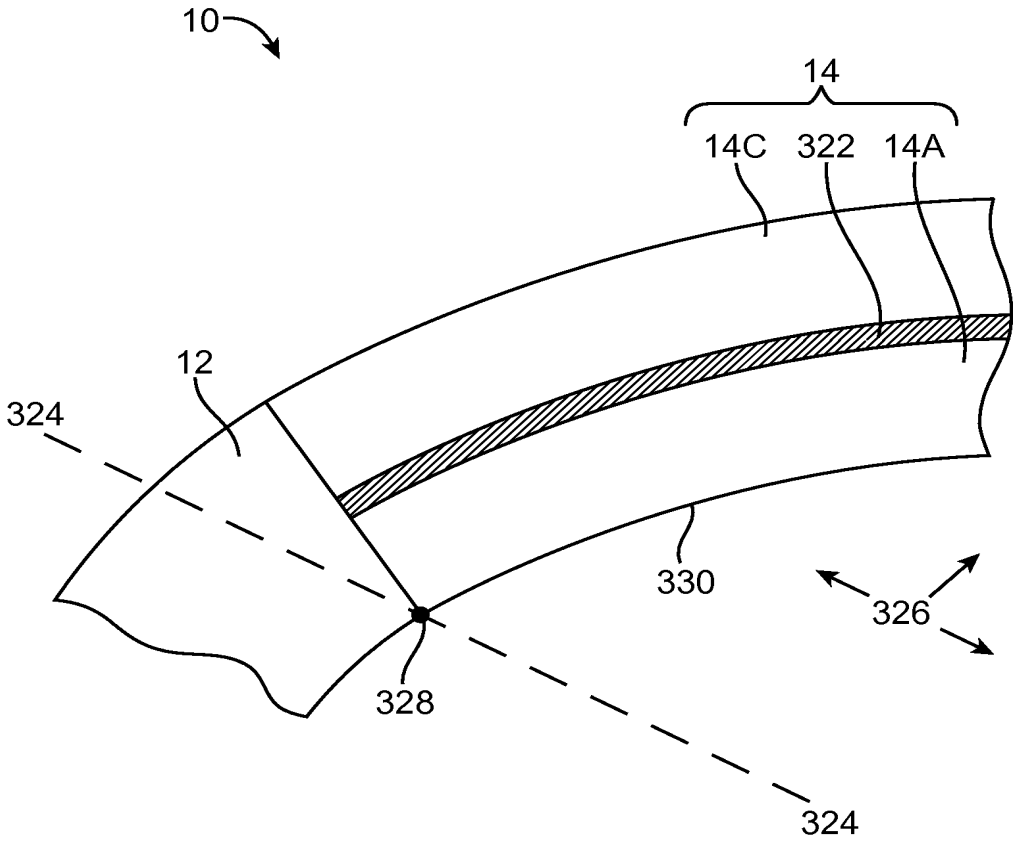

FIG. 25

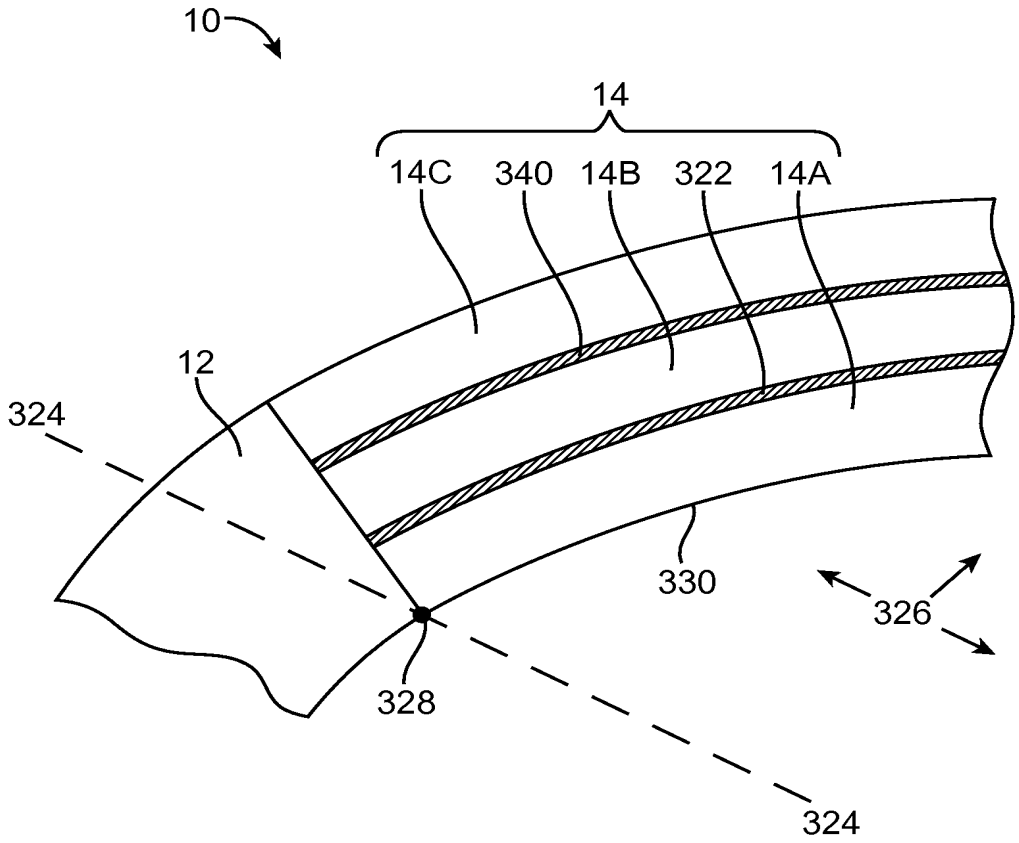

FIG. 26

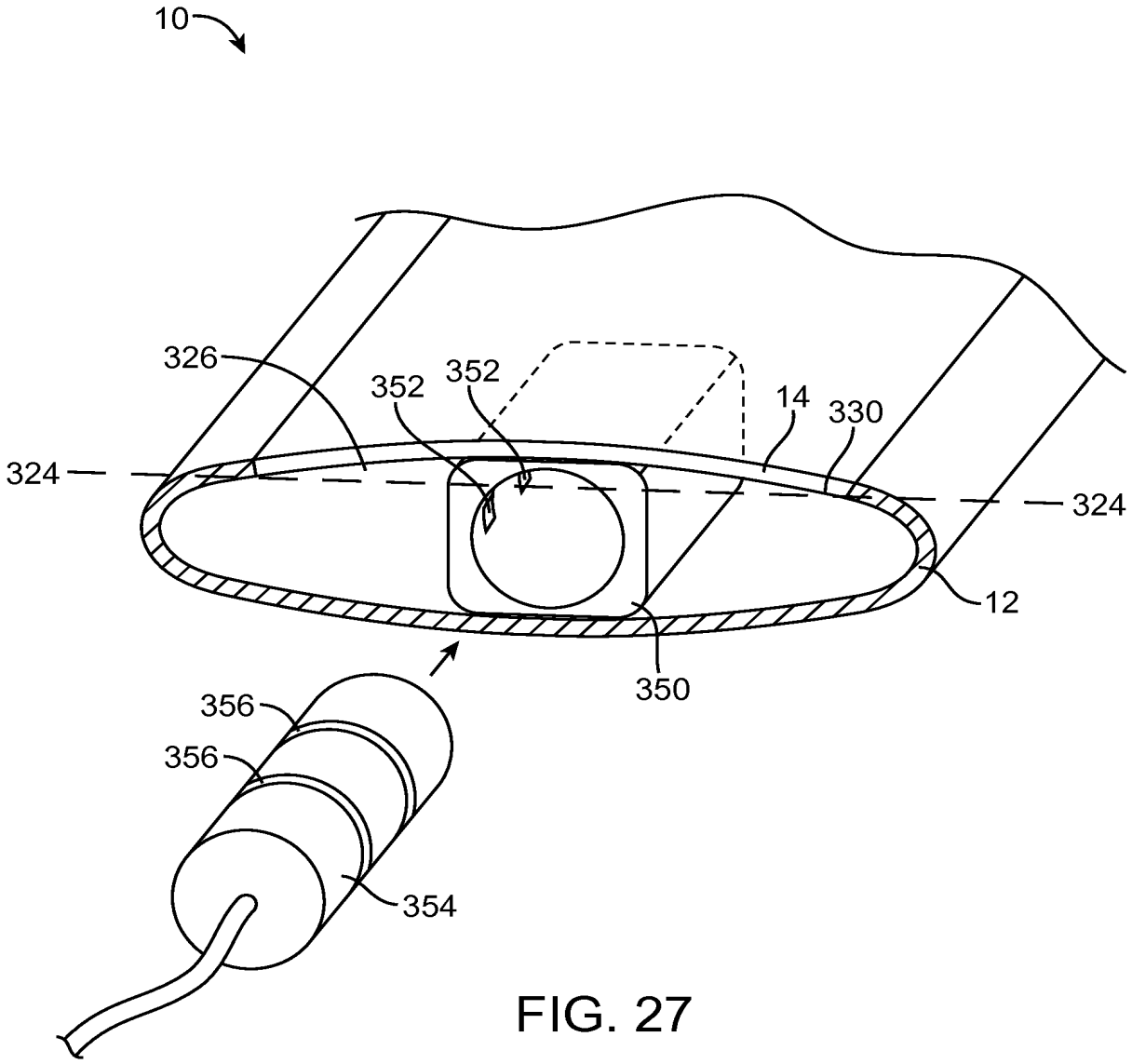

FIG. 27

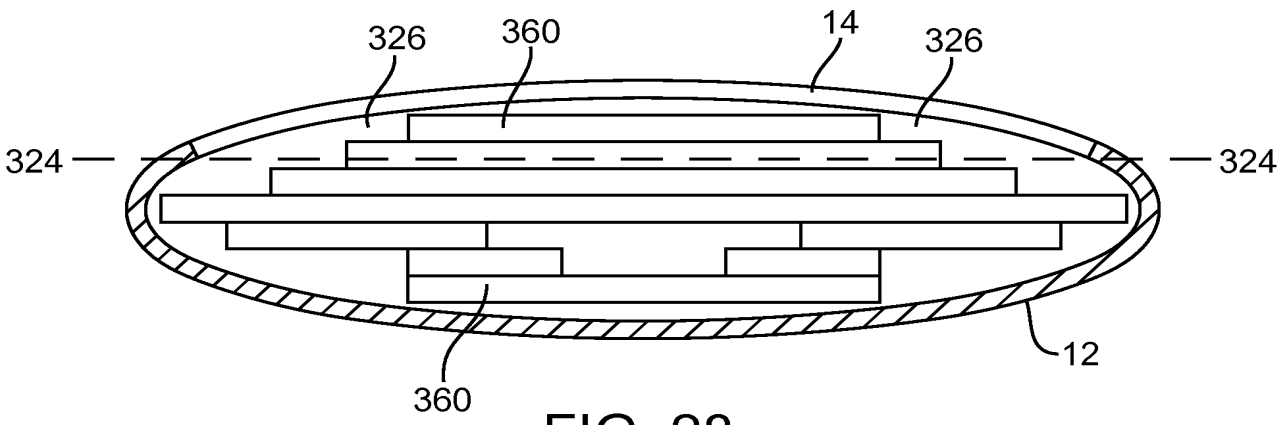

FIG. 28

