IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 6,926,670)
Issued: August 09, 2005)
Application No.: 10/054,330)
Filing Date: January 22, 2002)

For: Wireless MEMS Capacitive Sensor for Physiologic Parameter Measurement

FILED VIA E2E

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,926,670

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I. INTRODUCTION

Abbott Laboratories, Abbott Laboratories, Inc. St. Jude Medical, Inc., and CardioMEMS LLC (collectively, "Petitioner") request *inter partes* review of claims 1-5, 21-29, and 31 of U.S. Patent No. 6,926,670, titled "Wireless MEMS Capacitive Sensor for Physiologic Parameter Measurement" ("'670 patent") (Ex. 1001). According to USPTO records, the '670 patent is assigned to Integrated Sensing Systems, Inc.

The '670 patent relates to an implantable inductor-capacitor (LC) resonant sensor device for continuous remote monitoring of physiologic parameters in a patient. As the '670 patent acknowledges, the use of LC resonant circuits for use as wireless implantable sensors was "well-known to those knowledgeable in the art." '670 patent, 1:32-37. While the challenged claims recite a sensing device being a "micro electromechanical system (MEMS)" with an "integrated inductor," those common features were taught by multiple prior art references not before the examiner and by the admitted prior art.

Accordingly, Petitioner asks the Board to institute review of the '670 patent and find all challenged claims unpatentable.

II. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8

A. Real Parties in Interest (37 C.F.R. § 42.8(b)(1))

The real-parties-in-interest are Abbott Laboratories, Abbott Laboratories, Inc., St. Jude Medical, LLC, and CardioMEMS LLC (collectively, "Petitioner").

B. Related Matters (37 C.F.R. § 42 8(b)(2))

The ’670 patent has been asserted in the following district court case pending in the Eastern District of Michigan: *Integrated Sensing Systems, Inc. v. Abbott Laboratories, et al.*, Case No. 2:19-cv-10041-DPH-EAS.

C. Lead and Backup Counsel and Service Information

Under 37 C.F.R. §§ 42.8(b)(3), 42.8(b)(4), and 42.10(a), Petitioner designates the following lead counsel:

- Michael A. Morin (Reg. No. 40,734), michael.morin@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000; Washington, D.C. 20004-1304; 202.637.2298 (Tel.); 202.637.2201 (Fax).

Petitioner also designates the following backup counsel:

- Jonathan M. Strang (Reg. No. 61,724), jonathan.strang@lw.com, Latham & Watkins LLP; 555 Eleventh Street, NW, Ste. 1000; Washington, D.C. 20004-1304; 202.637.2362 (Tel.); 202.637.2201 (Fax).
- S. Giri Pathmanaban (Reg. No. 75,986), giri.pathmanaban@lw.com, Latham & Watkins LLP; 140 Scott Drive, Menlo Park, CA 94025; 650.470.4851 (Tel.); 650.463.2600 (Fax).

Under 37 C.F.R. § 42.10(b), a Power of Attorney from Petitioner is attached. Petitioner consents to electronic service.

D. Fee for *Inter Partes* Review

The Director may charge the fee specified by 37 C.F.R. § 42.15(a) to Deposit Account No. 506269.

III. GROUNDS FOR STANDING (37 C.F.R. § 42.104(A))

Petitioner certifies that the ’670 patent is available for *inter partes* review and that the Petitioner is not barred or estopped from requesting *inter partes* review of the challenged claims of the ’670 patent on the grounds identified herein.

IV. IDENTIFICATION OF CLAIMS BEING CHALLENGED (37 C.F.R. § 42.104(B))

A. Statutory Ground for the Challenge

Petitioner requests *inter partes* review of claims 1-4, 21, 26-27, and 31 of the ’670 patent on these grounds:

Ground	**Claims**	**Basis**
1	1-4, 21, 26-27, 31	§ 102: Akar
2	1-5, 21-25, 28-29, 31	§ 102: Allen-379
3	26-27	§ 103: Allen-379 in view of Renaud, with or without Park

V. OVERVIEW OF THE ’670 PATENT

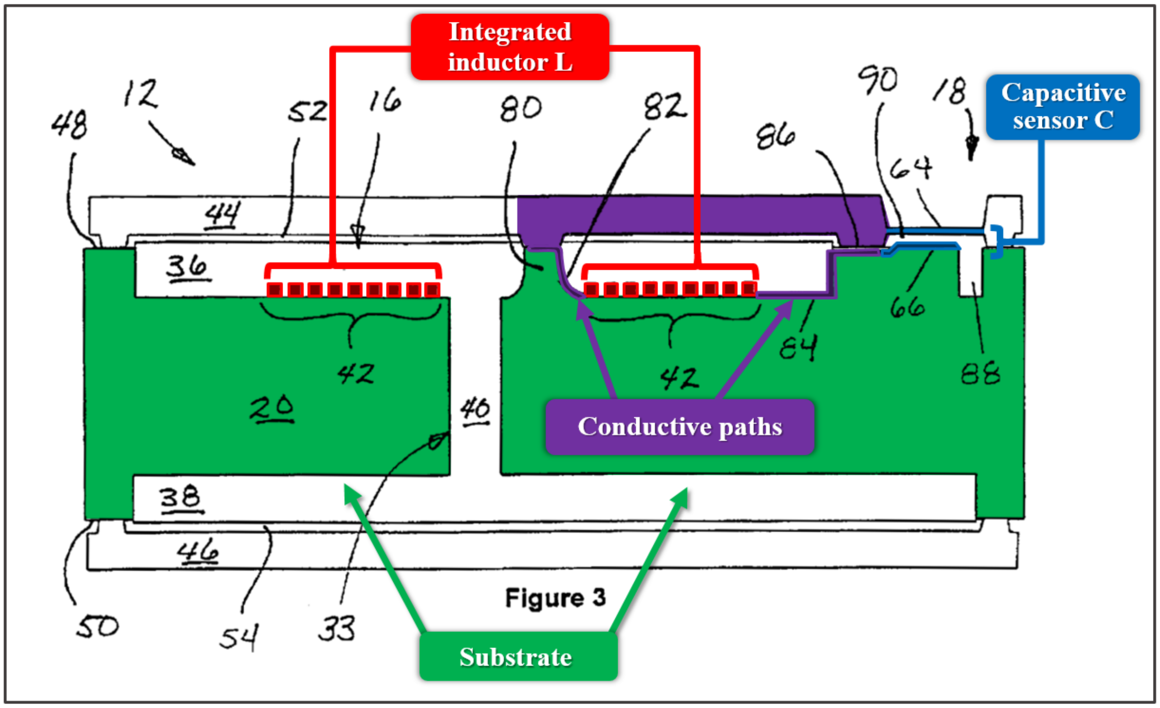
A. The ’670 Patent

The ’670 patent claims priority to provisional application nos. 60/263,327 (“’327 provisional,” Ex. 1003), filed January 22, 2001, and 60/278,634 (“’634 provisional," Ex. 1004), filed March 26, 2001, and relates to "an implantable microfabricated sensor device and system for measuring a physiologic parameter of interest within a patient." '670 patent, Abstract.

The '670 patent explains that LC resonant circuits, also referred to as "LC tank resonators," were "well-known to those knowledgeable in the art" for use as wireless implantable sensors. '670 patent, 1:32-37; Allen Decl. ¶ 38 (Ex. 1024) (explaining that the term "tank" is used because the oscillation of energy between the inductor and capacitor connected in parallel is analogous to water sloshing back and forth in a tank). The LC resonant circuit of the implantable sensing device includes a (1) parallel plate capacitor (represented by the letter C), which varies with some physical parameter (e.g., pressure), thus acting as a "capacitive sensor," and (2) an inductor (represented by the letter L) that operates as an antenna for wireless communication with an external readout device, and (3) a series-parallel connection between the capacitor and inductor. '670 patent, 1:32-50, 10:30-35; Allen Decl. ¶¶ 38-40.

The '670 patent states that the LC resonator devices of the prior art fabricated the capacitive sensor and the inductor separately. '670 patent, 2:51-59. This allegedly resulted in assemblies that may be (1) "too large for many desirable applications, including intraocular pressure monitoring and/or pediatric applications" and (2) "prohibitively expensive to manufacture." *Id*. Accordingly, the ’670 patent teaches and claims an “invention” in which the inductor is “microfabricated with the sensor itself” using common MEMS fabrication techniques. *Id.*, 3:28-31, 3:46-60 (“[T]he present invention provides a MEMS sensor … microfabricated utilizing common microfabricating techniques.…”); Allen Decl. ¶¶ 45-51 (also discussing admitted prior art LC resonant sensors).

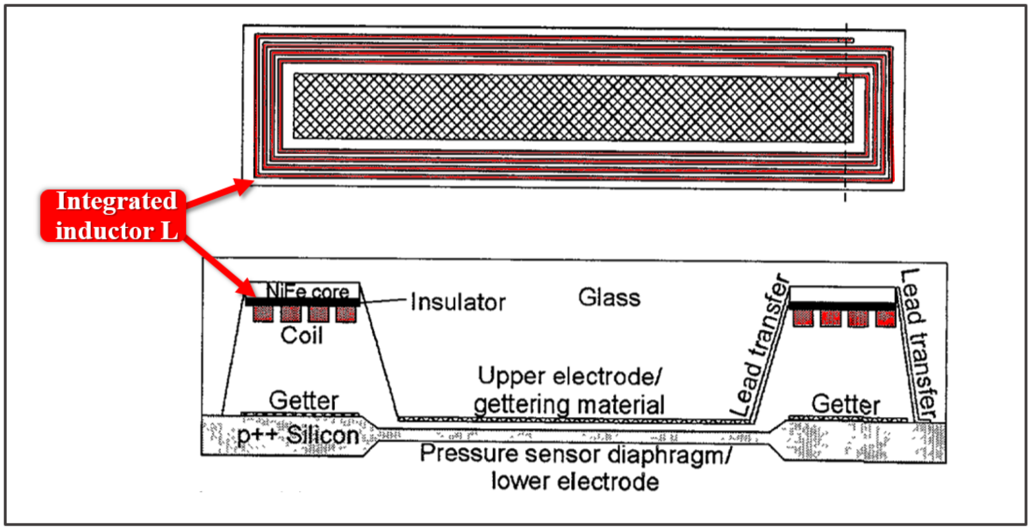
Annotated Figure 3 below is a cross section of the ’670 patent’s pressure sensing device, showing the “integrated inductor” coil (red) and the capacitive “sensor” (blue), including its movable electrode 64 and fixed electrode 66. ’670 patent, 6:30-32, 7:25-36. The integrated inductor coil and fixed electrode 66 are formed on the surface of a common “substrate 20” (green). *Id.*, 7:30-35. Although Figure 3 depicts the capacitive sensor to the side of the integrated inductor, the ’670 patent also explains that the sensor “may be located within, above, or below the turns of the coil 42.” *Id.*, 9:45-50. Also shown in annotated Figure 3 are the “traces 82, 84” that create a plurality of “electrical path[s]” (purple) that connect the two plates of the capacitor to the inner and outer most turns of the integrated inductor, forming a LC resonant circuit. *Id.*, 8:66-9:7.



’670 patent, Fig. 3 (annotated); Allen Decl. ¶¶ 52-53.

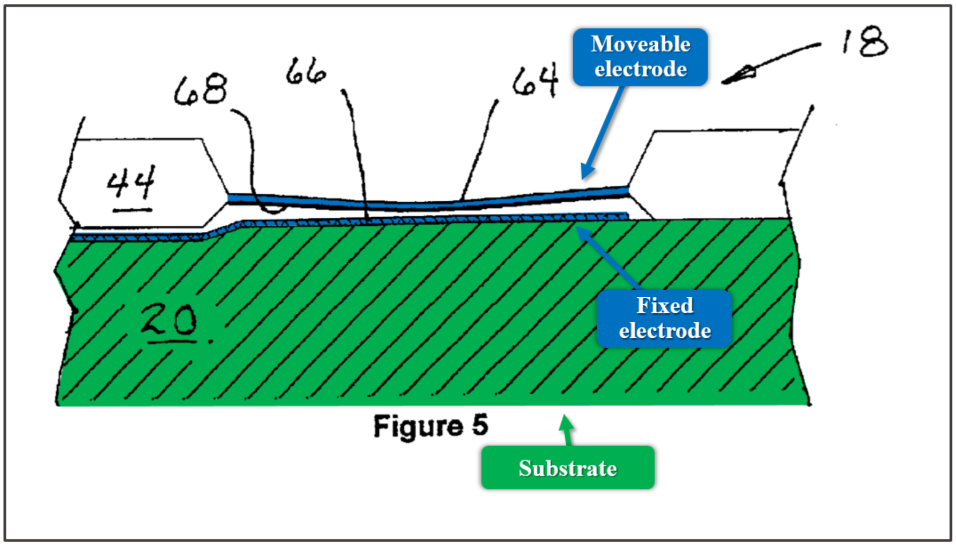
Figure 3 is a cross section and so the integrated inductor coil 42 is depicted as a discontinuous series of black squares. Those black squares represent a continuous planar coil of conductive material forming the integrated inductor. Allen Decl. ¶ 54; ’670 patent, 6:30-41.

A top down depiction of an integrated inductor is shown in annotated Figure 12(b) from the ’634 provisional, which shows how the coils look from above:



’634 provisional, Fig. 12(b) (annotated), Ex. 1004, 3, 9 (Figure 12 depicts “[i]ntegration of an inductor or coil into a capacitive sensor structure.”); Allen Decl. ¶ 54.

Annotated Figure 5 from the ’670 patent below is an enlarged cross-sectional view of Figure 3’s capacitive sensor 18. ’670 patent, 4:46-48. Capacitive sensor 18 can be “constructed in many forms commonly know[n] to those familiar with the art.” *Id.*, 7:27-29. The bottom plate of capacitive sensor 18 (called “conductive layer” or “fixed electrode 66”) is formed on the surface (“upper face 48”) of substrate 20. *Id.*, 7:33-36. Upper cap layer 44 is formed to define a thin and flexible diaphragm 64 (also called “moveable electrode 64”). *Id.*, 7:28-38. The diaphragm 64 can be conductive and/or plated with a conductive layer 68.

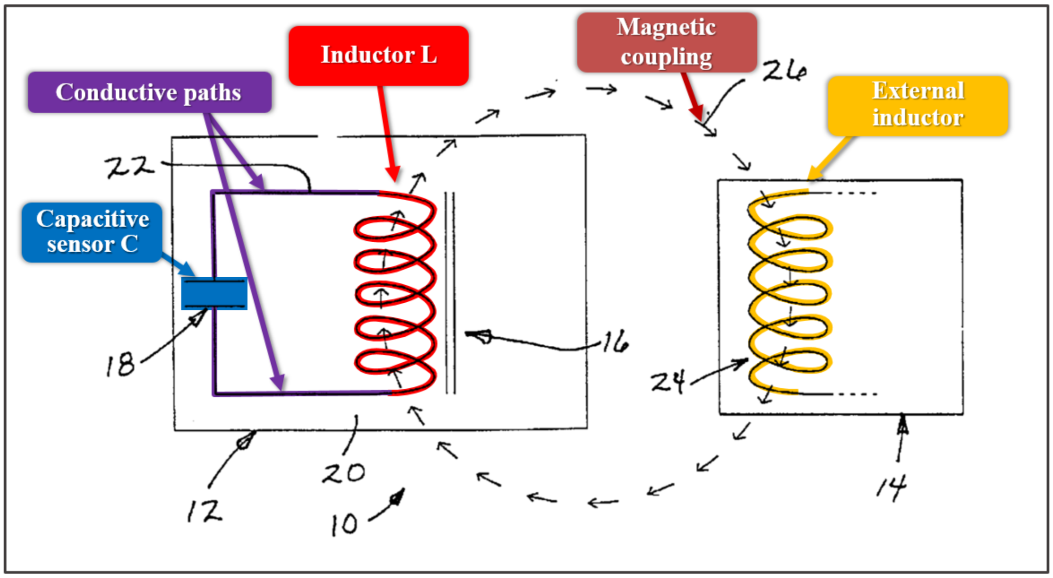


’670 patent, Fig. 5 (annotated), 7:26-38; Allen Decl. ¶ 55.

The diaphragm (with or without the conductive layer) is referred to as the “moveable electrode” of the capacitor because applied pressure to the top surface of the capacitive pressure sensor deflects (moves) it towards fixed electrode 66. ’670 patent, 7:66-8:2; Allen Decl. ¶ 56. That movement changes the capacitance between the two plates. ’670 patent, 8:15-18 (the “standard equation of parallel plate capacitance, C= ϵA/d” where “plate separation d will vary with the applied pressure”). Thus, by implanting the sensor so that the moveable electrode is arranged in the path of the physical property being measured (e.g., pressure of a fluid), the property can be deduced by a change in capacitance. *Id.*, 8:2-6; Allen Decl. ¶ 56.