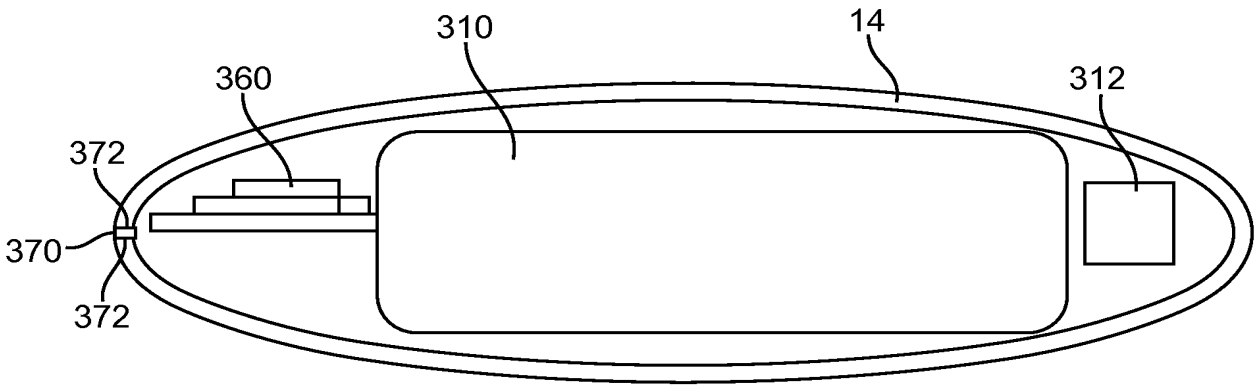

FIG. 29

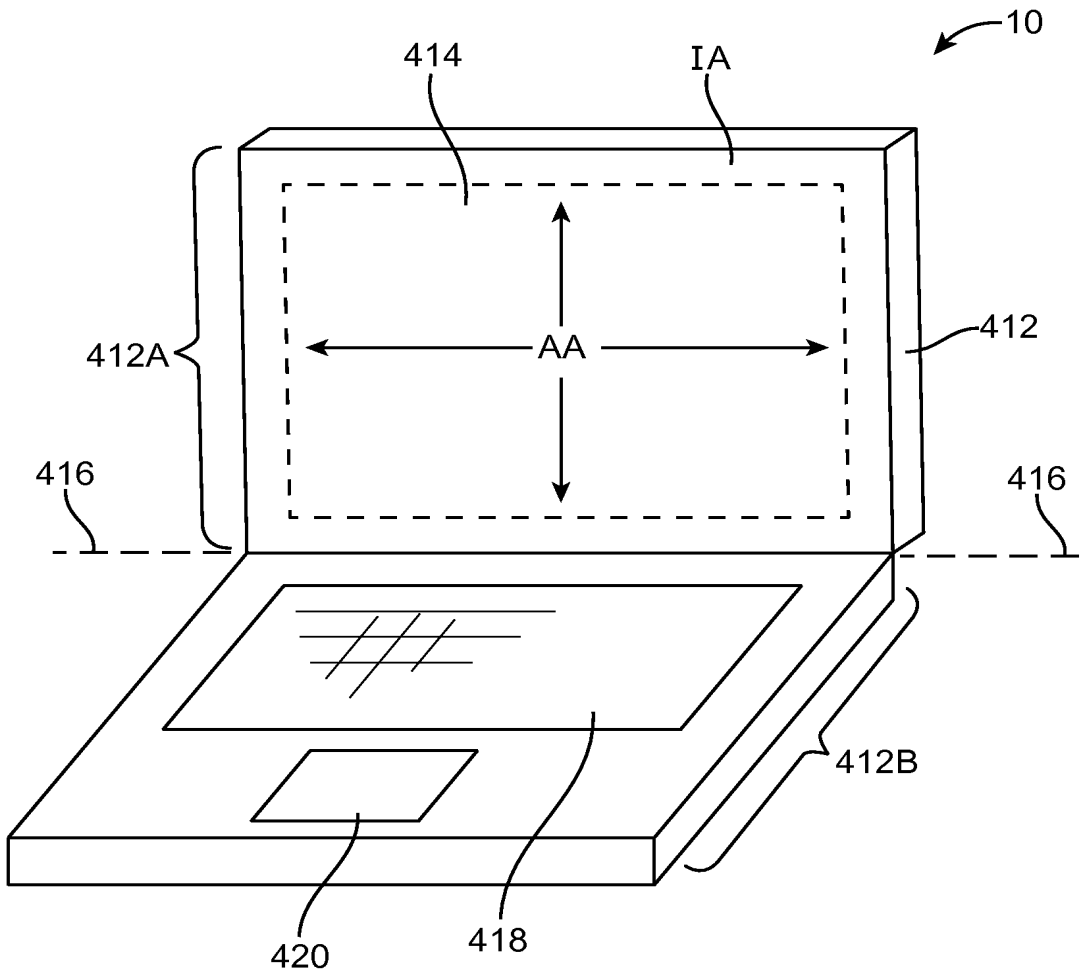

FIG. 30

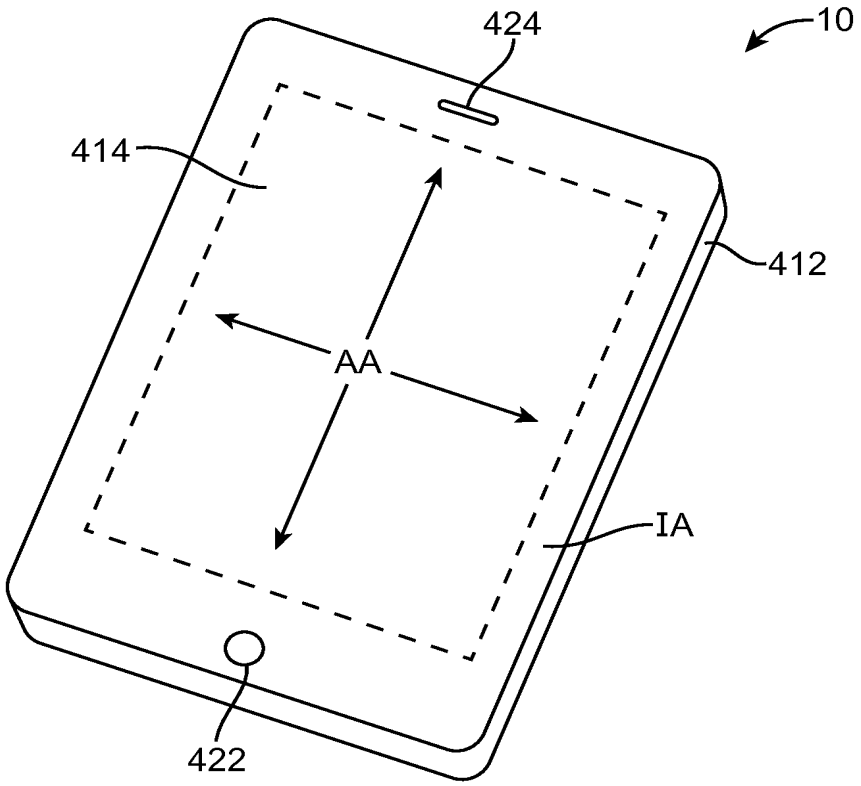

FIG. 31

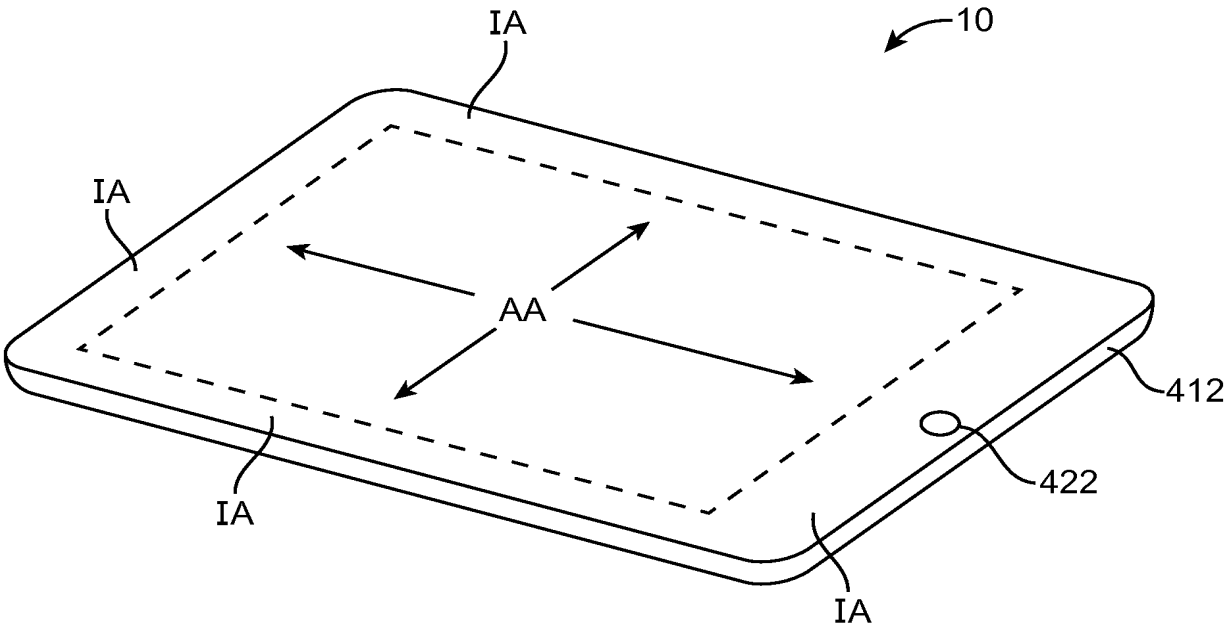

FIG. 32

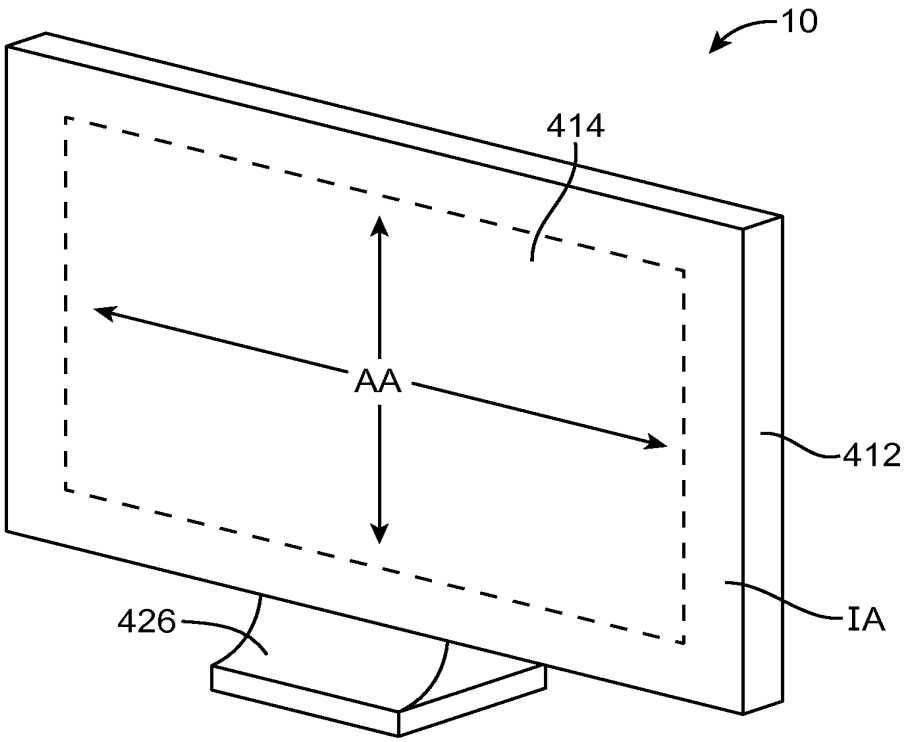

FIG. 33

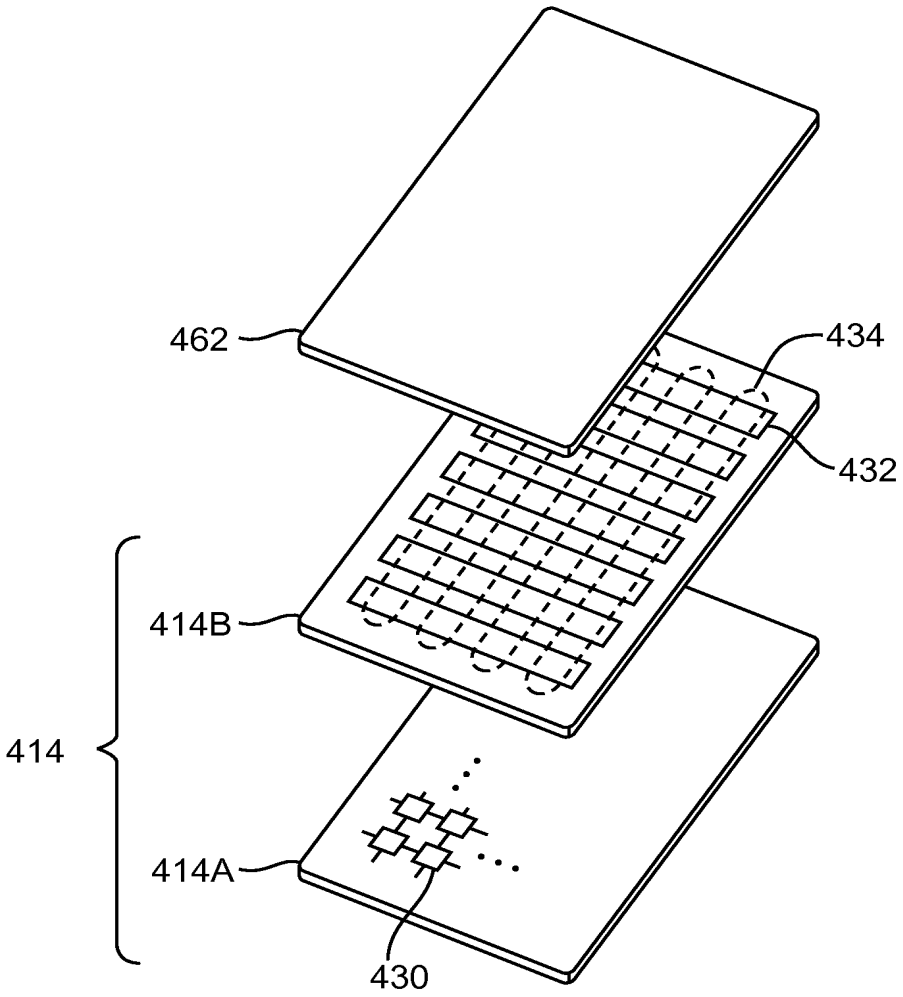

FIG. 34

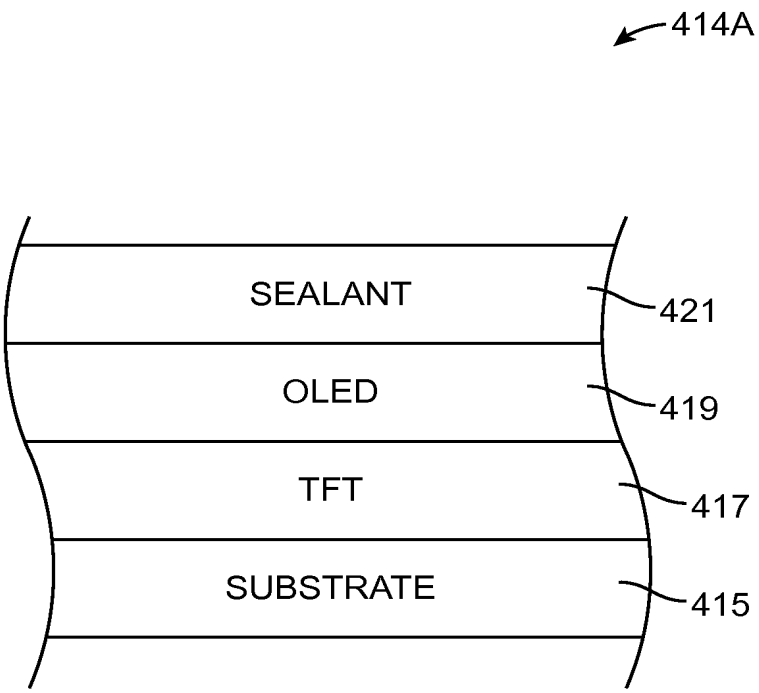

FIG. 35

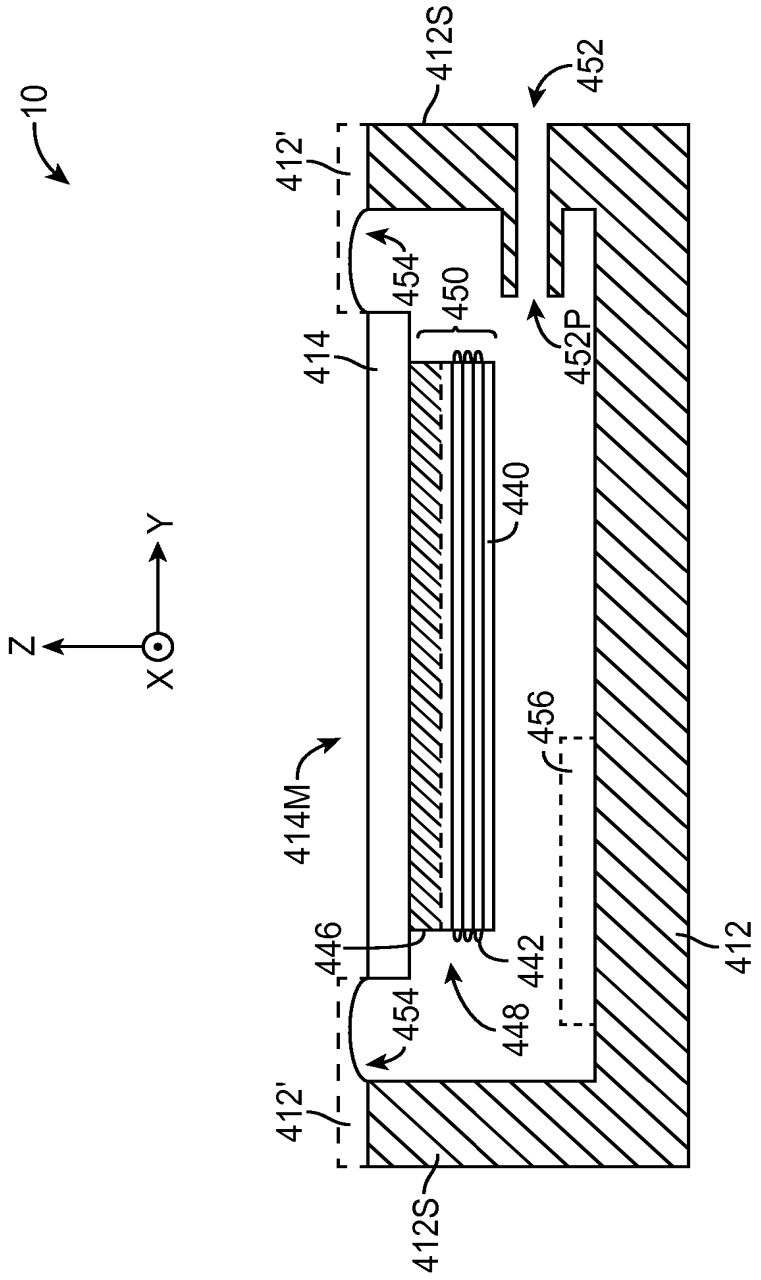
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FIG. 36