The ’670 patent includes a “schematic illustration of a wireless MEMS sensor system according to the principles of the present invention” as shown in annotated

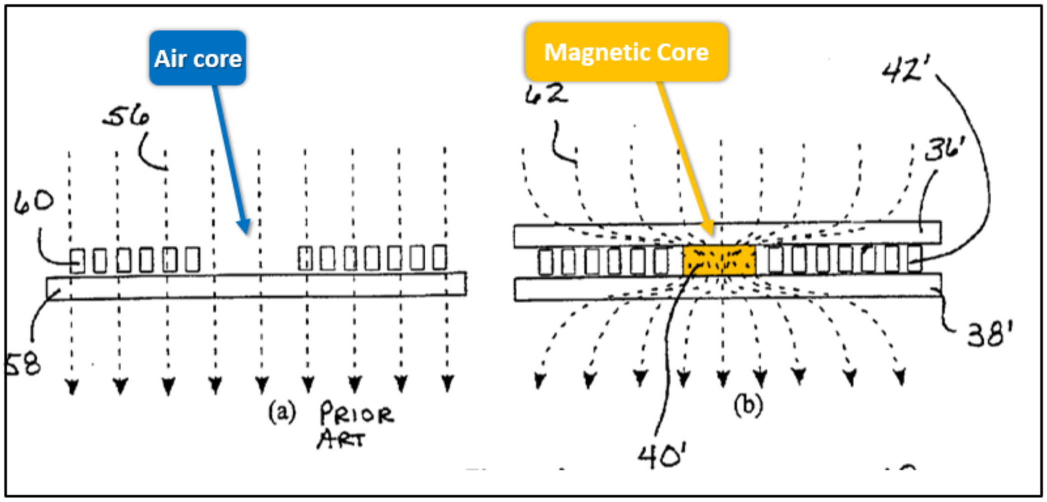
Figure 1 below. ’670 patent, Fig. 1, 4:32-34. On the left is the “pressure sensing device,” 12, which includes the “integrated inductor 16” (red) and “capacitive pressure sensor 18” (blue) connected in parallel (purple), and on the right is a non-implantable “readout device 14” that includes a “second inductor 24” (yellow).



’670 patent, Fig. 1 (annotated), 5:60-64; Allen Decl. ¶ 57.

The arrows arranged in a circle between the integrated inductor and non-implantable inductor show that the inductors are “couple[d] magnetically.” ’670 patent, 5:62-64. Before 2001, magnetic coupling was (and still is) a basic principle of wireless communication between two inductors placed in close proximity. Allen Decl. ¶¶ 41-44; ’670 patent, 1:33-36 (providing as background that “[a] number of proposed schemes for wireless communication rely on magnetic coupling between an inductor coil associated with the implanted device and a separate, external ‘readout’ coil”); 5:65-67 (stating that “readout device[s]” used to measure impedance of an external coil are "well known in the industry and in the sensing field in general"). This magnetic, or inductive, coupling allows detecting the physical parameter measured by the capacitive sensor. '670 patent, 1:35-49.

Thus, the integrated inductor allows reading the sensor wirelessly: any change in capacitance is measured indirectly by measuring the impedance of an external readout coil magnetically coupled to the integrated inductor. *Id.*, 1:50-54 (explaining this technique was known in the prior art), 5:62-64; Allen Decl. ¶¶ 39-44, 57. According to the '670 patent's alleged invention, the improvement is increasing the coupling effectiveness (and thus the distance at which the sensor may be read) by having an integrated inductor that comprises a "magnetic core" to concentrate the magnetic field, as shown above in Figure 3 and below in Figure 4B:



'670 patent, Fig. 4, 4:40-46, 6:63-7:16; Allen Decl. ¶ 58. Only claims 7-18 arguably recite the alleged improvement of including a "magnetic core" within the integrated inductor, and none of those claims are challenged here. *Id.* ¶ 59.

B. The Challenged Claims

Claim 1 is the only independent claim and recites an "implantable microfabricated sensor device for measuring a physiologic parameter of interest within a patient," wherein the sensor device essentially comprises three elements:

1. an "integrated inductor" formed on a substrate;
2. a "sensor" that is formed at least in part on the substrate;
3. wherein the integrated inductor and sensor are electrically connected by a "plurality of conductive paths" to define an "LC tank resonator."

As shown in the grounds below, sensor devices having these properties were disclosed in numerous prior art references. And, as discussed below, the remaining challenged claims depend from claim 1 and are also invalid in view of the prior art discussed herein.

C. Prosecution History

During prosecution, the examiner rejected all claims as obvious over U.S. Patent No. 6,567,703 to Thompson, et al., in view of U.S. Patent No. 6,101,371 to Barber, et al. '670 FH (Ex. 1002), 306. Specifically, the examiner found that the combination taught all of the limitations of claim 1, and that "the specific limitations of the dependent claims are either inherently or obviously met by either one of the cited references." *Id.*, 307.

In response, the patentee argued that the "claims of the present application specifically recite that the claimed MEMS device includes a sensor responsive to physiologic parameters that is formed at least in part on the surface of the substrate." *Id.*, 317. The applicant then argued that the art does not expressly state that "a portion of a sensor is formed on the surface of the substrate" and therefore fails to disclose the claimed feature. *Id.* The examiner issued a notice of allowance without any remarks.

VI. CLAIM CONSTRUCTION

The Board construes the claims "using the same claim construction standard that would be used" in District Court. 37 C.F.R. § 42.100.

A. "integrated inductor"

The term "integrated inductor" in claim 1 means "an inductor microfabricated with the sensor itself." This construction is correct because the patent expressly gives it that definition, it is the plain meaning in the art, it is supported by the surrounding claim language, and it is supported by the specification.

First and foremost, the '670 patent defines integrated inductor:

> Still another object of the present invention is to provide a wireless MEMS sensor system in which the sensing device utilizes ***an integrated inductor, an inductor microfabricated with the sensor itself***.

’670 patent, 3:28-31.[1] This is an explicit definition of what an “integrated inductor” is. *See Trading Techs. Int’l., Inc. v. eSpeed, Inc.*, 595 F.3d 1340, 1353 (Fed. Cir. 2010) (finding inventors defined the term “static” where the specification stated “The values in the price column are static; that is, they do not normally change positions unless a re-centering command is received (discussed in detail later).”).

The ’670 patent’s definition of “integrated inductor” is also supported by the rest of the claim language. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1314 (Fed. Cir. 2005) (en banc) (“[T]he claims themselves provide substantial guidance as to the meaning of particular claim terms.”). The “integrated inductor” of claim 1 is “formed on a substrate,” just like the components of an integrated circuit are formed with each other on a substrate using microfabrication techniques most often already known in the art. Allen Decl. ¶¶ 66-68. The preamble of claim 1 further reinforces this conclusion, reciting that the implantable pressure sensing device is “microfabricated” and that it comprises both the “integrated inductor” and a “sensor.” ’670 patent, claim 1. The subsequent claim limitations require that the “integrated inductor” and “at least one sensor” are “formed on” the same substrate. *Id.* Because the integrated inductor and sensor are microfabricated on the same

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[1] All emphasis added unless otherwise noted.

substrate, a POSITA would have understood that the inductor and capacitor are microfabricated *together*. Allen Decl. ¶ 66-68.

Moreover, the ’670 patent distinguishes an “integrated inductor” from hand or machine wound inductors formed as discrete components. Allen Decl. ¶ 70. The ’670 patent identifies other prior art references using LC resonant circuits that did “not take advantage of recent advances in silicon (or similar) microfabrication technologies” like the claimed invention. ’670 patent, 1:67-2:7. Those references each describe an inductor formed as a discrete component by wrapping a wire around a mandrel, then assembling them into a sensor device with a capacitive sensor. Allen Decl. ¶¶ 71-72 (comparing the inductors disclosed in the conventionally fabricated LC resonators with the inductors disclosed in the microfabricated LC resonators).

Following this background discussion, the ’670 patent exclusively discloses planar or layered inductors formed on the surface of the substrate using known microfabrication techniques. ’670 patent, 3:47-50 (“The implantable unit is microfabricated utilizing common microfabricating techniques….”); 5:60-64 (“As an example, the preferred embodiment integrates a capacitive pressure sensor 18 into a common substrate 20 with the integrated inductor 16.”), Figs. 3, 4, 11; Allen Decl. ¶ 69; *Boss Control, Inc. v. Bombardier Inc.*, 410 F.3d 1372, 1377 (Fed. Cir. 2005) (“[T]he patentee’s choice of preferred embodiments can shed light on the intended scope of the claims.”).

The explicit definition in the ’670 patent of “integrated inductor” is consistent with how the term was used in the art at the time. *Arthur A. Collins, Inc. v. N. Telecom Ltd.*, 216 F.3d 1042, 1044-45 (Fed. Cir. 2000). The term “integrated inductor” is akin to an “integrated circuit,” and refers to forming an inductor on a substrate such that it can be batch microfabricated with other components (such as a capacitive sensor) rather than individually constructed of discrete electronic components. Allen Decl. ¶¶ 73-74 (discussing examples below).

For example, the ’670 patent cites to Darrow as disclosing a “microfabricated sensors” that are an “alternative to conventionally fabricated devices” that require “complex assembly processes [that make] such devices prohibitively expensive to manufacture for widespread use.” ’670 patent, 2:57-67. As prior art of record, Darrow has “particular value as a guide to the proper construction of [integrated inductor], because it may indicate not only the meaning of the term to persons skilled in the art, but also that the patentee intended to adopt that meaning.” *Kumar v. Ovonic Battery Co.*, 351 F.3d 1364, 1368 (Fed. Cir. 2003) (citation omitted). Darrow describes an “integrated inductor” that is “directly fabricated on a wafer (or wafers) ***with other required circuit components, to form an integrated, MEMS-based implantable transducer circuit***.” Darrow (Ex. 1018), 7:1-7, claim 22.

Other prior art references also show that a POSITA would have understood “integrated inductor” to be consistent with the express definition in the ’670 patent.

Collins, 216 F.3d at 1044-45 ("Even when prior art is not cited in the written description or the prosecution history, it may assist in ascertaining the meaning of a term to a person skilled in the art."). For example, Petersen describes an "integrated micromachined inductor coil" that is a "flat coil that is coplanar and coaxial with the first capacitor plate" and "made by removing selected portions of material from a conductive sheet." Petersen (Ex. 1006), 3:67-4:11; 7:32-37. Petersen distinguishes its inductor from non-integrated inductors in the prior art that are "produced by hand winding and hand assembly, which is both costly and inefficient." Petersen, 2:41-43; *see also, generally, id.*, 2:35-3:19 (discussing five prior art references disclosing LC resonant sensors using non-integrated inductors); Allen Decl. ¶ 74.

For these reasons, the term "integrated inductor" should be construed as an "inductor microfabricated with the sensor itself."

Regardless, this petition does not turn on this definition; even if the Board adopts a broader definition, *e.g.*, merely requiring the "inductor" to be physically and/or electrically "integrated" with the rest of the device, the claims are unpatentable for the same reasons presented herein. Allen Decl. ¶ 76.

B. "[said sensing device] being a micro electromechanical system (MEMS)"

The Board should construe "[said sensing device] being a micro electromechanical system (MEMS)" in claim 1 to mean that "[said sensing device] is made using microfabrication processes such as micromachining," but the claims are unpatentable under any reasonable construction of this term for the reasons explained herein.

The specification shows that an electromechanical sensor device is a MEMS device when it is made using microfabrication processes. Indeed, the ’670 patent admits that small electromechanical sensor devices were known in the prior art, but stated that they do not “take advantage of recent advances in silicon (or similar) microfabrication technologies.” ’670 patent, 2:4-7; *see also, id.*, 1:20-2:50 (describing known prior art devices). Rather, those “devices require a complex electromechanical assembly with many dissimilar materials,” resulting in “complex assembly processes” that “make such devices prohibitively expensive to manufacture for widespread use.” *Id.*, 2:50-59. In contrast with these prior art devices, the ’670 patent’s “MEMS sensor system” is manufactured using “common microfabricating techniques,” providing a “device where all components are located on the same chip.” *See id.*, 3:47-52; Allen Decl. ¶¶ 77-79 .

The ’670 patent also claims priority to two provisional applications that expressly define “micromachined” as “using batch-microfabrication techniques understood by those familiar with the art that are typically common to integrated-circuit and/or MicroElectroMechanical Systems (MEMS) fabrication processes.” ’327 provisional (Ex. 1003), 1; ’634 provisional (Ex. 1004), 2. In other words, micromachining is a type of microfabrication, and both micromachining and microfabrication of the electromechanical components comprising the claimed sensor device (e.g. an "integrated inductor" and "sensor responsive to physiologic parameters"), will result in the sensing device being a MEMS, as reflected in Petitioner's construction. Allen Decl. ¶¶ 80.

Petitioner's construction also reflects how the term "MEMS" was used in the art at the time. Allen Decl. ¶ 81; *Collins*, 216 F.3d at 1044-45. For example, Roy teaches that MEMS "refers to a class of miniature electromechanical components and systems that are fabricated using techniques originally used in the fabrication of microelectronics," e.g., MEMS "pressure sensors" are "manufactured using microfabrication and micromachining techniques." Roy (Ex. 1012), 2:17-25. As another example, Christenson explains that "MEMS devices are created by microfabrication processes and techniques sometimes referred to as micromachining." Christenson (Ex. 1014), 1:30-32; *see also, e.g.,* Discenzo (Ex. 1013), 2:15-19 (describing a "viscosity sensor of a MEMS (micro-electro mechanical systems) type" that is "made using integrated circuit-like microfabrication techniques").

VII. PERSON HAVING ORDINARY SKILL IN THE ART

A person of ordinary skill in the art at the relevant time (around 2001) would have had at least a bachelor's degree in electrical or mechanical engineering (or equivalent) and at least two years' industry experience, or equivalent research.

Alternatively, a POSITA could substitute directly relevant additional education for experience, e.g., an advanced degree relating to the design of implantable medical devices, or an advance degree in electrical or mechanical engineering (or equivalent), with at least one year of industry experience. Allen Decl. ¶ 34.

This Petition does not turn on this precise definition, and the claims would be unpatentable from the perspective of any reasonable POSITA. *Id.* ¶ 36.

VIII. GROUND 1: CLAIMS 1-4, 21, 26-27, AND 31 ARE ANTICIPATED BY AKAR

A. Overview—Akar (Ex. 1010)

Akar is a master's thesis that was not considered during prosecution. Akar is § 102(b) art because, more than one year prior to the '670 patent's filing, it was made available to the extent that "persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence." *In re Lister*, 583 F.3d 1307, 1315 (Fed. Cir. 2009).

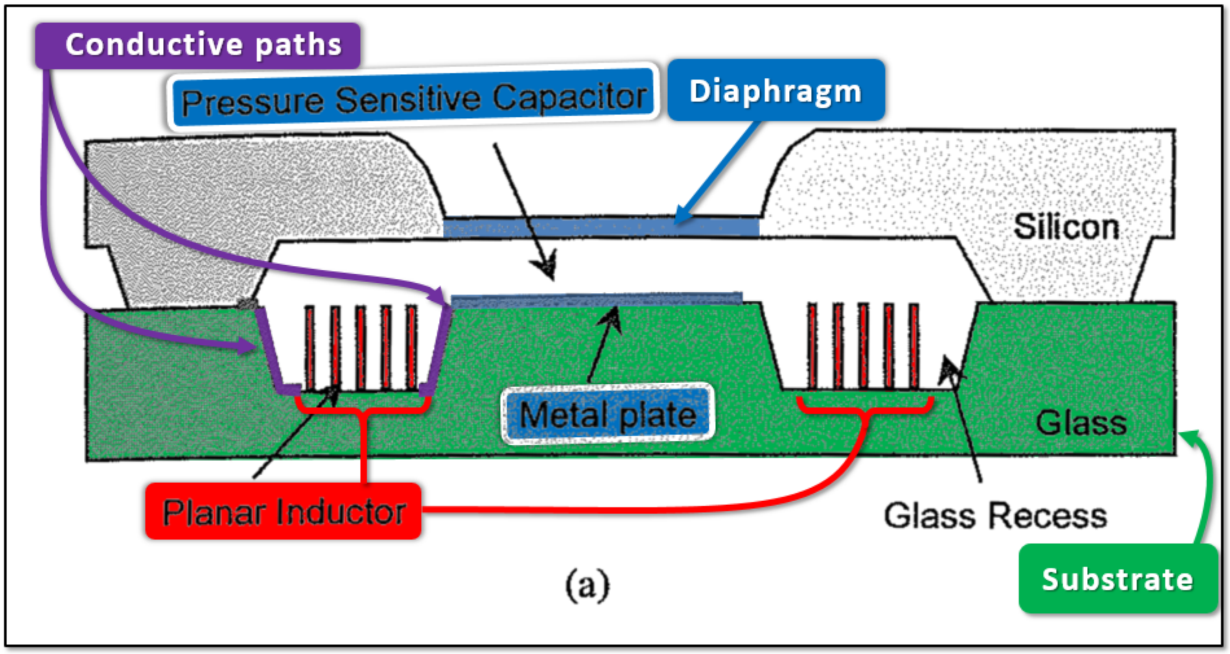
The first, second, and last page of Akar demonstrates that it was completed and approved by faculty members of METU in September 1998. The "Machine-Readable Cataloging" (MARC) record for Akar demonstrates that a POSA could have electronically searched by keyword and found Akar on November 18, 2018, which would have made it publicly available by late November, 1998, more than two years prior to the earliest filing priority date of the '670 patent. Hsieh-Yee Decl. (Ex. 1022) ¶¶ 28-34 (also establishing it would have been shelved at that time).

Akar itself expressly sets forth keywords "silicon micromachining," "capacitive pressure sensor," and "planar integrated coil" (Akar, iv). And its descriptive title, "Silicon Micromachined Capacitive Pressure Sensors For Industrial And Biomedical Applications," also provides sufficient public accessibility. Hsieh-Yee Decl. ¶ 30-34 (establishing that Akar could have been found by such a keyword search of its MARC record as of its November 18, 1998, cataloguing date); *Lister*, 583 F.3d at 1315-16 ("we conclude that the [reference] was publicly accessible as of the date that it was included in…the databases that permitted keyword searching of titles.").

And to be sure, "a single catalogued thesis in one university library" is "sufficient[ly] acccesib[le] to those interested in the art." *In re Hall*, 781 F.2d 897, 898-900 (Fed. Cir. 1986); *see also United Patents Inc. v. Sound View Innovations, LLC*, IPR2018-00599, Paper 11 at 16-20 (P.T.A.B. Sept. 10, 2018) (instituting petition and finding reasonable likelihood that a thesis was publicly accessible based on MARC cataloging records and expert librarian testimonial evidence). Moreover, a reasonably diligent POSA would have found Akar via the roadmap established by Akar's other publications, including a nearly identically titled article published in 1997 (Ex. 1027 (original and certified translation)) and a conference paper dated August 27-30, 2000 (Ex. 1026, entitled "A Wireless Batch Sealed Absolute Capacitive Pressure Sensor"). *Bruckelmyer v. Ground Heaters, Inc.*, 445 F.3d 1374, 1379 (Fed. Cir. 2006); *Cornell Univ. v. Hewlett-Packard Co.*, No. 01-CV-1974, 2008 U.S. Dist. LEXIS 39343, at *20-25 (N.D.N.Y. May 14, 2008). These articles describe similar subject matter and specifically refer the reader to the Middle East Technical University where Akar's thesis was submitted. *See, e.g.,* Ex. 1026, 585, 586, Figs. 2(a) and (b); Ex. 1027, 84, Fig. 2; *cf.* Akar, Cover, 7-8, Figs. 1.4(a) and (b).

Akar discloses "silicon micromachined capacitive pressure sensors," including a pressure sensor "for biomedical applications as an implantable pressure sensor." Akar, 3. Specifically, Akar's pressure sensor for biomedical applications can be "placed in a body or blood vessels, and it allows to measure the pressure remotely, without a need for wire connection." *Id.*, 7.

Akar shows in Figure 1.4a, annotated below, a "cross-section view of this new implantable wireless pressure sensor structure." Akar, 7. It includes a parallel plate "Pressure Sensitive Capacitor" formed by a "thin silicon diaphragm and a fixed bottom plate," wherein the fixed bottom plate is formed on the surface of a "Glass" substrate, and a "Planar Inductor"—which Akar also expressly refers to as an "integrated inductor"—placed into the "recess on the glass [substrate] using electroplating." *Id.*, 7-8, 11, 74. The "[o]ne end of the coil is connected to the fixed plate of the capacitor, while the other end of the coil touches the silicon. So both ends of the coil and the capacitor are short-circuited forming LC resonant circuit." *Id.*, 33.



Akar, Fig. 1.4a (annotated[2]), 8; *see also id.*, Figs. 1.4b, 8 (equivalent circuit diagram), 1.5, 3.7, 8, 35 (showing other views and layout of the "biomedical type pressure sensor"); Allen Decl. ¶ 85.

Akar teaches that "[w]henever pressure is applied over the sensor, the thin silicon diaphragm deflects downwards and gets closer to the bottom plate, increasing the value of the variable capacitor." Akar, 7-8. This capacitance change corresponds

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[2] All black text and arrows in Akar's figures are original, e.g., "Pressure Sensitive Capacitor" and "Planar Inductor." Only the colored annotations have been added throughout.

to a "change in the resonance frequency" of the wireless implantable sensor that can be "sensed remotely with inductive coupling, eliminating the need for wire connection." Akar, 8; Allen Decl. ¶ 86-87.

As described in detail below, Akar anticipates claims 1-4, 21, 26-27, and 31 of the '670 patent because it discloses each and every claim element arranged as in the claim.

B. Claim 1

1. [1pre]—"An implantable microfabricated sensor device for measuring a physiologic parameter of interest within a patient, said sensor comprising:"

Akar discloses the design and fabrication of "***micromachined*** capacitive ***pressure sensors***" for "biomedical applications as an ***implantable*** pressure sensor." Akar, 3, iii, iv ("new sensor structure for biomedical applications can be implanted in the body"), 7-8, 73 ("A number of silicon micromachining techniques has been established, including silicon bulk micromachining, anisotropic etching using etchants like EDP, KOH, and TMAH, electrochemical etch-stop, silicon-to-glass wafer bonding techniques."). The "fabricated pressure sensors are based on the deflecting micromachined thin silicon diaphragm anchored to glass substrate, forming variable capacitor with the applied pressure." *Id.*, iii, 7-8. As discussed previously, micromachining is a type of microfabrication that was known to POSITAs prior to 2001. Allen Decl. ¶¶ 132-133, 77-81; '327 provisional, 1; '634 provisional, 2. Further, Akar states that the fabrication of his "micromachined" pressure sensors was "completed successfully in the ***microfabrication facilities***" at the University of Michigan. Akar, 64; *see also, generally, id.*, 79-84 (exemplary micromachining process); Allen Decl. ¶ 133.

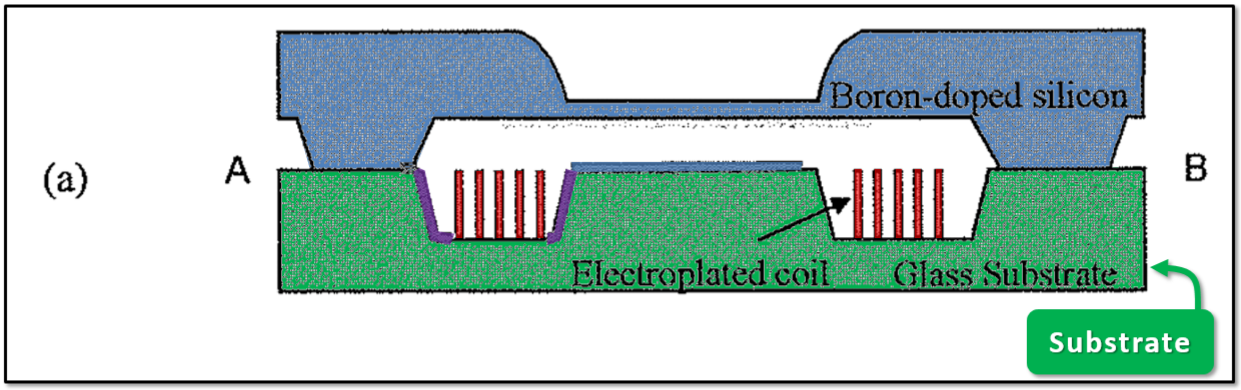
Akar teaches that its "new sensor structure for biomedical applications can be ***implanted in the body*** and can be monitored telemetrically without using any wire that breaks the skin." *Id.*, iv. For example, Akar teaches that the sensor can be "placed in a body or blood vessels, and allows it to measure the pressure" of the body or blood vessels (which are "physiologic parameters of interest within a patient") "remotely, without a need for wire connection." *Id.*, 7, 1 ("In the biomedical field, the pressure sensor is used to monitor the pressure in the cardiovascular and respiratory systems."), 9 ("Integration of a coil structure with the capacitive pressure sensor to develop wireless sensor for biomedical applications."); Allen Decl. ¶ 134.

2. [1a]—"an implantable sensing device, said sensing device being a micro electromechanical system (MEMS) comprising"

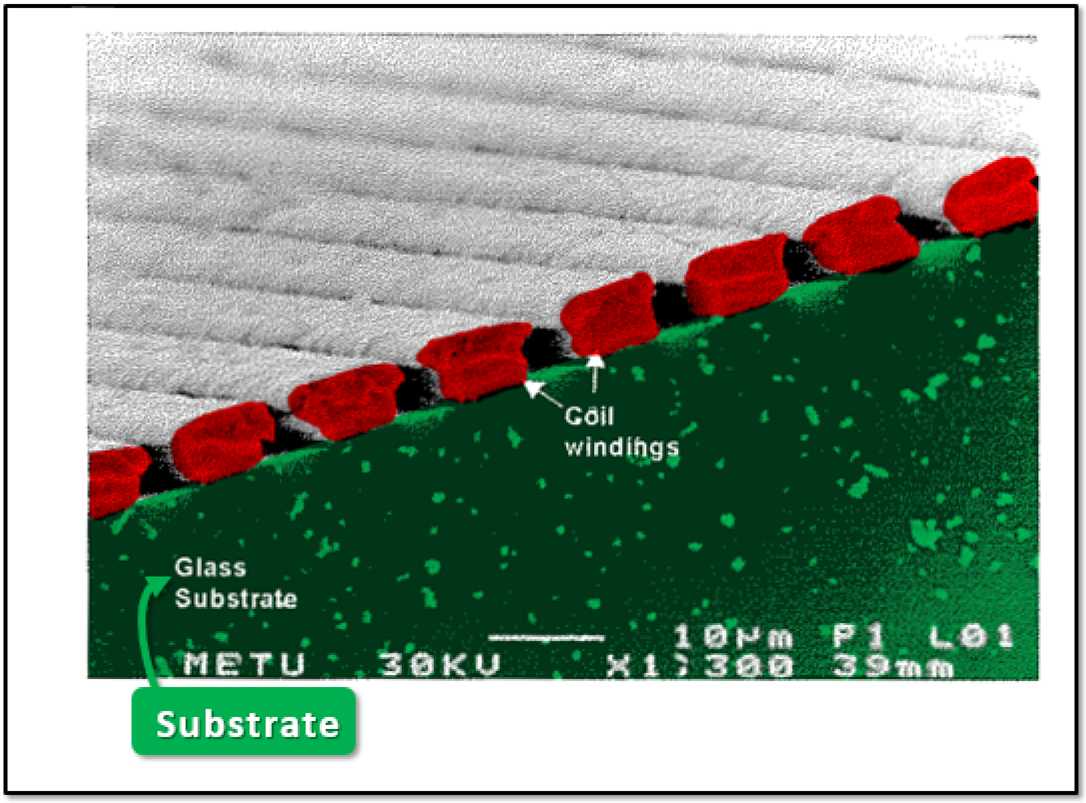
Akar discloses the claimed MEMS-based implantable sensing device. *See* limitation [1pre] above. Akar also teaches that its sensing device is possible due to the "development of Micro-Electro-Mechanical Systems (MEMS) technology." Akar, 1-2. Specifically, Akar explains that the "key methods of the MEMS technology" are "[s]ilicon micromachining techniques," and Akar explains that the disclosed pressure sensors are made using silicon micromachining techniques. Akar, 1 (Pressure sensors are fabricated using "[s]ilicon micromachining process [that] allows the implementation of thousands of pressure sensors on the same wafer."), iii, iv, 3, 8, 9, 29-30, 33, 35-42, Figs. 1.4, 1.5, 3.7; Allen Decl. ¶¶ 135-137. Akar concludes that his work "can be seen as an important step to establish the MEMS (Micro-Electro-Mechanical Systems) technology in Turkey." Akar, 74.

3. [1b]—"a substrate,"

Akar discloses a substrate. It states that the "fabricated pressure sensors are based on the deflecting micromachined thin silicon diaphragm anchored to ***glass substrate***, forming variable capacitor with the applied pressure." Akar, iii.



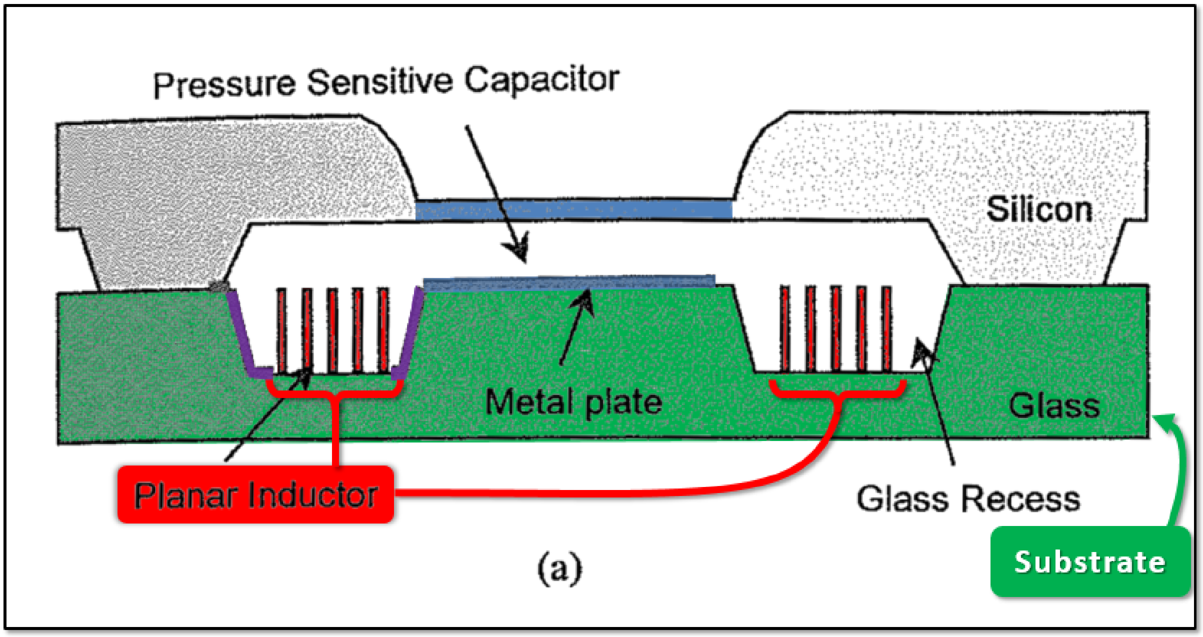
Akar, Fig. 3.7a (annotated), 35, 32; Allen Decl. ¶ 138.



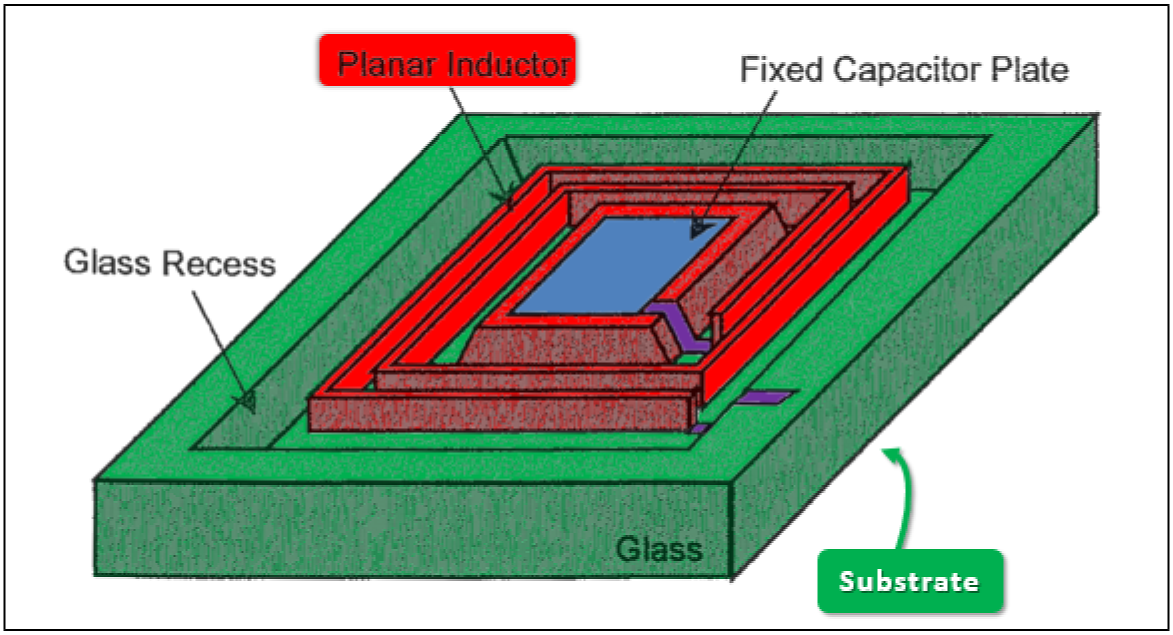
Akar, Fig. 4.10 (annotated), 53 ("Figure 4.10 shows … ***glass substrate***."); *see also, e.g.*, *id.*, Figs. 1.5, 8 (element annotated "glass"), 3.7d, 35 (same), 38-39 (glass wafer processing), 32-33, 24; Allen Decl. ¶¶ 138-139.