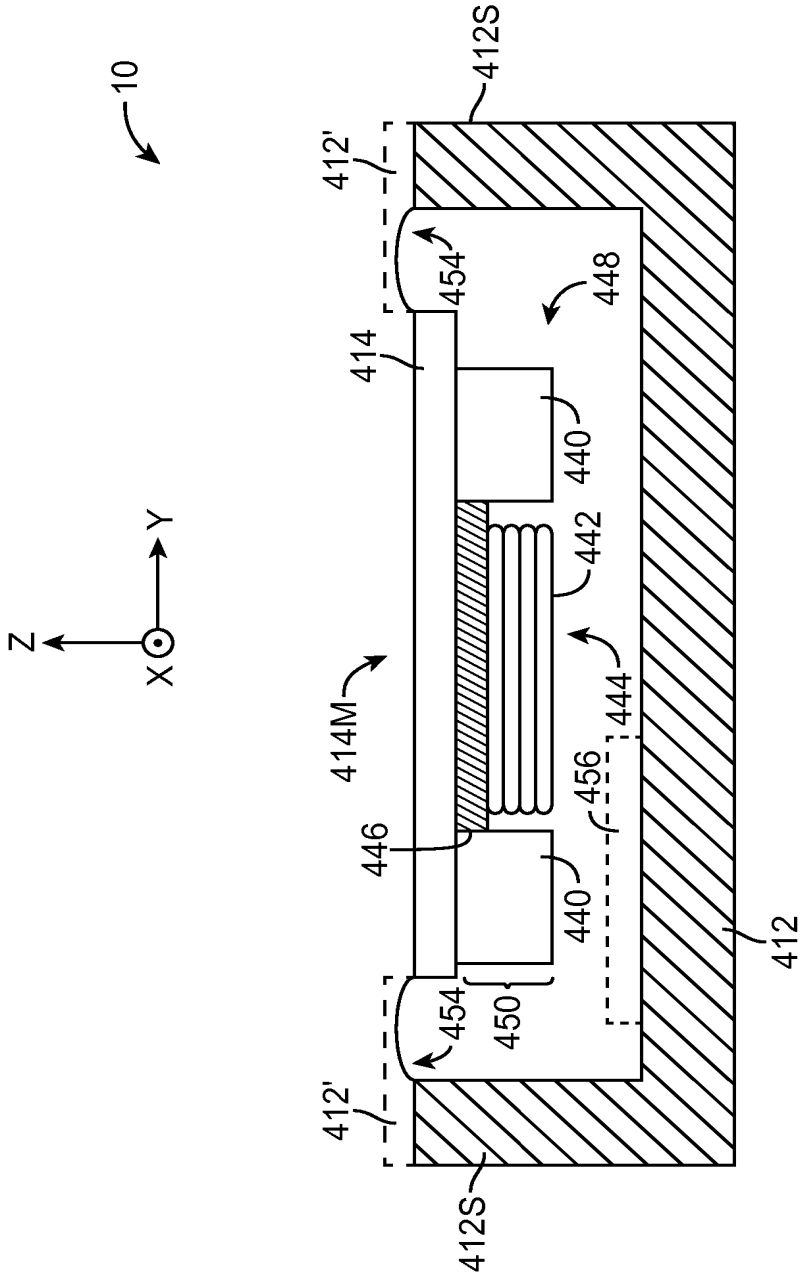
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FIG. 37

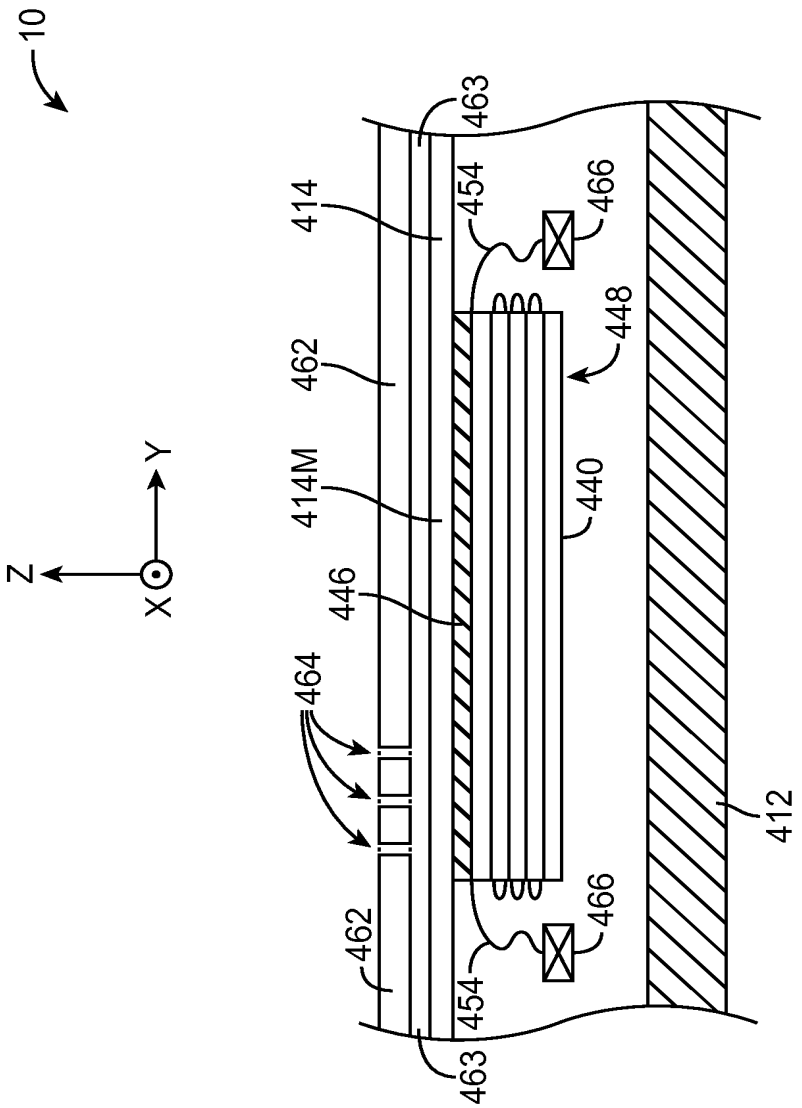
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FIG. 38

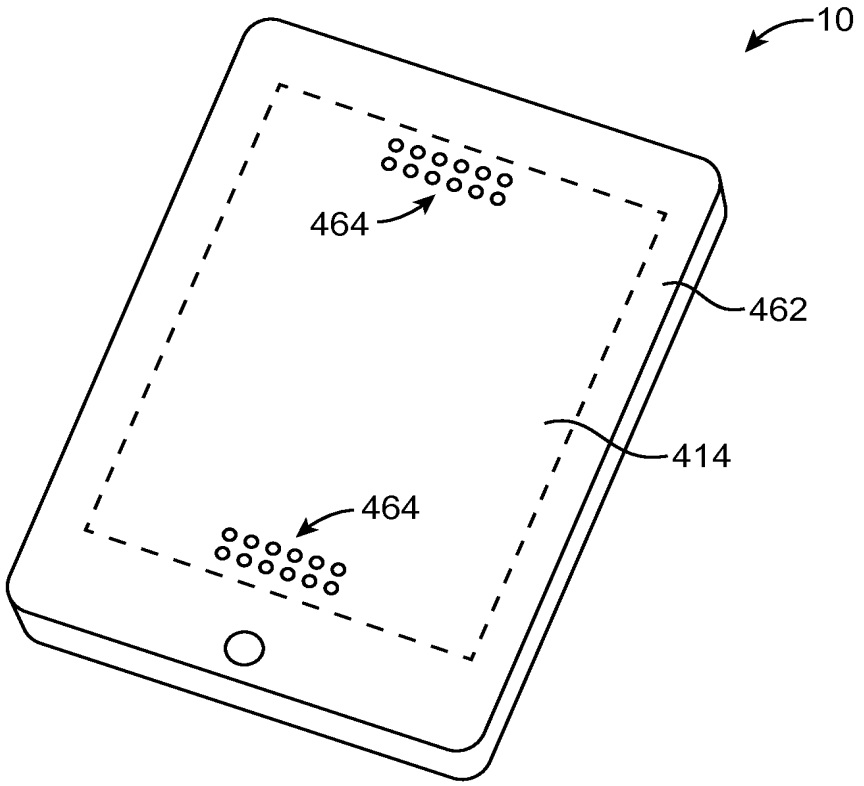

FIG. 39

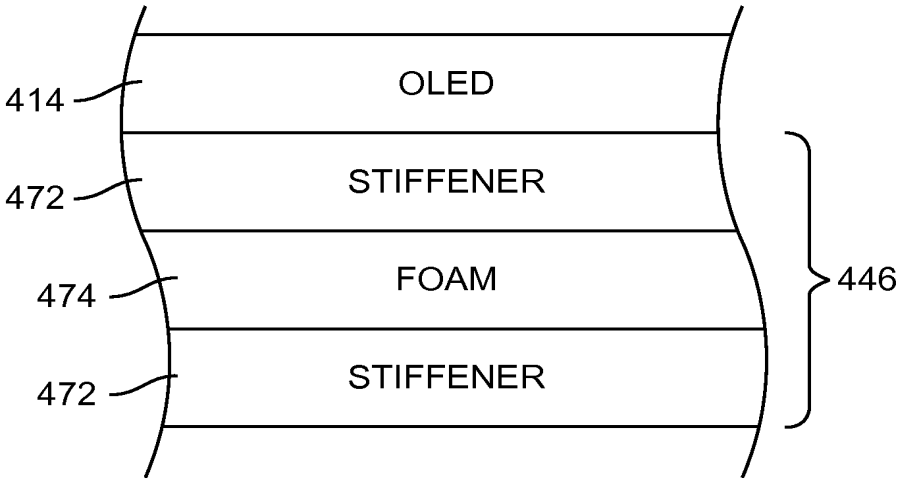

FIG. 40

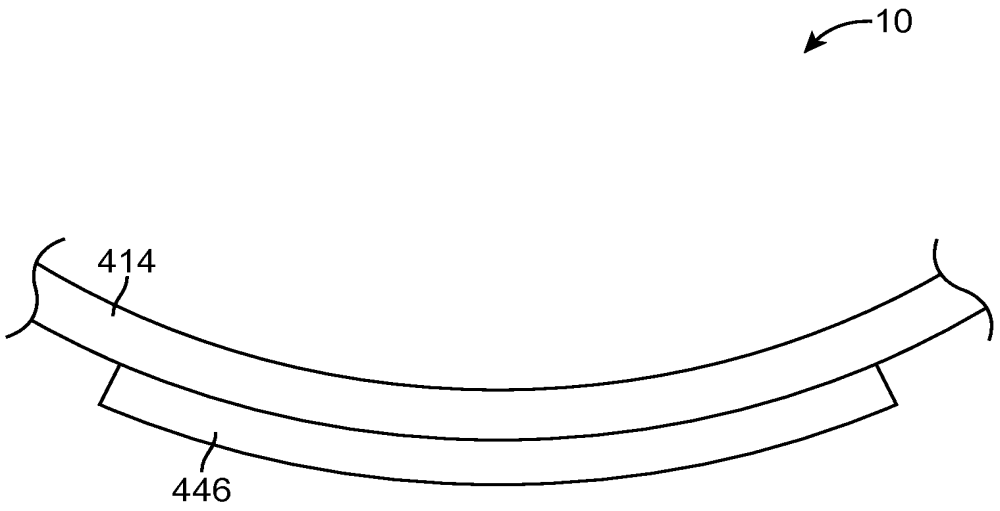

FIG. 41

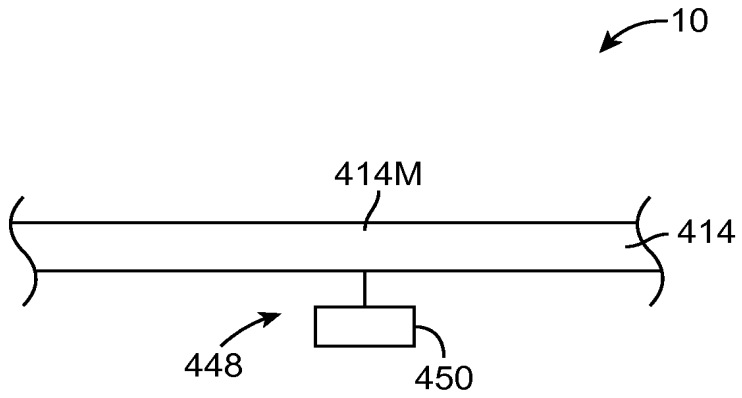

FIG. 42

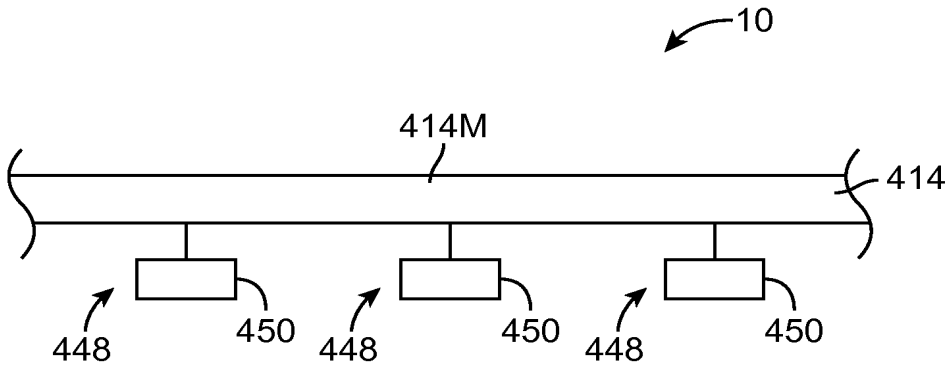

FIG. 43

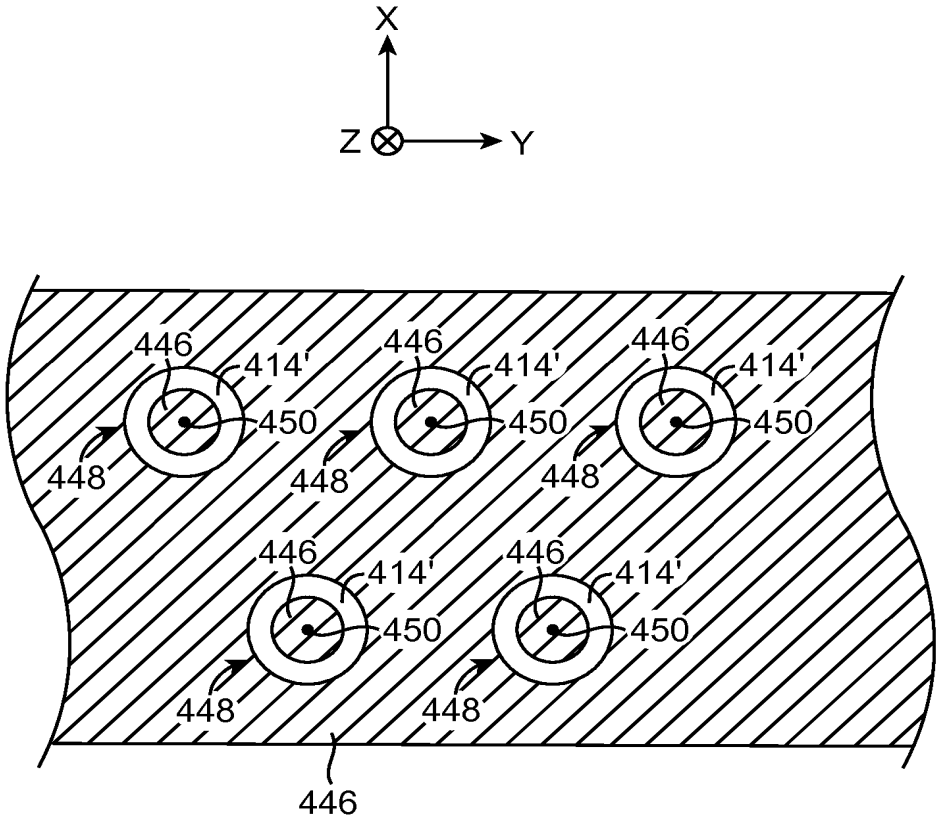
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FIG. 44