4. [1c]—"an integrated inductor formed on the substrate,"

Akar discloses this feature, explaining that "the most important circuit element for the wireless pressure sensor is the ***integrated coil*** for wireless measurement systems." Akar, 22-25 (Section 2.2, "Inductor Structure"), 11 ("Section 2.2 explains ***integrated coil*** parameters and ***integration of the coil with the sensor capacitor*** for wireless measurement of the pressure."). Akar discloses the "***integrated inductor*** is used for inductive coupling with an external inductor for remote measurement of resonance frequency of the sensor," and that the "coil is implemented using gold electroplating." Akar, 74. In the biomedical pressure sensor disclosed by Akar, the "planar [integrated] coil structure [is] placed into the recess on the glass [substrate] using electroplating" shown in Figures 1.4a and 1.5 below.

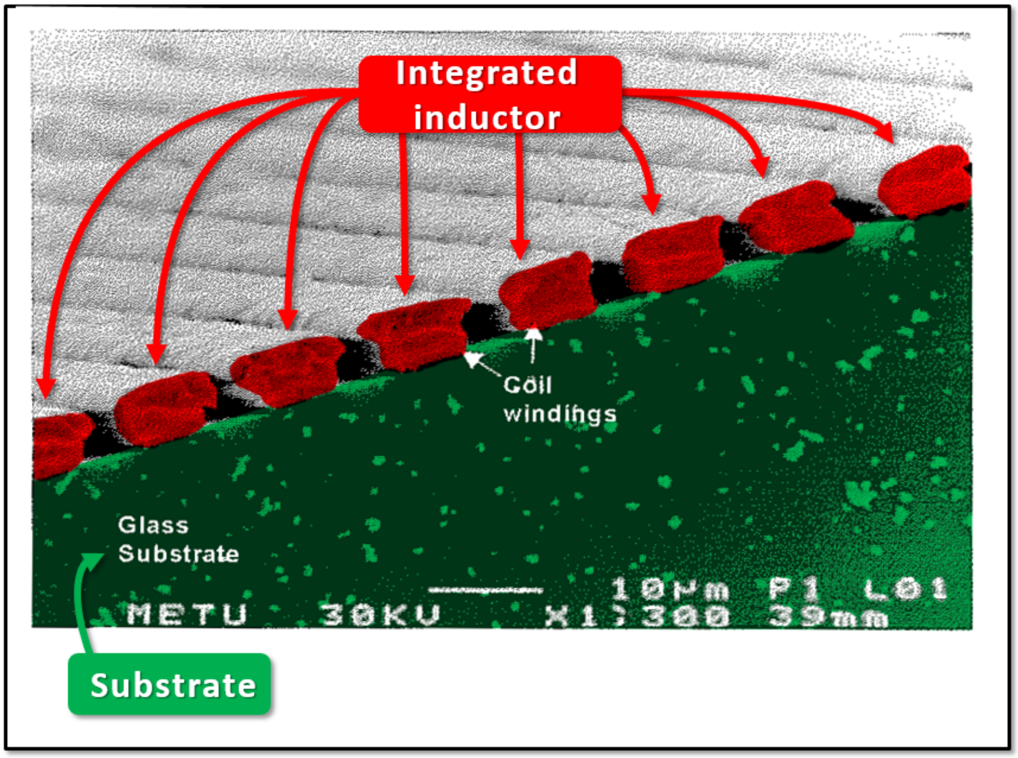


Akar, Fig. 1.4a (annotated), 8, Fig. 3.7a, 35 (similar, labeling integrated inductor the "electroplated coil"); Allen Decl. ¶ 140.



Akar, Fig. 1.5 (annotated), 8, 24 ("inductor structure is fabricated on the glass substrate"), Fig. 3.7d, 35 (showing layout view of the glass substrate side of the sensor device, labeling integrated inductor the "Electroplated Coil Windings"); Allen Decl. ¶ 140.

The integrated inductor formed on the glass substrate is also shown in Figure 4.10 below, which is a "SEM photograph of the gold electroplated coil windings over glass substrate."



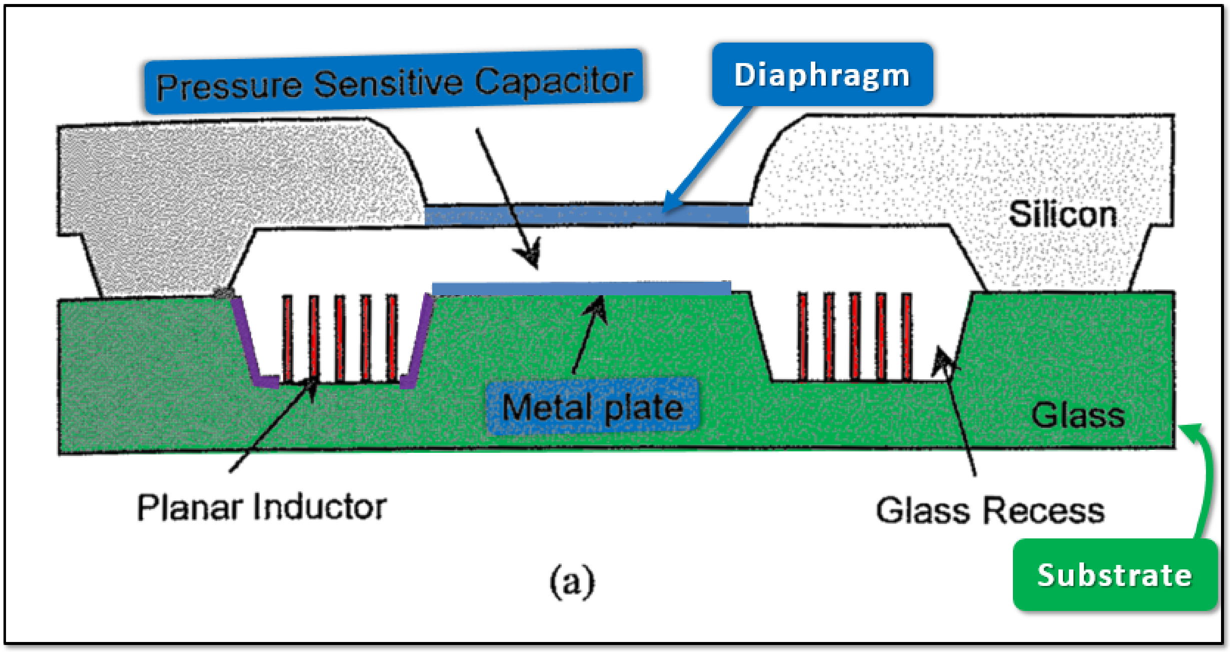
Akar, Fig. 4.10 (annotated), 53; Allen Decl. ¶ 142.

Furthermore, Akar discloses that in the "glass wafer process of the pressure sensors," the "fixed plates of the capacitors" and the seed material used to form the integrated inductor coils are formed as part of the same metallization step. In other words, the inductor is microfabricated with the sensor itself. Akar, 38-39, *see also id.*, 8 ("coil integration with the sensor capacitor forms an LC resonant circuit"), 9 ("[i]ntegration of a coil structure with the capacitive pressure sensor to develop wireless sensor for biomedical applications"); Claim Construction section above; Allen Decl. ¶ 141.

5. [1d]—"at least one sensor responsive to the physiologic parameters and being formed at least in part on the substrate,"

Akar discloses this feature, explaining that its pressure sensor devices for both industrial and biomedical applications include a "pressure sensitive capacitor [that] is formed by a thin silicon diaphragm and a fixed bottom plate." Akar, 7 (describing industrial type capacitive pressure sensor structure), 8 ("general sensor structure" for biomedical type sensor is the "same as the previously explained industrial type pressure sensor"); Allen Decl. ¶¶ 143-144. Whenever pressure is applied over the pressure sensitive capacitor, "the thin silicon diaphragm deflects downwards and gets closer to the bottom plate, increasing the value of the variable capacitor." Akar, 7-8. In the wireless biomedical type capacitive pressure sensor, the sensor can be "placed in a body or blood vessels" allowing the measurement of "physiologic parameters" remotely as a "change in the resonance frequency due to capacitance change." Akar, 7-8, 1 (sensors can be used to monitor pressure in "cardiovascular and respiratory systems"); Allen Decl. ¶¶ 145, 147.

Akar illustrates the "Pressure Sensitive Capacitor" in its biomedical type pressure sensor in Figure 1.4a below, wherein the "Metal plate" of the capacitor is formed on the "Glass" substrate.

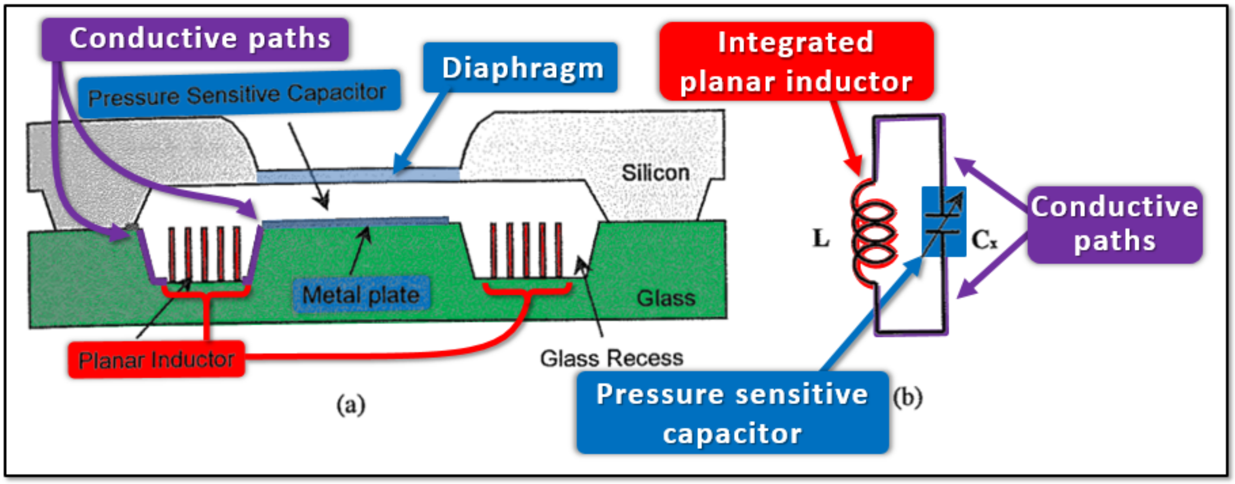


Akar, Fig. 1.4a (annotated), 8; Allen Decl. ¶ 146.

Thus, as shown above, Akar discloses "at least one sensor responsive to the physiologic parameters" (the "Pressure Sensitive Capacitor") and "being formed at least in part on the substrate" (the "Metal plate"), in the same way that the capacitive pressure sensor in the '670 patent is a sensor and formed at least in part on the substrate. *C.f.* '670 patent, 7:26-41, Fig. 5; Allen Decl. ¶¶ 147-148.

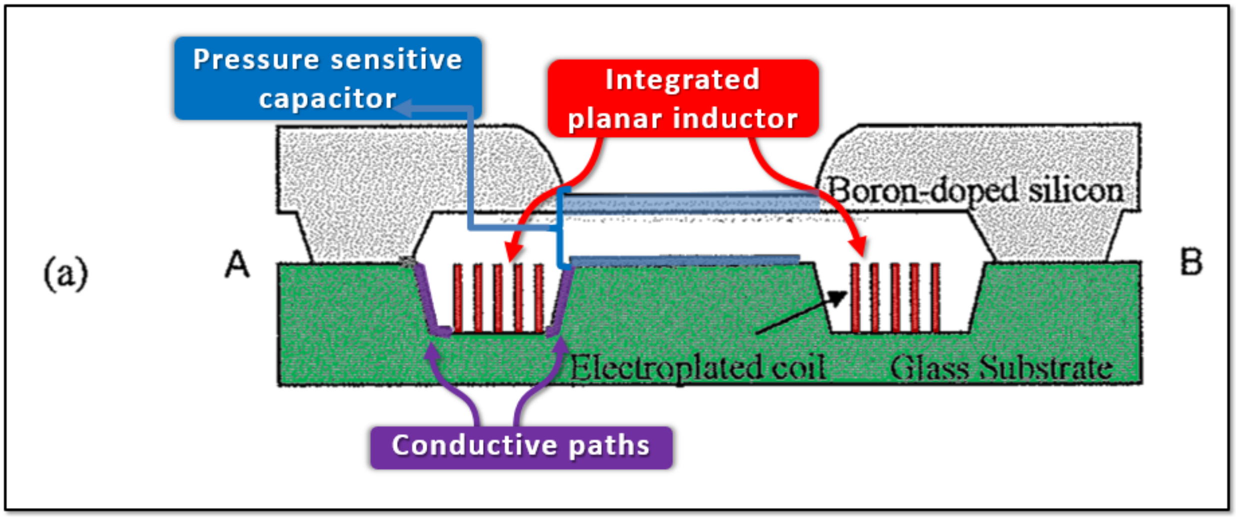
6. [1e]—"a plurality of conductive paths electrically connecting said integrated inductor with said sensor,"

Akar discloses this feature. Akar discloses that the inductor "coil integration with the sensor capacitor forms an LC resonant circuit as shown in Figure 1.4b." Akar, 8. As annotated below, this includes two conductive paths (purple) connecting the integrated inductor (red) and capacitor sensor (blue).

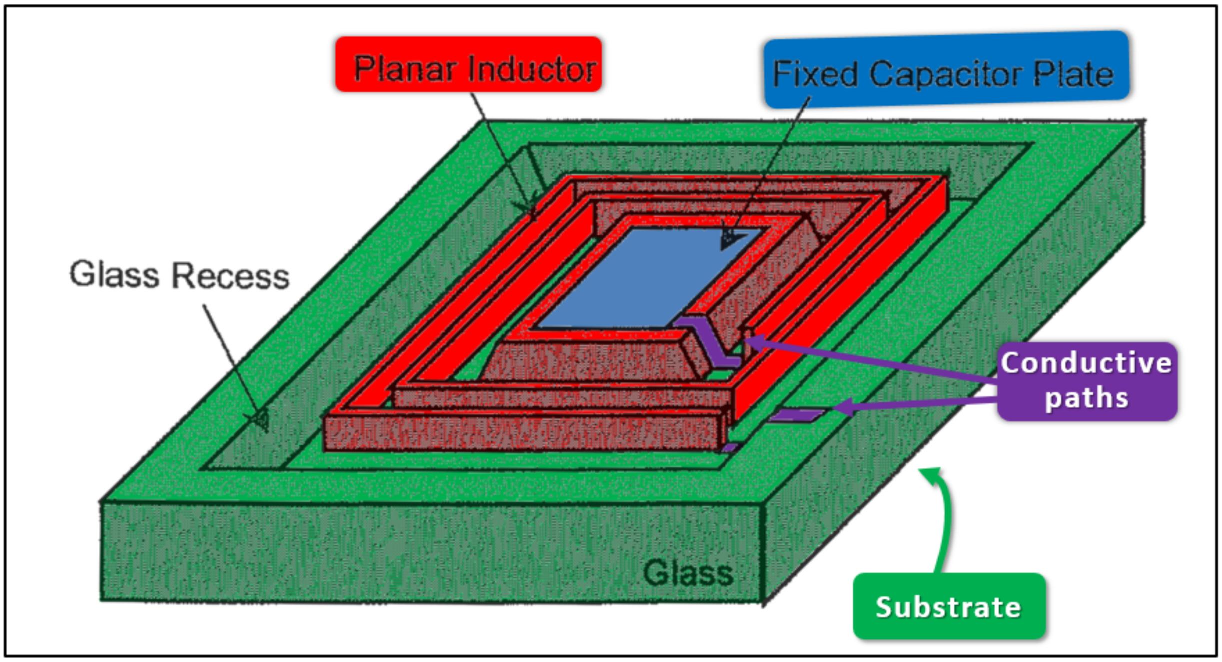


Akar, Figs. 1.4a and 1.4b (annotated), 8; Allen Decl. ¶ 149.

Furthermore, as described with respect to Figures 1.5 and 3.7a, shown below, "[o]ne end of the [integrated inductor] coil is connected to the fixed plate of the capacitor, while the other end of the coil touches to the silicon." Akar, 33. The "silicon" includes the diaphragm of the capacitor sensor, and it is highly doped and therefore conductive. Akar, 29-30 ("Highly Boron-Doped Diaphragm Formation"), 32; *c.f.* '670 patent, 3:57-59 ("Being highly doped, the silicon layer itself operates as the conductive path for the moveable electrode."). Accordingly, "both ends of the coil and the capacitor are short-circuited forming LC resonant circuit." Akar, 33, 32, 7-8; Allen Decl. ¶¶ 150-152.

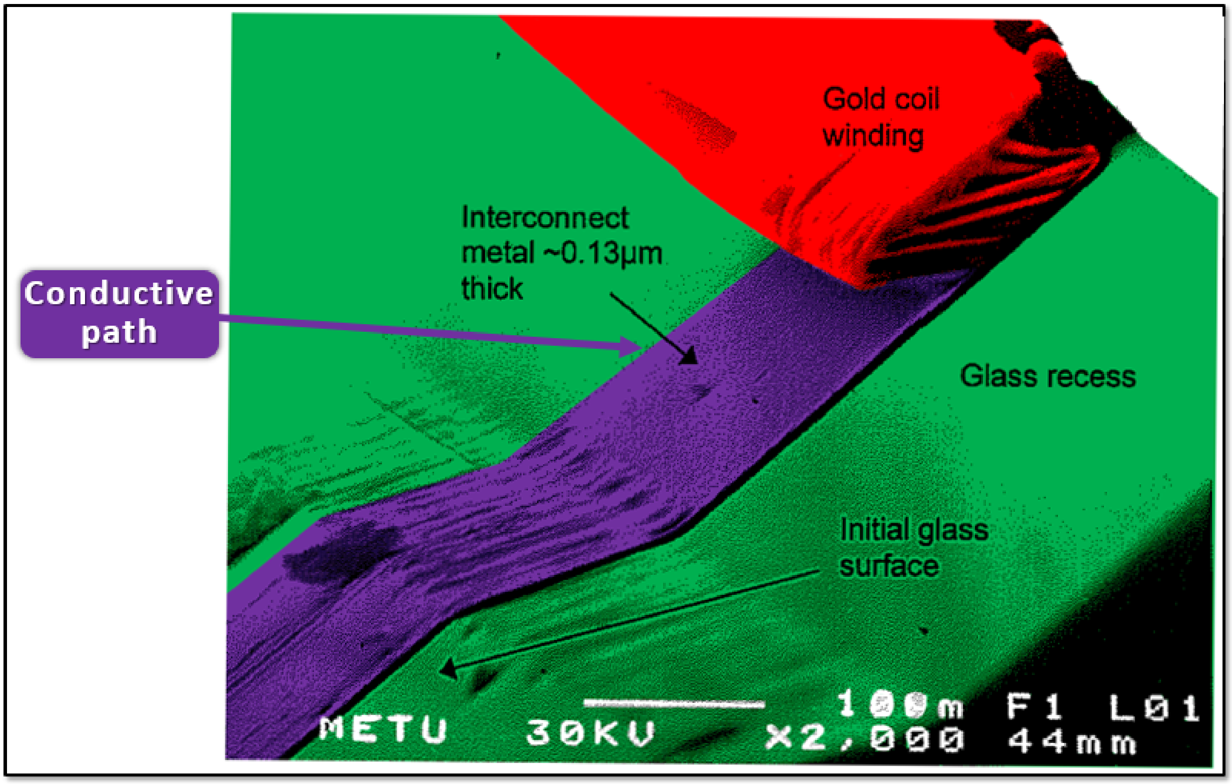


Akar, Fig. 3.7a (annotated), 35, 37 (glass substrate "support[s] electrical connections through metal lines"); Allen Decl. ¶ 151.



Akar, Fig. 1.5 (annotated), 8; Allen Decl. ¶ 151.

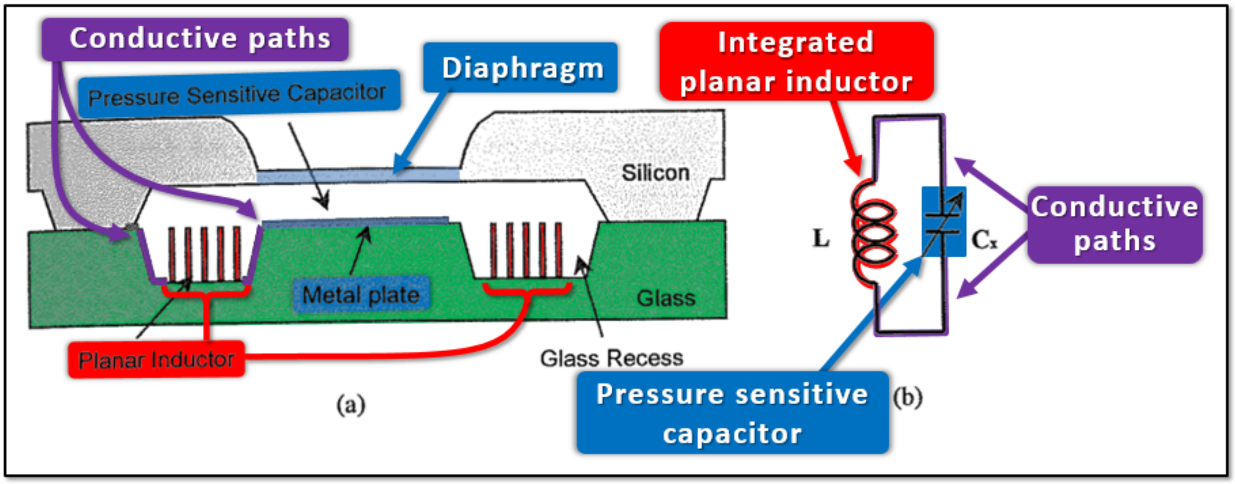
The electrical connection between the inner coil of the integrated inductor and the fixed capacitor plate is also shown in Figure 4.12 below, a SEM view of the "interconnect metal between the [integrated inductor] coil and the capacitor plate at the edge of the glass recess."



Akar, Fig. 4.12 (annotated), 54; Allen Decl. ¶ 153.

7. [1f]—"said integrated inductor, said sensor and said conductive paths cooperatively defining an LC tank resonator."

Akar's integrated planar inductor (*see* limitation [1c] above), pressure sensitive capacitor (*see* limitation [1d] above) and conductive paths (*see* limitation [1e] above) together define an LC tank resonator as claimed, which is also shown in equivalent circuit form in annotated Figure 1.4b below.

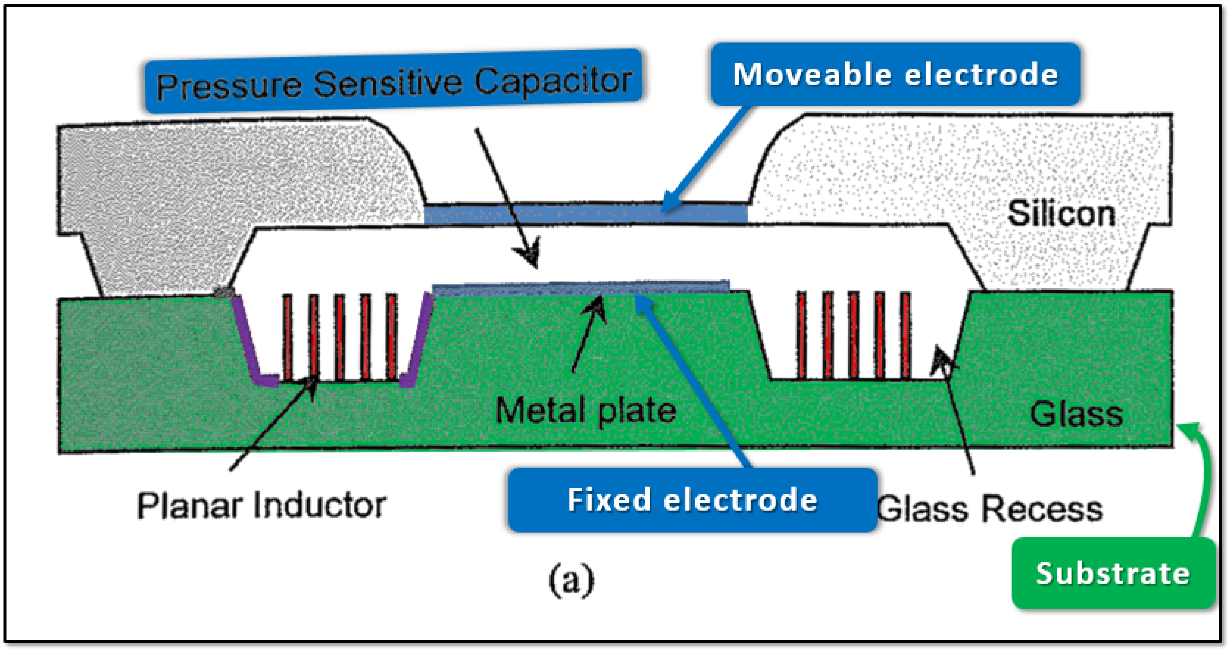


Akar, Figs. 1.4a and 1.4b (annotated), 8 ("This coil integration with the sensor capacitor forms an LC resonant circuit as shown in Figure 1.4b."), 9 ("Planar rectangular coil structure has been integrated with the sensor capacitor inside the sensor body to form an LC circuit."), 33 ("So both ends of the coil and the capacitor are short-circuited forming LC resonant circuit."), 74 ("For wireless pressure measurement, a planar coil structure has been integrated with the pressure sensor structure making an LC resonance circuit."); Allen Decl. ¶¶ 154, 38 (also explaining that a LC resonant circuit is the same as a LC tank resonator).

C. Claims 2 and 3

Claim 2 depends from claim 1, further reciting "wherein said sensor is a capacitive sensor having a fixed electrode and a moveable electrode." Claim 3 depends from claim 2, and further recites "wherein said fixed electrode is formed on said substrate." These claims are anticipated for the same reasons as claim 1 and as further explained in the following paragraphs.

Akar discloses a "pressure sensitive capacitor" having a "fixed bottom plate" (the claimed "fixed electrode") and a "thin silicon diaphragm" (the claimed "moveable electrode"). Akar, 7-8. In Figure 1.4a, shown below, Akar labels the claimed capacitive sensor as "Pressure Sensitive Capacitor," the claimed fixed electrode as "Metal plate" formed on the "Glass" substrate, and the claimed moveable electrode is the conductive "Silicon" directly above the "Metal plate."



Akar, Fig. 1.4a (annotated), 8; *see also, id.*, Fig. 1.5, 8 (showing the "Fixed Capacitor Plate"), Figs. 3.7a-d, 35; Allen Decl. ¶ 157.

The "thin silicon diaphragm" in Akar is a "moveable electrode" because "[w]henever pressure is applied over the sensor, the thin silicon diaphragm deflects downwards and gets closer to the bottom plate, increasing the value of the variable capacitor." Akar, 7-8, 11-22 (Section 2.1, explaining the performance of a capacitive sensor due to the deflection of the diaphragm in response to pressure); *c.f.* ’670 patent, 3:53-57, 7:31-33; Allen Decl. ¶ 158.

D. Claim 4

Claim 4 depends from claim 2, further reciting “wherein said sensor is a pressure sensor.” It is anticipated for the same reasons as claim 2 and as further explained here.

Akar’s sensor is a pressure sensor; it expressly discloses a “wireless capacitive pressure sensor” including a “pressure sensitive capacitor” that changes in response to changes in pressure. Akar, iii-iv (as relating to biomedical type sensor), 7-9, 11-22 (design methodology for capacitive pressure sensor), 32-33, 35-41 (fabrication sequence of the capacitive pressure sensor); Allen Decl. ¶ 160.

E. Claim 21

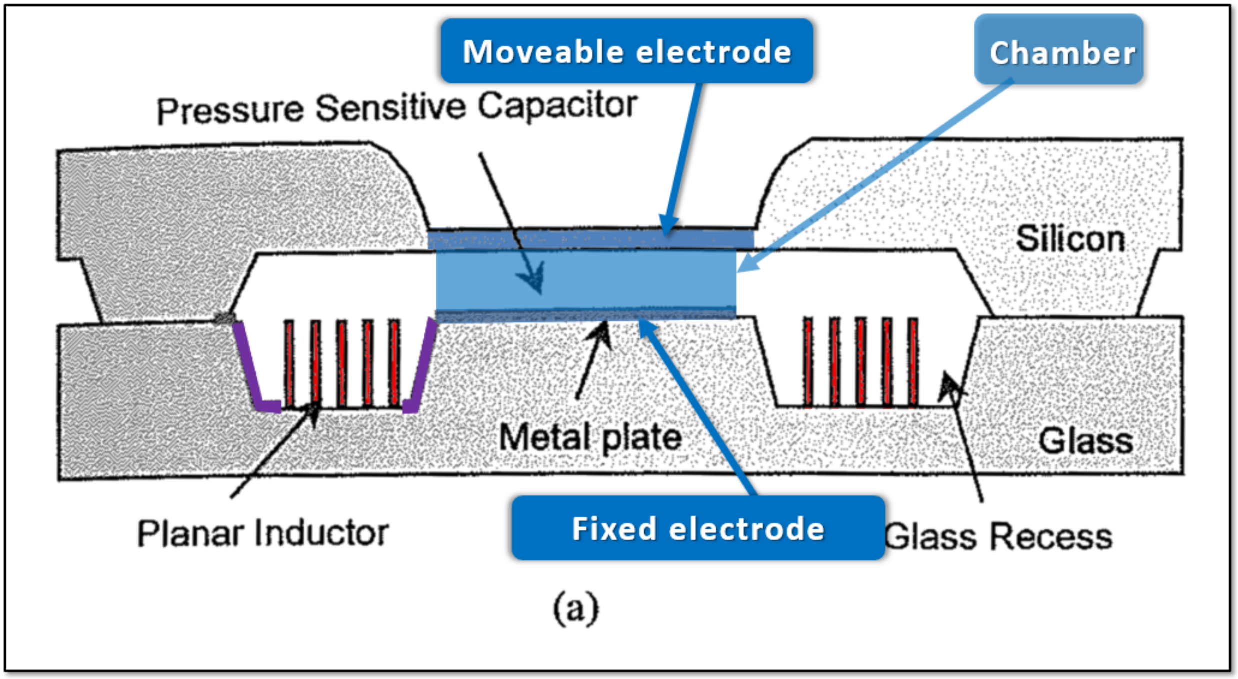
Claim 21 depends from claim 1, further reciting “wherein said sensor device is wireless.” Claim 21 is anticipated for the same reasons as claim 1 and as further explained below.

Akar discloses an “implantable ***wireless*** pressure sensor structure” for biomedical applications. Akar, 7 (“The sensor can be placed in a body or blood vessels, and it allows to measure the pressure remotely, ***without a need for wire connection.***”). Specifically, the integrated inductor and capacitive pressure sensor form an LC circuit that can be used to sense changes in capacitance, corresponding to changes in applied pressure, "remotely with inductive coupling, eliminating the need for wire connection." *Id.*, 8, 9 ("wireless sensor for biomedical applications"), 11 ("This chapter describes general elements of the … ***wireless*** sensor."), 22 ("The most important circuit element for the ***wireless*** pressure sensor is the integrated coil for ***wireless*** measurement systems."), 74 ("***wireless*** pressure measurement"); Allen Decl. ¶ 162.

F. Claims 26 and 27

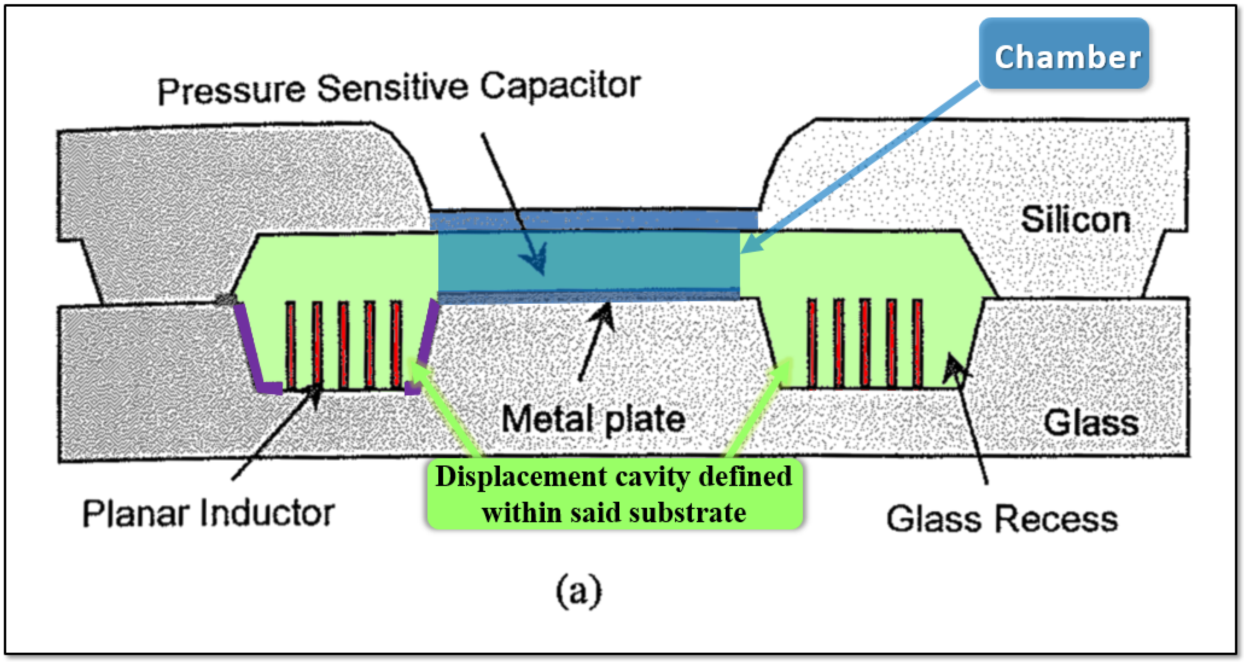
Claim 26 depends from claim 1, further reciting "wherein said sensor is a capacitive sensor including a fixed electrode and a moveable electrode, said fixed and moveable electrodes defining a chamber therebetween, said chamber being in fluid communication with a displacement cavity." Claim 27 depends from claim 26, and further recites "wherein said displacement cavity is defined within said substrate." Akar anticipates claims 26 and 27 for the same reasons it anticipates claims 1 and 2, and as further explained below.