Electronic Acknowledgement Receipt

EFS ID:	15076320
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	Proximity Sensor
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Chad D Terrell/Paula Hurley
Filer Authorized By:	Chad D Terrell
Attorney Docket Number:	080900.1059
Receipt Date:	28-FEB-2013
Filing Date:	26-MAY-2011
Time Stamp:	12:19:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	IDS_080900_1059.pdf	73690 ef1dae0679005696674395 5eefd5ca4f316972c1	no	2

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	SB08_080900_1059.pdf	75644 c4a493a44d78d333ed24714bc8bbe8f05327b01d	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	WO_2012_129247.pdf	4285007 bc72f0894d8245fb68ef787739b6478d1890b4b4	no	142
Warnings:					
Information:					
		Total Files Size (in bytes):	4434341		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor:	Harald Philipp
Application No.:	13/116764
Filing Date:	May 26, 2011
Art Unit:	2858
Confirmation No.:	6159
Examiner:	Huy Q. Phan
Title:	*Proximity Sensor*

Commissioner of Patents
PO Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Supplemental Information Disclosure Statement (IDS)

Applicant respectfully requests, pursuant to 37 C.F.R. §§ 1.56, 1.97, and 1.98, that the documents listed on the attached PTO/SB/08 Form be considered and cited in the examination of the above-identified patent application. Pursuant to 37 C.F.R. §§ 1.97(g) and (h), Applicant makes no representation that a search has been made, that these documents are material to patentability of the present application, or that these documents qualify as prior art.

Copies of U.S. patents and U.S. patent application publications have not been provided. To the extent applicable, documents other than U.S. patents and U.S. patent application publications are enclosed for the convenience of the Examiner.

Applicant believes this IDS is being submitted before the mailing of a first Office Action on the merits. Therefore, pursuant to C.F.R. § 1.97(b), no fee is believed to be due for this submission. However, the Commissioner is authorized to charge any necessary fees and credit any overpayments to Deposit Account No. 02-0384 of Baker Botts L.L.P.

Respectfully submitted,

BAKER BOTTS L.L.P.
Attorneys for Applicant

/Chad Terrell/

Chad D. Terrell
Reg. No. 52,279
214-953-6813

Date: February 28, 2013

Correspondence Address:

Customer No. **12323**

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Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

EXAMINER
NGUYEN, HOAI AN D

ART UNIT	PAPER NUMBER
2868	

DATE MAILED: 01/31/2014

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/116,764	05/26/2011	Harald Philipp	080900.1059	6159

TITLE OF INVENTION: PROXIMITY SENSOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/30/2014

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

12323 7590 01/31/2014
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/116,764	05/26/2011	Harald Philipp	080900.1059	6159

TITLE OF INVENTION: PROXIMITY SENSOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/30/2014

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, HOAI AN D	2868	324-663000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above**)
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/116,764	05/26/2011	Harald Philipp	080900.1059	6159

12323 7590 01/31/2014

Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

EXAMINER	
NGUYEN, HOAI AN D	

ART UNIT	PAPER NUMBER
2868	

DATE MAILED: 01/31/2014

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 554 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 554 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 13/116,764	Applicant(s) PHILIPP ET AL.	
	Examiner HOAI-AN D. NGUYEN	Art Unit 2868	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the Preliminary Amendment filed on June 1, 2011*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-20*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 5/26/11; 12/14/11; 8/18/12 &2/28/13
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. Receipt is acknowledged of the Preliminary Amendment filed on June 1, 2011. Claims 1-20 are pending in the application.

Allowable Subject Matter

3. Claims 1-20 are allowed.

4. The following is an examiner's statement of reasons for allowance:

With regard to claim 1, the prior art does not teach, suggest or render obvious the claimed apparatus in combination as claimed including one or more computer-readable non-transitory storage media coupled to the sensing element and embodying logic that is operable when executed to:

- Determine an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and
- If the amount of time that has elapsed exceeds a predetermined time duration, then initiate a particular function of the apparatus.

With regard to claims 2-9, these claims are allowed due to at least by virtue of their dependencies directly or indirectly from the base claim.

With regard to claim 10, the prior art does not teach, suggest or render obvious the claimed method in combination as claimed including:

- Determining an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and
- If the amount of time that has elapsed exceeds a predetermined time duration, then initiating a particular function of an apparatus.

With regard to claims 11-15, these claims are allowed due to at least by virtue of their dependencies from the base claim.

With regard to claim 16, the prior art does not teach, suggest or render obvious the claimed computer-readable non-transitory storage media in combination as claimed embodying logic that is operable when executed to:

- Determine an amount of time that has elapsed since the sensing element last detected a change of capacitance indicative of a key touch on the touch screen; and
- If the amount of time that has elapsed exceeds a predetermined time duration, then initiate a particular function of the apparatus.

With regard to claims 17-20, these claims are allowed due to at least by virtue of their dependencies directly or indirectly from the base claim.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

CONTACT INFORMATION

Any inquiry concerning this communication or earlier communications from the examiner should be directed to HOAI-AN D. NGUYEN whose telephone number is (571)272-2170. The examiner can normally be reached on MON-THURS. (7:15 - 5:45).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Arleen M. Vazquez can be reached on (571)-272-2619. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

HOAI-AN D. NGUYEN
Primary Examiner
Art Unit 2868

/HOAI-AN D. NGUYEN/
Primary Examiner, Art Unit 2868

Notice of References Cited	Application/Control No. 13/116,764	Applicant(s)/Patent Under Reexamination PHILIPP ET AL.	
	Examiner HOAI-AN D. NGUYEN	Art Unit 2868	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2006/0170411 A1	08-2006	Kurachi et al.	324/132
*	B	US-7,245,131 B2	07-2007	Kurachi et al.	324/663
*	C	US-2008/0047764 A1	02-2008	Lee et al.	178/18.06
*	D	US-2008/0147350 A1	06-2008	Jean, Philippe	702/150
*	E	US-2008/0246723 A1	10-2008	Baumbach, Jason G.	345/156
*	F	US-2009/0225044 A1	09-2009	Jeon et al.	345/173
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** 13/116764		**First Named Inventor:** Harald Philipp
	Attorney Docket No: 080900.1059	**Art Unit:** 2858	**Filing Date:** 05-26-2011

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	FIRST NAMED INVENTOR
	A	2012/0242588	27 September 2012	Myers
	B	2012/0242592	27 September 2012	Rothkopf
	C	2012/0243151	27 September 2012	Lynch
	D	2012/0243719	27 September 2012	Franklin

UNPUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	FILING DATE	FIRST NAMED INVENTOR
	E	61/454936	21 March 2011	Myers
	F	61/454950	21 March 2011	Lynch
	G	61/454894	21 March 2011	Rothkopf

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	COUNTRY	TRANSLATION (YES OR NO)
	H	WO 2012/129247	27 September 2012	PCT	
	I				

NON-PATENT LITERATURE (NPL)

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	J		
	K		
	L		
	M		
	N		
	O		
	P		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /HADN/

EXAMINER /Hoai-An Nguyen/	DATE CONSIDERED 01/13/2014

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** ~~Unassigned~~	**First Named Inventor:** Harald Philipp	
	Attorney Docket No: 080900.1059	**Art Unit:** ~~Unassigned~~	**Filing Date:** ~~Herewith~~

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**FIRST NAMED INVENTOR**
	A	5,730,165	03-24-1998	Philipp
	B	6,452,494	09-17-2002	Harrison
	C	6,452,514	09-17-2002	Philipp
	D	6,466,036	10-15-2002	Philipp
	E	7,091,727	08-15-2006	Lee
	F	7,567,088	07-28-2009	Yoshida
	G	7,714,595	05-11-2010	Fujiwara
	H	7,797,115	09-14-2010	Tasher
	I	2003/0132763	07-17-2003	Ellenz
	J	2006/0250142	11-09-2006	Abe
	K	2007/0062739	03-22-2007	Philipp
	L	2007/0076897	04-05-2007	Philipp
	M	2009/0027068	01-29-2009	Philipp
UNPUBLISHED U.S. APPLICATIONS				
		DOCUMENT NUMBER	**FILING DATE**	**FIRST NAMED INVENTOR**
	N			
	O			

FOREIGN PATENT DOCUMENTS					
		DOCUMENT NUMBER	**PUBLICATION OR ISSUE DATE**	**COUNTRY**	**TRANSLATION (YES OR NO)**
	P	1536314 A2	06-01-2005	EP	
	Q	2431725 A1	05/02/2007	GB	

NON-PATENT LITERATURE (NPL)			
		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	**DATE**
	R	UK Intellectual Property Office, Search Report for GB 0813682.2	11-04-2008
	S	Datasheet "QT100-Charge Transfer IC," Quantum Research Group	2006
	T	Datasheet "QT110-Touch Sensor IC," Quantum Research Group	2004

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /HADN/

EXAMINER /Hoai-An Nguyen/	DATE CONSIDERED 01/13/2014

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	2	("20110242051").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/01/09 23:31
S2	34	("7920129" | "8040326" | "20120242588" | "7663607" | "8031174" | "8049732" | "20090315854" | "8179381" | "20120242592" | "20120243151" | "8031094" | "7875814" | "20120243719").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/09 23:32
S3	59	(324/663.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:34
S4	89	(324/658.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:34
S5	22	(324/649.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:35
S6	42	(324/600.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:36
S7	186	(702/57.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:37
S8	10	(340/545.4.ccls.) and @ad<"20080722"	US-PGPUB;	OR	ON	2014/01/10

		and @pd>"20110114"	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			09:38
S9	21	(340/545.2.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:38
S10	46	(340/545.1.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:39
S11	189	(340/541.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:39
S12	307	(340/540.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:40
S13	177	(381/74.ccls.) and @ad<"20080722" and @pd>"20110114"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 09:40
S14	4	(("7952366") or ("20090027068")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/01/10 09:42
S15	25	(S3 S4 S5 S6) and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (presen$3 absen$3 exist$5 proximity appearance touch) near2 (key user object person body target finger subject member element structure cable wire component conductor human occupancy human driver operator occupancy occup$5))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:06
S16	6	S7 and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3	US-PGPUB; USPAT;	OR	ON	2014/01/10 10:12

		analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (presen$3 absen$3 exist$5 proximity appearance touch) near2 (key user object person body target finger subject member element structure cable wire component conductor human occupancy human driver operator occupancy occup$5))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S17	59	(S8 S9 S10 S11 S12) and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (presen$3 absen$3 exist$5 proximity appearance touch) near2 (key user object person body target finger subject member element structure cable wire component conductor human occupancy human driver operator occupancy occup$5))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:12
S18	7	S13 and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (presen$3 absen$3 exist$5 proximity appearance touch) near2 (key user object person body target finger subject member element structure cable wire component conductor human occupancy human driver operator occupancy occup$5))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:13
S20	19	S15 and ((check$3 detect$3 sens$3 measur$3 comput$3 calculat$3 $2valuat$3 examin$3 test$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 meter$3 gaug$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 capacitance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:17
S21	3	S16 and ((check$3 detect$3 sens$3 measur$3 comput$3 calculat$3 $2valuat$3 examin$3 test$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 meter$3 gaug$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 capacitance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:18
S22	5	S17 and ((check$3 detect$3 sens$3 measur$3 comput$3 calculat$3 $2valuat$3 examin$3 test$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 meter$3 gaug$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 capacitance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:18
S23	2	S18 and ((check$3 detect$3 sens$3 measur$3 comput$3 calculat$3 $2valuat$3 examin$3 test$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 meter$3 gaug$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 capacitance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/10 10:20
S24	3632	((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and ((skew disturbance noise change variation difference variance	US-PGPUB; USPAT; USOCR;	OR	ON	2014/01/11 16:03

		drop error deviation fluctuation distortion tolerance) near2 capacitance)) and @ad<"20080725"	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S26	0	S24 and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 ((range interval amount period duration band block) adj2 time)) with ((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/11 16:12
S27	4	S24 and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 ((range interval amount period duration band block) adj2 time)) same ((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/11 16:19
S29	31	S24 and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 ((range interval amount period duration band block) adj2 time)) and (((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance)) near2 capacitance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/11 16:23
S30	478	((Philipp near2 Harald) (Snoad near2 Kevin)).inv.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:03
S31	1	S30 and ((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 ((range interval amount period duration band block) adj2 time)) with ((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:04
S32	0	(((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 ((range interval amount period duration band block) adj2 time)) with ((detected measured recorded	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:37

		captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) adj2 capacitance)) and @ad<"20080725"				
S33	0	(((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 ((range interval amount period duration band block) adj2 time)) with ((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) adj2 capacitance)) and @ad<"20110526"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:37
S34	0	(((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) adj2 capacitance)) and @ad<"20080725"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:38
S35	0	(((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) adj2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) adj2 capacitance)) and @ad<"20110526"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:39
S36	3	(((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and @ad<"20080725"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:40
S37	3	(((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:40

		error deviation fluctuation distortion tolerance) near2 capacitance)) and @ad<"20110526"				
S38	1	S30 and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/12 22:41

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S39	1	(((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and ((skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and ((pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored) near2 (range interval amount period duration band block) near2 time)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:45
S40	1	(((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and ((skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and ((pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored) near2 (range interval amount period duration band block))).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:46
S41	1	(((touch$3 adj2 (screen panel sens$3 detect$3	US-	OR	ON	2014/01/12

		pad)) and ((skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored)).clm.	PGPUB; USPAT; UPAD			23:49
S42	1	(((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and ((skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance))).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:50
S43	1	(((skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and ((pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored) near2 (range interval amount period duration band block) near2 time)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:55
S44	1	((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:56

		fluctuation distortion tolerance) near2 capacitance)) and ((pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored) near2 (range interval amount period duration band block) near2 time)).clm.				
S45	1	(((skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and ((pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored) near2 (range interval amount period duration band block))).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:58
S46	1	((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and ((pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored) near2 (range interval amount period duration band block))).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/12 23:58
S47	1	((touch$3 adj2 (screen panel sens$3 detect$3 pad)) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored)).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2014/01/13 00:01
S48	3	(((skew disturbance noise change variation	US-	OR	ON	2014/01/13

		difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance) and (((check$3 detect$3 sens$3 examin$3 determin$3 recogniz$3 inspect$3 analy$4 anali$4 monitor$3 diagnos$3 identif$4 record$3 judg$3 find$3 indicat$3 verif$4 captur$3) near2 (range interval amount period duration band block) near2 time) with ((detected measured recorded captured) near2 (skew disturbance noise change variation difference variance drop error deviation fluctuation distortion tolerance) near2 capacitance)) and (pre$1select$3 pre$1determin$3 pre$1defin$3 specif$5 pre$1set$4 maximum minimum limit threshold reference desir$5 expected wanted standard known bench$1mark stored)).clm.	PGPUB; USPAT; UPAD			00:01

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PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** 13/116764	**First Named Inventor:** Harald Philipp	
	Attorney Docket No: 080900.1059	**Art Unit:** 2858	**Filing Date:** 26 May 2011

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	FIRST NAMED INVENTOR
	A	7,875,814	01-25-2011	Chen
	B	8,040,326	10-18-2011	Hotelling
	C	8,179,381	05-15-2012	Frey
	D	2009/0315854	12-24-2009	Matsuo

UNPUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	FILING DATE	FIRST NAMED INVENTOR
	E			
	F			
	G			
	H			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	COUNTRY	TRANSLATION (YES OR NO)
	I				
	J				

NON-PATENT LITERATURE (NPL)

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	K		
	L		
	M		
	N		
	O		
	P		
	Q		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /HADN/

EXAMINER	DATE CONSIDERED
/Hoai-An Nguyen/	01/13/2014

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

PTO/SB/08 **INFORMATION DISCLOSURE STATEMENT BY APPLICANT**	**Application Number:** 13/116764		**First Named Inventor:** Harald Philipp
	Attorney Docket No: 080900.1059	**Art Unit:** ~~Unassigned~~	**Filing Date:** 26 May 2011

ISSUED U.S. PATENTS AND PUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	FIRST NAMED INVENTOR
	A	7,663,607	02-16-2010	Hotelling
	B	7,920,129	04-05-2011	Hotelling
	C	8,031,094	10-04-2011	Hotelling
	D	8,031,174	10-04-2011	Hamblin
	E	8,049,732	11-01-2011	Hotelling

UNPUBLISHED U.S. APPLICATIONS

		DOCUMENT NUMBER	FILING DATE	FIRST NAMED INVENTOR
	F			
	G			
	H			
	I			

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	PUBLICATION OR ISSUE DATE	COUNTRY	TRANSLATION (YES OR NO)
	J				
	K				

NON-PATENT LITERATURE (NPL)

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	L		
	M		
	N		
	O		
	P		
	Q		
	R		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /HADN/

EXAMINER	DATE CONSIDERED
/Hoai-An Nguyen/	01/13/2014

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to the applicant.