Akar discloses a pressure sensitive capacitor having a fixed electrode (a "fixed capacitor plate" on the glass substrate) and a moveable electrode (a silicon conductive diaphragm) as demonstrated above with respect to claim 2. *See* Claim 2 discussion above. Between the diaphragm (moveable electrode) and the fixed capacitor plate of the pressure sensitive capacitor is a "gap (the separation between the diaphragm and the glass base)" of about "2 μm." Akar, 37, 30 ("Fabrication starts with etching of a small recess on a silicon wafer to define the capacitive gap."), 54 ("targeted gap 2 µm"). This gap corresponds to the claimed "chamber" as shown below in annotated Figure 1.4a.



Akar, Fig. 1.4a (annotated), 8; Allen Decl. ¶¶ 164-165.

Akar also discloses that the planar integrated inductor coil structure is placed into a "recess on the glass using electroplating." Akar, 8. These recesses in the glass substrate form a "displacement cavity" for residual gasses that is in fluid communication with the gap ("chamber") defined between the two electrodes of the pressure sensitive capacitor, as required by claims 26 and 27, and shown in annotated Figure 1.4a below.



Akar, Fig. 1.4a (annotated), 8; *see also id.*, Fig. 1.5, 8 (showing the "Glass part of the sensor with the planar coil structure placed into the recess"), 38 (describing glass etch to form recesses), Fig. 4.12, 54 (SEM photographs showing that the gap and glass recess where the integrated inductor are formed are directly connected); Allen Decl. ¶ 166.

The '670 patent explains that a displacement cavity "is sized such that the total internal sensor volume, the combined volume of the displacement cavity 88 and the interior chamber 90, varies minimally with deflection of the diaphragm 64 over its operational range of displacement" to "compensate for the various negative effects of any residual gas" inside the detector. '670 patent, 9:25-37; Allen Decl. ¶ 167. That is true here, too, as the combined volume of Akar's glass recess (displacement cavity) and gap (chamber) are large compared to the change in volume that occurs when the diaphragm deflects due to changes in sensed pressure. Allen Decl. ¶ 167 (also explaining that a displacement cavity ensures that the upper plate's deflection will have a smaller effect on the internal pressure of the sensor).

G. Claim 31

Claim 31 recites: "The sensor device of claim 1 as part of a sensing system further comprising a non-implantable readout device, said readout device including a second inductor adapted to magnetically couple with said integrated inductor to read changes in said LC tank resonator as a result of said sensor sensing the physiologic parameter of interest." Akar anticipates claim 31 for the same reasons as claim 1, and as further described below.

Akar discloses that "[c]apacitive pressure sensors require a readout electronic circuit." Akar, 65. As to its implantable biomedical type pressure sensor, discussed above with respect to claim 1, Akar teaches that the readout electronic circuit would include an "external inductor." Akar, 74. The external inductor is used "for remote measurement of resonance frequency of the sensor" through "inductive coupling" with the "integrated inductor" of the implantable sensor, i.e., it is "adapted to magnetically couple with said integrated inductor to read changes in said LC tank resonator." *Id.*; Allen Decl. ¶ 169; *see id.* ¶¶ 40-43 (explaining that inductive coupling is the same as magnetic coupling). Akar discloses that changes in resonant frequency correspond to changes in pressure sensed by the capacitive sensor, allowing pressure "in a body or blood vessels" ("physiologic parameters") to be measured "remotely, without a need for wire connection." Akar, 7-8; Allen Decl. ¶¶ 170-171.

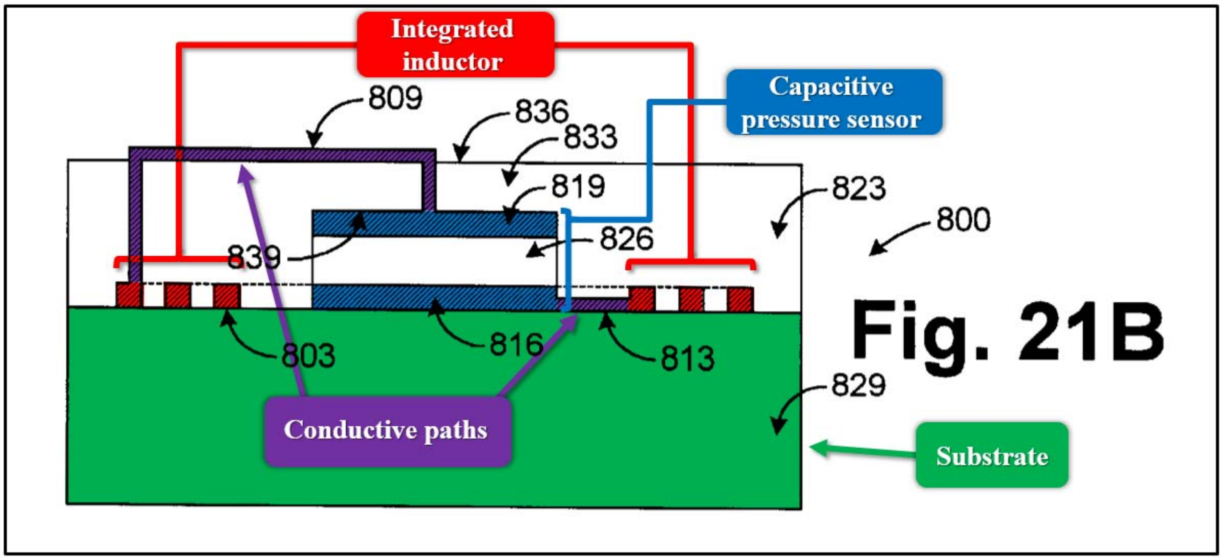
Akar states that the design of the particular "external readout electronic circuitry" (i.e., the claimed "non-implantable readout device") to "detect the resonance frequency of the wireless pressure sensor" was left for "future work." Akar, 74. The law of anticipation does not require, however, that Akar disclose an actual use of the claimed "non-implantable readout device." Rather, it is sufficient that Akar suggested its use as discussed above. *See Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1383 (Fed. Cir. 2015) ("Though it is true that there is no evidence in Grab of actual performance of combining the ruthenium binder and PVD coatings, this is not required. Rather, anticipation only requires that those suggestions be enabled to one of skill in the art.") (internal quotation marks and citations omitted); *Bristol-Myers Squibb Co. v. Ben Venue Labs., Inc.*, 246 F.3d 1368, 1379 (Fed. Cir. 2001). Indeed, a POSITA would have found Akar's disclosures to be enabling because the design of external readout circuitry for an implantable LC resonant frequency was admittedly well known to a POSITA prior to the critical date of the '670 patent. '670 patent, 5:65-6:1 ("The readout device 14 is constructed according to techniques well known in the industry and in the sensing field in general. As such, the readout device 14 is not illustrated or described in great detail."); Allen Decl. ¶ 172; *see id.* ¶¶ 220-225, 265-270, 350-355 (providing additional examples of known external readout circuitry for a LC resonant pressure sensor, including Petersen, Park, and Allen-379); Section VIII.L above (external readout circuitry in Allen-379).

IX. GROUND 2: CLAIMS 1-5, 21-25, 28-29, AND 31 ARE ANTICIPATED BY ALLEN-379

A. Overview—Allen-379 (Ex. 1009)

Allen-379 was not considered during prosecution and is § 102(e) prior art because it is a U.S. patent filed before the '670 patent's actual and earliest-claimed filing dates. It is also § 102(a) art because it issued before the '670 patent's actual filing date.

Allen-379 discloses a "surface [micro]machined pressure sensor." Allen-379, 19:17-47, Fig. 21B; *id.*, 9:32-34 ("Generally the term 'machining' as employed herein refers to ***micromachining*** techniques."); Allen Decl. ¶ 117-119, 124; *see id.* ¶ 124 n.5 (also explaining that the introductory discussion in column 9 applies to the surface micromachined embodiments). That sensor "includes a resonant circuit that comprises an inductor coil 803 and a capacitor 806." Allen-379, 19:20-22. The capacitor 806 is "comprised of first and second plates 816 and 819," and as shown in annotated Figure 21B below, the "inductor coil 803" (red) "and first plate" of the variable capacitive sensor (blue) are both "disposed on a substrate 829" (green). *Id.*, 19:24-34. Allen-379 also discloses that the "inductor coil 803 and the capacitor 806 are electrically coupled via a first connector 809 and a second connector 813" (purple).

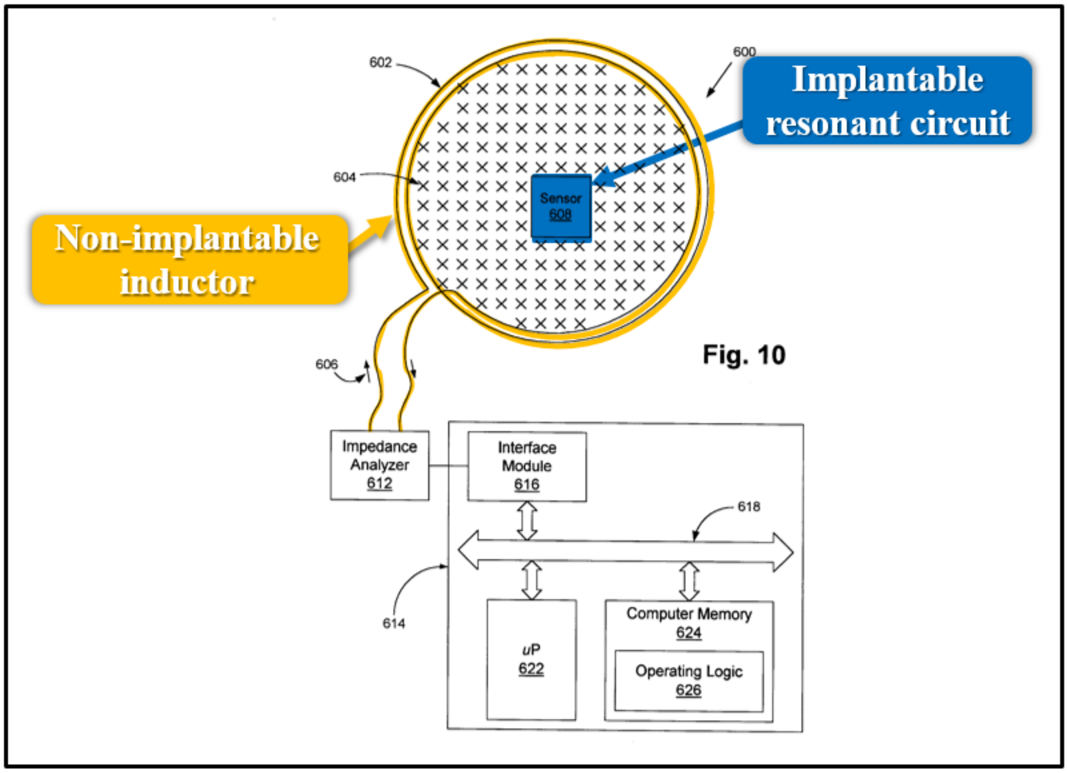


Allen-379, Fig. 21B (annotated), 19:20-24; Allen Decl. ¶ 120.

In addition to a surface micromachined pressure sensor, Allen-379 also discloses a surface micromachined temperature sensor. That temperature sensor has a structure constructed similar to the capacitor sensor structure above, except that the material making up the dielectric region 923 is "selected to have a permittivity that varies with temperature, thereby causing the capacitance of the capacitor 906 to vary with changing temperature." Allen-379, 21:36-22:21, Fig. 24A; Allen Decl. ¶ 121.

Allen-379 also discloses that "several sensors" can be "employed in the same environment at the same time." *Id.*, 18:33-43; Allen Decl. ¶ 122. Allen-379's sensors can be used for a variety of applications, including "wirelessly sensing pressure, temperature, and other physical properties" for "medical applications in which physical properties within or outside of the body may be sensed for various medical purposes." Allen-379, 1:14-16, 26:18-21.

As shown in annotated Figure 10 below, Allen-379's sensors can be part of an "impedance excitation system" where an external inductor "electromagnetically couple[s]" with the integrated "inductor coil resident on the sensor." Allen-379, 15:5-17. This allows changes in pressure or temperature, depending on the type of sensor employed, to be wirelessly measured.



Allen-379, Fig. 10 (annotated), 15:1-17; *see also id.*, 3:19-50, 10:34-51, 15:63-16:13, Fig. 12; Allen Decl. ¶¶ 123-124.

B. Claim 1

1. [1pre]—"An implantable microfabricated sensor device for measuring a physiologic parameter of interest within a patient, said sensor comprising:"

Allen-379 discloses pressure and temperature sensor devices manufactured using "batch fabrication techniques and other ***micromachining***[3] techniques that are known to those skilled in the art." Allen-379, 10:60-64. Those sensor devices feature "inductive-capacitive (LC) resonant circuit[s] with a variable capacitor" for determining the pressure and temperature "of a specific environment." *Id.*, 2:16-20, 2:30-32. Allen-379 provides that these sensors can be used in a variety of applications, including for measuring "physical properties within … the body" "for various medical purposes." *Id.*, 26:18-21. Allen-379 also teaches that when used in these "[m]edical applications," the "actual materials employed" will require the "use of biocompatible materials." Allen-379, 9:5-15; Allen Decl. ¶¶ 289-290. For example, Allen-379 teaches that its sensors can be manufactured using doped silicon and low temperature glasses, which are materials that a POSITA would have

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[3] Micromachining is and was a common microfabrication technique for making ICs and MEMS. Allen Decl. ¶¶ 289, 78-82; '634 provisional, 2; '327 provisional, 1; *see* Section VI.B above.

understood to be biocompatible for use in implantable sensors. Allen Decl. ¶ 290; Allen-379, 20:17-42; Park (Ex. 1008), 7124; Akar-2000 (Ex. 1026), 586; Akar, 7-8.

A POSITA would have understood from the disclosure of Allen-379 that the disclosed micromachined wireless sensors were implantable. Allen-379 describes "medical applications" requiring "biocompatible materials" to measure pressure or temperature "within … the body." Allen-379, 9:10-12, 26:19-23; Allen Decl. ¶¶ 290-292. As the '670 patent admits, the "key issue" for implantability is that the "sensor must be biocompatible," which Allen-379 also recognizes. '670 patent, 10:51-52; Allen-379, 9:10-12; Allen Decl. ¶ 290. As the '670 patent admits, the use of micromachined wireless sensors as implantable devices had long been known by POSITAs. '670 patent, 1:65-3:23 (summarizing myriad prior-art implantable devices, and merely proposing purported improvements in wireless range and manufacturability). *See, e.g.*, Petersen, 2:26-3:20, 6:20-10:15 (Ex. 1006, summarizing various prior-art implantable sensors and describing in detail its own); Park, 7124-28 (Ex. 1008, discussing its implantable sensor); Allen Decl. ¶ 292; *see also id.* ¶¶ 45-48, 132-134, 173-174, 241-243 (discussing the '670 patent's cited references, Petersen, Park, and Akar). Accordingly, a POSITA would have understood that Allen-379's micromachined wireless sensor made of "biocompatible materials" to measure pressure or temperature "within a body" was implantable.

2. [1a]—"an implantable sensing device, said sensing device being a micro electromechanical system (MEMS) comprising"

Allen-379 teaches pressure and temperature sensor devices for measuring physical properties within the body ("implantable sensing devices"). *See* limitation [1pre] above.

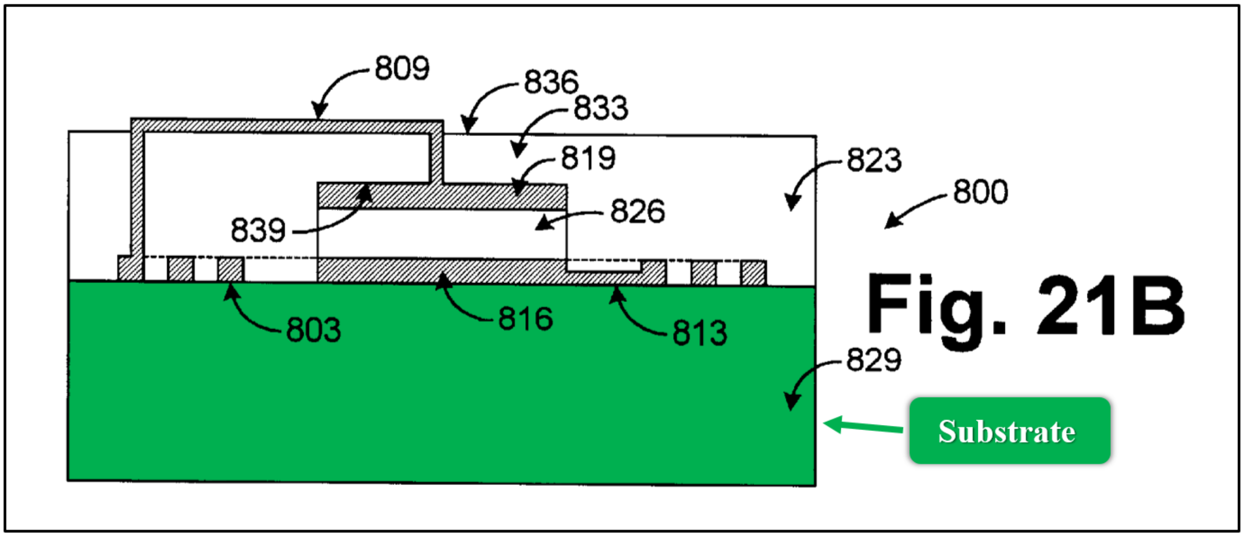
Allen-379's pressure and temperature sensing devices shown in Figures 21A-B and 24A are MEMS devices. *See* Claim Construction section above. They are surface micromachined and include resonant circuits comprising an inductor coil and a variable capacitor. Allen-379, 19:17-29, 21:34-50. Each of these surface micromachined pressure and temperature sensors include mechanical movement, i.e., the top plate of the capacitive sensor moves in response to pressure and temperature, respectively, as discussed with reference to limitation [1d] below. Allen Decl. ¶ 294.

Allen-379's electrical and electromechanical components are made using micromachining techniques and made from "materials known in the micromachining, microfabrication, and electronic packaging art," which a POSITA would have understood to indicate that the disclosed sensors are micro electromechanical systems (MEMS). Allen Decl. ¶ 295; Secton VI.B (Claim Construction) above; Allen-379, 19:17-47 (describing "Surface [Micro]Machined Pressure Sensor"), 21:34-65 ("Surface [Micro]Machined Temperature Sensor

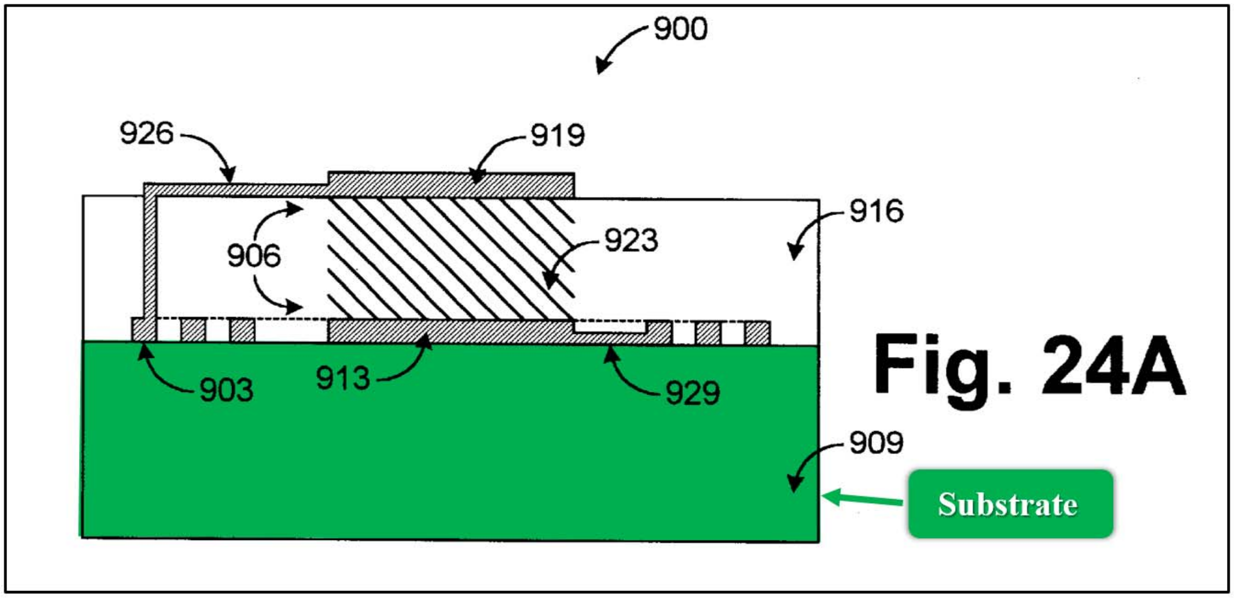
(Variable Capacitance)"), 20:17-42, 10:60-64, 9:33-35 ("Generally, the term 'machining' as employed herein refers to micromachining techniques as well as other techniques by which one may generate equivalent sensor structures to those described herein."); *c.f.* '327 provisional (Ex. 1003), 1 (defining "micromachined" as common to MEMS fabrication processes); '634 provisional (Ex. 1004), 2 (same).

3. [1b]—"a substrate,"

Allen-379 discloses its surface micromachined "pressure sensor 800" is formed on a "substrate 829," and "temperature sensor 900" is formed on a "substrate 909," annotated green in Figures 21B and 24A, respectively, below.



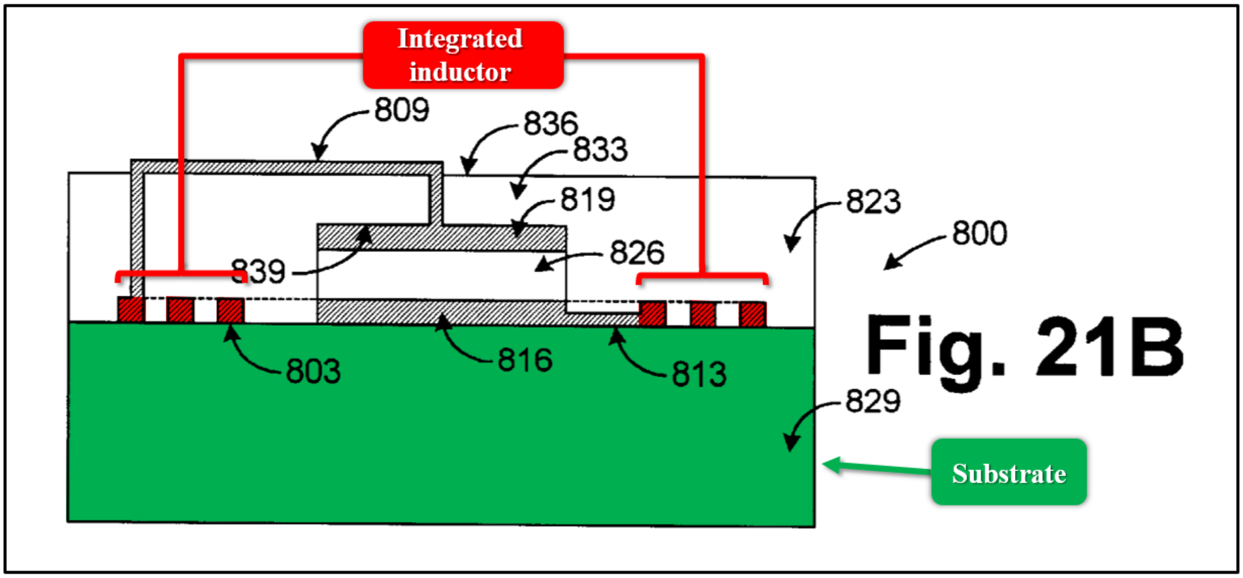
Allen-379, Fig. 21B (annotated), 19:30-33 ("With reference to FIG. 21B … substrate 829"); 4:54-61 ("The pressure sensor further includes a substrate…."); Allen Decl. ¶ 296.



Allen-379, Fig. 24A (annotated), 21:36-41 ("With reference to FIG. 24A … substrate 909"), 5:2-9 ("The temperature sensor also includes a substrate.…"); Allen Decl. ¶ 297.

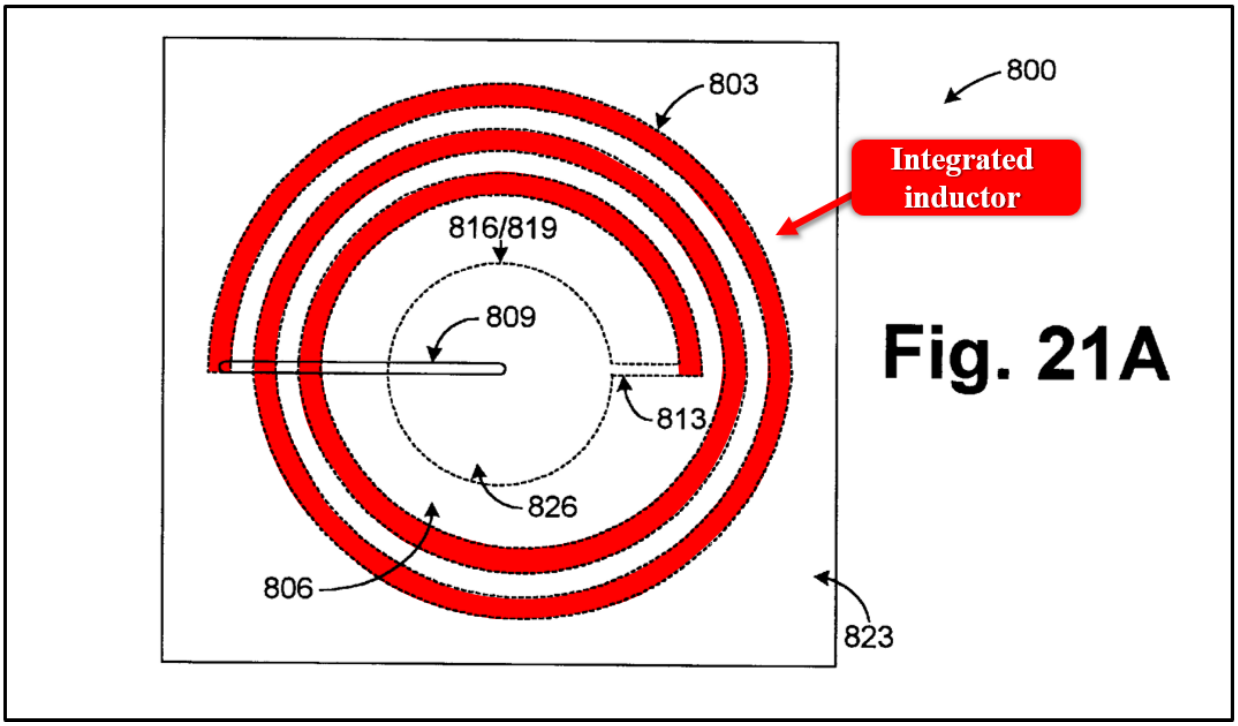
4. [1c]—"an integrated inductor formed on the substrate,"

Allen-379 discloses its pressure sensor 800 "includes a resonant circuit that comprises an inductor coil 803" that is "disposed on" the surface of substrate 829 as shown in annotated Figure 21B below.



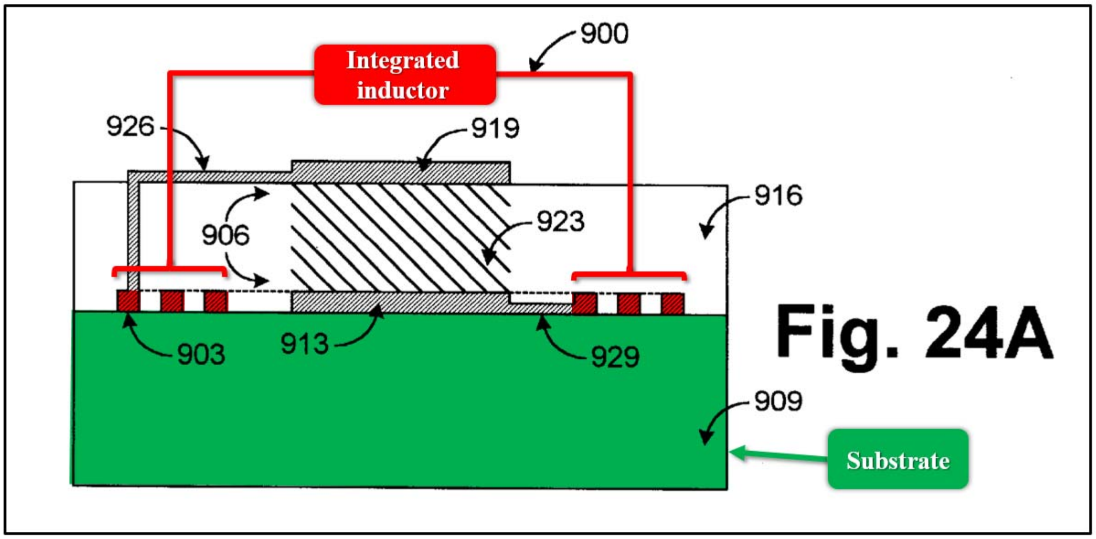
Allen-379, Fig. 21B (annotated), 19:20-22, 19:30-34; Allen Decl. ¶ 298.

Allen-379 also provides a top-down view of the integrated inductor, as annotated in Figure 21A below.



Allen-379, Fig. 21A (annotated); Allen Decl. ¶ 299.

Similarly, Allen-379's temperature sensor 900 includes an integrated inductor 903 formed on the substrate 909, as shown in annotated Figure 24A below.



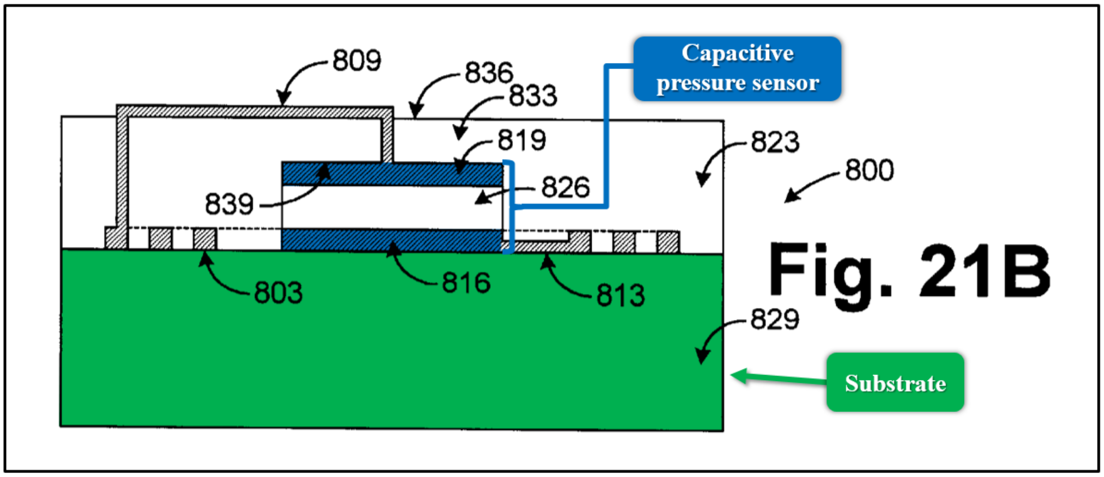
Allen-379, Fig. 24A (annotated), 21:38-45 ("The temperature sensor 900 includes an inductor coil 903 … placed on the substrate 909."); Allen Decl. ¶ 300.

Additionally, as discussed in Section VI.A (Claim Construction), the claimed "integrated inductor" is "microfabricated with the sensor itself." Here, Allen-379 teaches that the "inductor coil and the first plate 816" of the capacitive sensor (discussed below with respect to limitation [1d]) are formed together in the same microfabrication process. Allen-379, 23:64-24:6 (describing an "exemplary method of manufacturing of the pressure sensor 800 using surface machining techniques," wherein the inductor and first plate of the capacitor are formed in Step A using "standard processes such as photolithography, stencil printing," etc.), 24:58-61 ("similar steps may be taken" for temperature sensor); Allen Decl. ¶ 301.

5. [1d]—"at least one sensor responsive to the physiologic parameters and being formed at least in part on the substrate,"

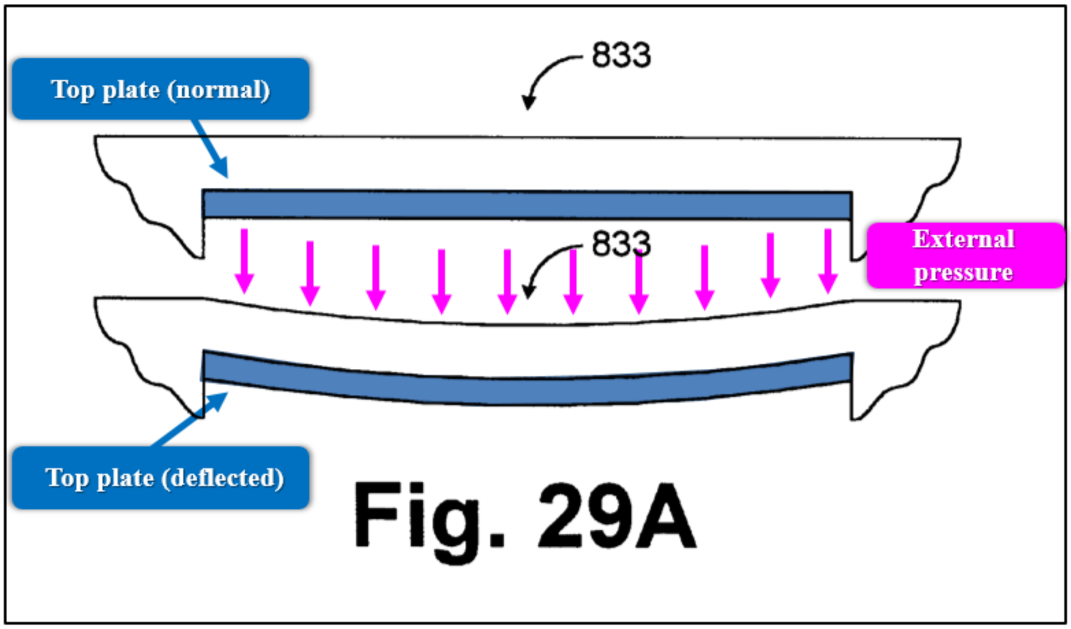
Allen-379's surface micromachined sensors include capacitive sensors responsive to physiologic parameters and are formed at least in part on the substrate. Allen Decl. ¶¶ 302-309.