U.S. PATENT AND TRADEMARK OFFICE

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13116764	PHILIPP ET AL.
	Examiner	**Art Unit**
	HOAI-AN D NGUYEN	2868

CPC		
Symbol	**Type**	**Version**

CPC Combination Sets				
Symbol	**Type**	**Set**	**Ranking**	**Version**

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/HOAI-AN D NGUYEN/ Primary Examiner.Art Unit 2868	01/13/2014	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

Issue Classification

Application/Control No.	Applicant(s)/Patent Under Reexamination
13116764	PHILIPP ET AL.
Examiner	**Art Unit**
HOAI-AN D NGUYEN	2868

US ORIGINAL CLASSIFICATION

CLASS	SUBCLASS
324	663

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
340	545.4				

INTERNATIONAL CLASSIFICATION

CLAIMED					NON-CLAIMED				
G	0	1	R	27 / 26 (2006.01.01)					
G	0	8	B	13 / 08 (2006.01.01)					

NONE

(Assistant Examiner) (Date)

Total Claims Allowed: 20

/HOAI-AN D NGUYEN/
Primary Examiner.Art Unit 2868 01/13/2014

(Primary Examiner) (Date)

O.G. Print Claim(s)	O.G. Print Figure
1	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13116764	PHILIPP ET AL.
	Examiner	**Art Unit**
	HOAI-AN D NGUYEN	2868

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17												
	2		18												
	3		19												
	4		20												
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	10														
	11														
	12														
	13														
	14														
	15														
	16														

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 20	
/HOAI-AN D NGUYEN/ Primary Examiner.Art Unit 2868 (Primary Examiner)	01/13/2014 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination
	13/116,764	PHILIPP ET AL.
	Examiner	Art Unit
	HOAI-AN D. NGUYEN	2868

SEARCHED			
Class	Subclass	Date	Examiner
Updated	previous search areas.	1/10/2014	HADN
324	663	1/10/2014	HADN
324	658	1/10/2014	HADN
324	649	1/10/2014	HADN
324	600	1/10/2014	HADN
702	57	1/10/2014	HADN
340	545.4	1/10/2014	HADN
340	545.2	1/10/2014	HADN
340	545.1	1/10/2014	HADN
340	541	1/10/2014	HADN
340	540	1/10/2014	HADN
381	74	1/10/2014	HADN

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner
Interference Search History Printout.		1/13/2014	HADN

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
Reviewed all previously searched prior art references in the parent case 12/179,769.	1/10/2014	HADN
Considered IDS.	1/10/2014	HADN
Text search in EAST.	1/11/2014	HADN
Text search in EAST.	1/12/2014	HADN
Inventors' names searched.	1/12/2014	HADN
Text search in EAST.	1/13/2014	HADN

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 6159

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/116,764	05/26/2011 RULE	324	2868	080900.1059

APPLICANTS

INVENTORS

Harald Philipp, Zug, SWITZERLAND;
Kevin Snoad, Chicester, UNITED KINGDOM;

**** CONTINUING DATA ***************************

This application is a CON of 12/179,769 07/25/2008 PAT 7952366
which claims benefit of 60/952,053 07/26/2007

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

06/07/2011

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /HOAI-AN D NGUYEN/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		SWITZERLAND	10	20	3

ADDRESS

Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201
UNITED STATES

TITLE

Proximity Sensor

FILING FEE RECEIVED		
1090	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13116764	PHILIPP ET AL.
	Examiner	**Art Unit**
	HOAI-AN D NGUYEN	2868

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	01/13/2014								
	1	=								
	2	=								
	3	=								
	4	=								
	5	=								
	6	=								
	7	=								
	8	=								
	9	=								
	10	=								
	11	=								
	12	=								
	13	=								
	14	=								
	15	=								
	16	=								
	17	=								
	18	=								
	19	=								
	20	=								

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

12323 7590 01/31/2014
Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/116,764	05/26/2011	Harald Philipp	080900.1059	6159

TITLE OF INVENTION: PROXIMITY SENSOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	04/30/2014

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, HOAI AN D	2868	324-663000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 Baker Botts LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Atmel Corporation
(B) RESIDENCE: (CITY and STATE OR COUNTRY): San Jose, CA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 020384 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ☐ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ☐ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date 4/29/2014
Typed or printed name Chad D. Terrell Registration No. 52,279

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Harald Philipp, et al.
Serial No.:	13/116,764
Filed:	May 26, 2011
Group No.:	2868
Examiner:	Hoai An D Nguyen
Notice of Allowance Mailed:	January 31, 2014
Confirmation No.:	6159
Title:	Proximity Sensor

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Applicants appreciate the Examiner's allowance of Claims 1-20. Pursuant to 37 C.F.R. § 1.104, Applicants respectfully issue a statement commenting on the Examiner's reasons for allowance. Applicants respectfully disagree with the Examiner's reasons for allowance to the extent that they are inconsistent with applicable case law, statutes, and regulations. Furthermore, Applicants do not admit to any characterization or limitation of the claims or to any characterization of a reference by the Examiner, particularly any that are inconsistent with the language of the claims considered in their entirety and including all of their constituent limitations.

Respectfully submitted,
BAKER BOTTS L.L.P.
Attorneys for Applicants

Chad D. Terrell
Registration No. 52,279

Date: April 29, 2014
CUSTOMER NO. 12323

Electronic Patent Application Fee Transmittal

Application Number:	13116764
Filing Date:	26-May-2011
Title of Invention:	PROXIMITY SENSOR
First Named Inventor/Applicant Name:	Harald Philipp
Filer:	Vernon E. Evans/mary johnson
Attorney Docket Number:	080900.1059

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt

EFS ID:	18887607
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	PROXIMITY SENSOR
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Vernon E. Evans/mary johnson
Filer Authorized By:	Vernon E. Evans
Attorney Docket Number:	080900.1059
Receipt Date:	29-APR-2014
Filing Date:	26-MAY-2011
Time Stamp:	12:23:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$960
RAM confirmation Number	11945
Deposit Account	020384
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	0809001059issuefee.PDF	98539 3a3810ea324afa80cafa883ead96ab8fd7a5000b	no	1
Warnings:					
Information:					
2	Post Allowance Communication - Incoming	0809001059comments.PDF	43447 59c8266e67f449658f0359be18d994d70e2f9e36	no	1
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30264 c2a11215a26011af4655144bbdff31920bc04405	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	172250		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/116,764	06/10/2014	8749251	080900.1059	6159

12323 7590 05/21/2014

Baker Botts L.L.P.
2001 Ross Avenue, 6th Floor
Dallas, TX 75201

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 569 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Harald Philipp, Zug, SWITZERLAND;
Kevin Snoad, Chicester, UNITED KINGDOM;

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 151145

OR

I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☑ The address associated with the above-mentioned Customer Number

OR

The address associated with Customer Number:

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Inventor or Joint Inventor (title not required below)

Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Ciaran O'Gara	Date (Optional)	
Name	Ciaran O'Gara		
Title	Managing Director, Solas OLED Limited		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 151145

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 151145

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Solas OLED Limited
4-5 Burton Hall Road
Sandyford, Dublin 18 Ireland

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date
Name	Ciaran O'Gara	Telephone
Title	Managing Director., Solas OLED Limited	

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	13/116,764
Filing Date	05-26-2011
First Named Inventor	Harald Philipp
Title	PROXIMITY SENSOR
Art Unit	2868
Examiner Name	NGUYEN, HOAI AN D
Attorney Docket Number	0056.007US02

SIGNATURE of Applicant or Patent Practitioner

Signature	/Michael Messinger/	Date (Optional)	
Name	Michael Messinger	Registration Number	37575
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Harald Philipp, Kevin Snoad

Application No./Patent No.: 8,749,251 Filed/Issue Date: 10-06-2011

Titled: PROXIMITY SENSOR

Solas OLED Limited, a Corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: PHILIPP, HARALD, SNOAD, KEVIN To: QRG LIMITED

   The document was recorded in the United States Patent and Trademark Office at
   Reel 030284, Frame 0692, or for which a copy thereof is attached.

2. From: QRG LIMITED To: ATMEL CORPORATION

   The document was recorded in the United States Patent and Trademark Office at
   Reel 030284, Frame 0752, or for which a copy thereof is attached.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(c)

3. From: MICHROCHIP TECHNOLOGY INCORPORATED, AMTEL CORPORATION To: SOLAS OLED LIMITED

The document was recorded in the United States Patent and Trademark Office at
Reel 048201, Frame 0225, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Michael Messinger/	February 28, 2019
Signature	Date
Michael Messinger	37575
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	35282803
Application Number:	13116764
International Application Number:	
Confirmation Number:	6159
Title of Invention:	PROXIMITY SENSOR
First Named Inventor/Applicant Name:	Harald Philipp
Customer Number:	12323
Filer:	Michael V. Messinger
Filer Authorized By:	
Attorney Docket Number:	080900.1059
Receipt Date:	01-MAR-2019
Filing Date:	26-MAY-2011
Time Stamp:	17:09:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	00560000000_POASigned.pdf	332922 64721d76744525315c78d9434252dd144d2835a9	no	3

Warnings:

Information:					
2	Power of Attorney	0059007US02_POA_PTOAIA82A.pdf	125638 e40ec4b186942dde03f3a4d5c5ad33ddbc0c8394	no	1
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	0059007US02_Assignment373.pdf	121265 fdf7991c80c1e365c4aa91fad3d7e02157e724c3	no	3
Warnings:					
Information:					
			Total Files Size (in bytes):	579825	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/116,764	05/26/2011	Harald Philipp	0056.007US02

CONFIRMATION NO. 6159

POA ACCEPTANCE LETTER

151145
Shami Messinger PLLC
1000 Wisconsin Ave. NW
Suite 200
Washington, DC 20007

OC00000106409416

Date Mailed: 03/08/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/01/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mnguyen/

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/116,764	05/26/2011	Harald Philipp	080900.1059

CONFIRMATION NO. 6159

POWER OF ATTORNEY NOTICE

12323
Baker Botts L.L.P./Atmel Corporation
2001 Ross Avenue
SUITE 700
Dallas, TX 75201

OC000000106409396

Date Mailed: 03/08/2019

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/01/2019.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/mnguyen/