First, Allen-379 discloses a pressure sensor 800 that includes a "capacitor 806" that "is comprised of first and second plates 816 and 819." Allen-379, 19:20-27. Allen-379 teaches that the first plate 816 is "disposed on" and "affixed to" the "substrate 829." Allen-379, 19:30-33, 19:39-42. The second capacitive plate is placed directly above the first plate 816, such that the two plates are separated by an air gap "cavity 826." Allen-379, 19:39-42. This is shown in annotated Figure 21B below.



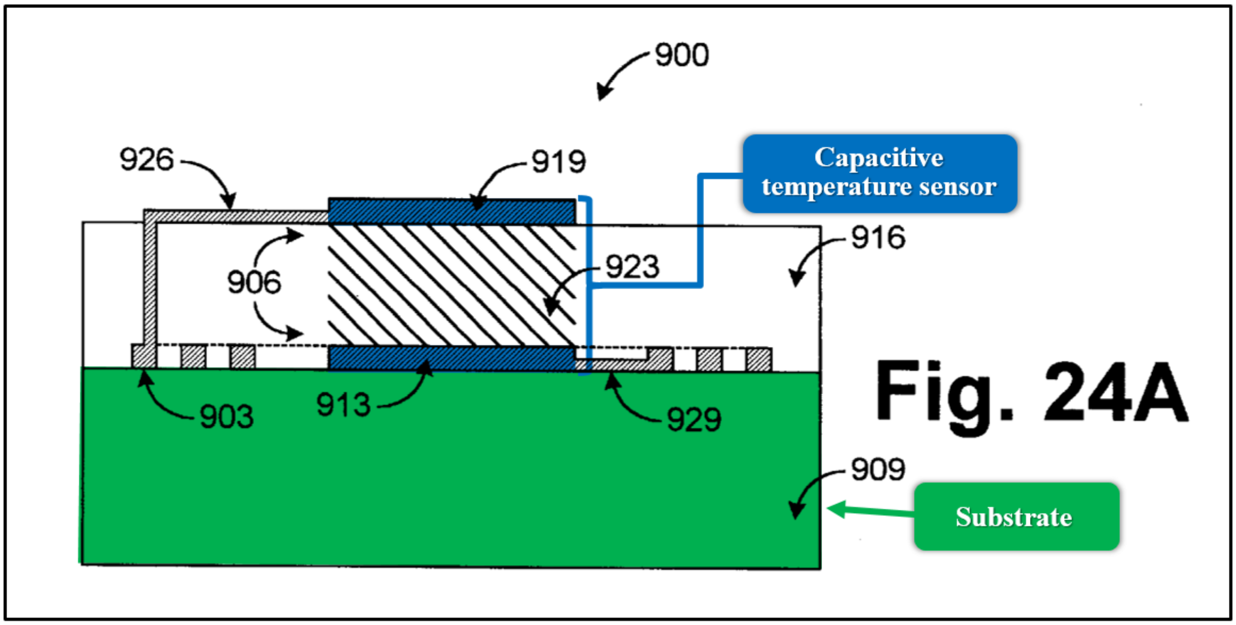
Allen-379, Fig. 21B (annotated), 19:18-47; Allen Decl. ¶ 302.

The capacitor plates form a capacitive pressure "sensor," in the same way that the '670 patent's "capacitive sensor" is a pressure sensor. '670 patent, 7:26-41; Allen Decl. ¶¶ 302-303. The capacitance of capacitor 826 varies in response to external pressure (a "physiologic parameter"). The second capacitive plate is "affixed to the interior surface 839 of [a] diaphragm 833," and the diaphragm is "moveable upon the application of a pressure" to its exterior surface 836. Allen-379, 19:35-39. The "movement of the diaphragm 833" changes the "capacitance of the capacitor 806 due to the fact that the first and second plates 816 and 819 have a variable relative position depending on the pressure applied to the external surface 836." *Id.*, 19:42-47. The normal and a deflected state of the diaphragm and top plate are shown in annotated Figure 29A below.



Id., Fig. 29A (annotated), 25:5-7; Allen Decl. ¶¶ 304-305.

Second, Allen-379's surface micromachined temperature sensor 900 discloses this feature. As shown in annotated Figure 24A below, temperature sensor 900 has a similar structure to pressure sensor 800, except that the material between the capacitor plates varies with temperature.



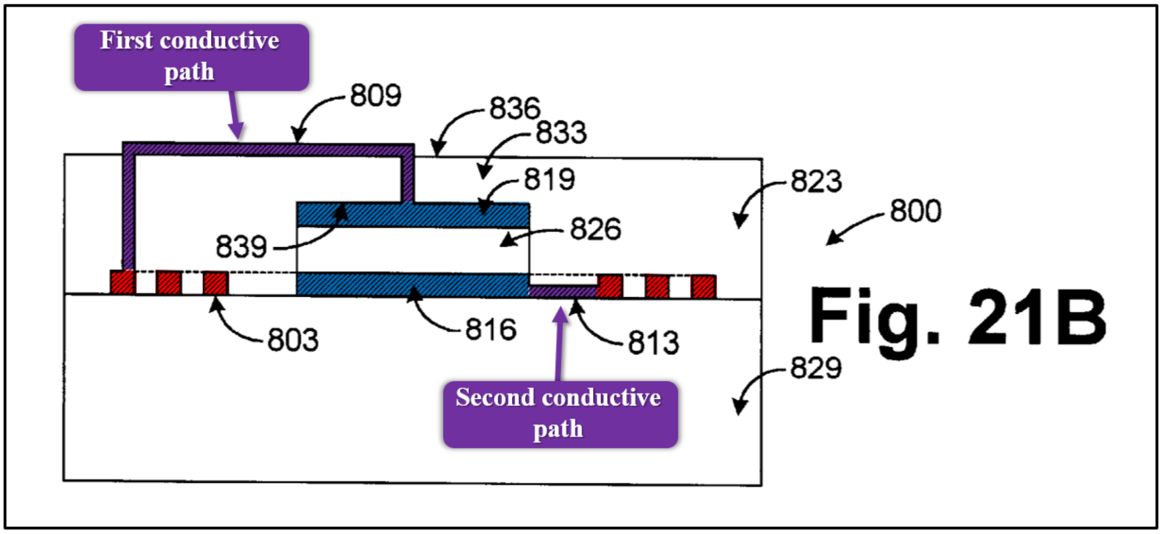
Allen-379, Fig. 24A (annotated), 21:36-48 (capacitor 906 comprising a first plate 913 "placed on the substrate 909" and a second plate 919 that is "disposed on top of the structural layer 916 opposite the first plate 913"); Allen Decl. ¶ 306.

The capacitance of capacitor 906 varies in response to changes in temperature in two ways: (1) the material between the first and second plates is a dielectric with a "permittivity that varies with temperature, thereby causing the capacitance of the capacitor 906 to vary with changing temperature" (Allen-379, 21:51-54), and (2) the top plate moves "due to thermal expansion effects" of the dielectric material "resulting in a change in capacitance." *Id.*, 12:16-33; Allen Decl. ¶¶ 307-308. Notably, the '670 patent describes the same design for its temperature sensor. '670 patent, 13:12-16; Allen Decl. ¶ 309.

6. [1e]—"a plurality of conductive paths electrically connecting said integrated inductor with said sensor,"

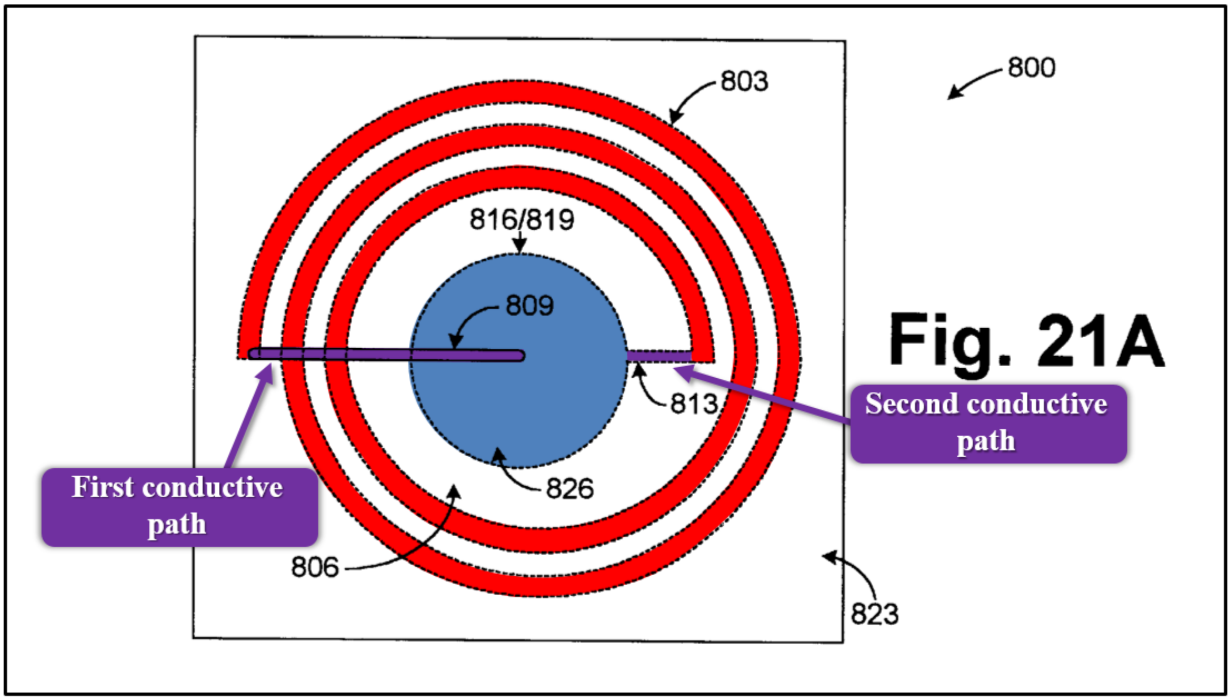
Allen-379's pressure and temperature sensor devices are LC resonant circuits with a plurality of conductive paths electrically connecting the integrated inductor (limitation [1c] above) with the capacitive sensor (limitation [1d] above).

Starting with the pressure sensor device 800: "[t]he inductor coil 803 and the capacitor 806 are electrically coupled via a ***first connector 809 and a second connector 813***." Allen-379, 19:22-24. These two conductive paths are shown in annotated Figure 21B below:



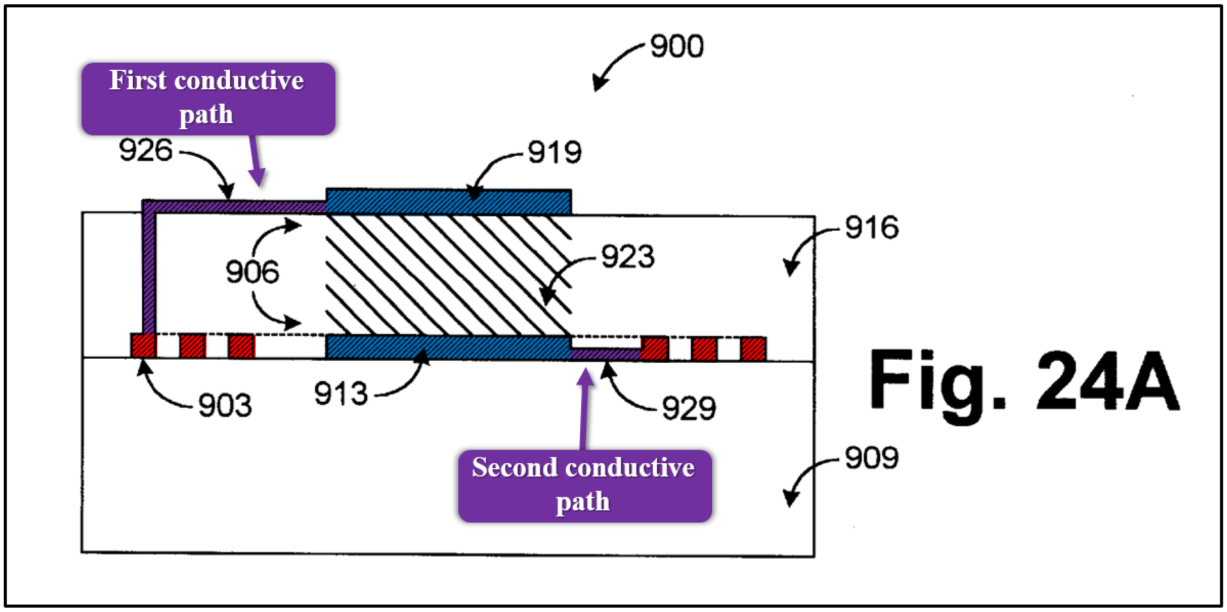
Allen-379, Fig. 21B (annotated); *see also id.*, 19:67-20:4 (regarding Figure 21D, which is identical to Figure 21B except the second plate is on the external surface of the diaphragm: "***first electrical connection 843*** couples the second plate 819 to the inductor coil 803, and ***a second electrical connection 846*** couples the inductor coil 803 at the opposite end of the inductor coil 803 to the first plate 816"), Fig. 21D; Allen Decl. ¶¶ 311-312 (explaining non-substantive difference between Figs. 21B and 21D).

These conductive paths are also disclosed from a top view of the same pressure sensor device, which shows that the "inductor coil 803 and the capacitor 806 are electrically coupled via a ***first connector 809 and a second connector 813***."



Allen-379, Fig. 21A (annotated), 19:18-24; Allen Decl. ¶ 313.

The temperature sensor device also has two of the claimed conductive paths: "[t]he inductor coil 903 is electrically coupled to the capacitor 906 via ***first and second conductive members 926 and 929***," as shown below.



Allen-379, Fig. 21A (annotated), 21:58-65; Allen Decl. ¶ 314.

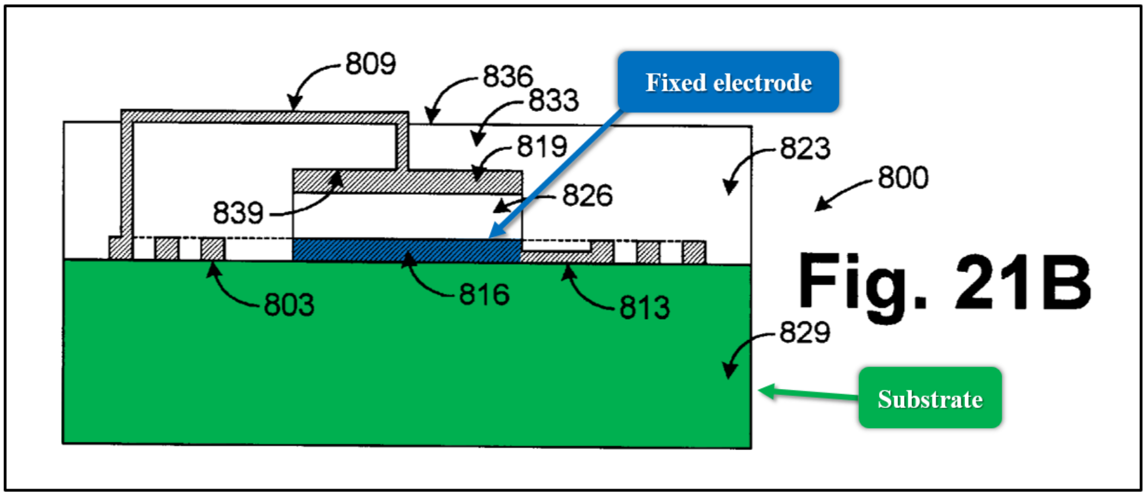
7. [1f]—"said integrated inductor, said sensor and said conductive paths cooperatively defining an LC tank resonator."

Allen-379 discloses this feature, teaching that its integrated inductor (limitation [1c] above), capacitive sensor (limitation [1d] above), and plurality of conductive paths (limitation [1e] above) together define an "inductive-capacitive (LC) resonant circuit with a variable capacitor." Allen-379, Abstract, 2:16-25 ("The pressure sensor features an inductive-capacitive (LC) resonant circuit with a variable capacitor."), 2:30-39 ("The temperature sensor features an inductive-capacitive (LC) resonant circuit with a variable capacitor."), 3:19-30, 4:54-56, 5:3-5, 10:10-25 (resonant frequency formula for the pressure sensor), 12:10-35 (resonant frequency formula for the temperature sensor), 19:18-22 ("pressure sensor 800 includes a resonant circuit that comprises an inductor coil 803 and a capacitor 806"), 21:35-39; 22:3-7; Allen Decl. ¶ 315.

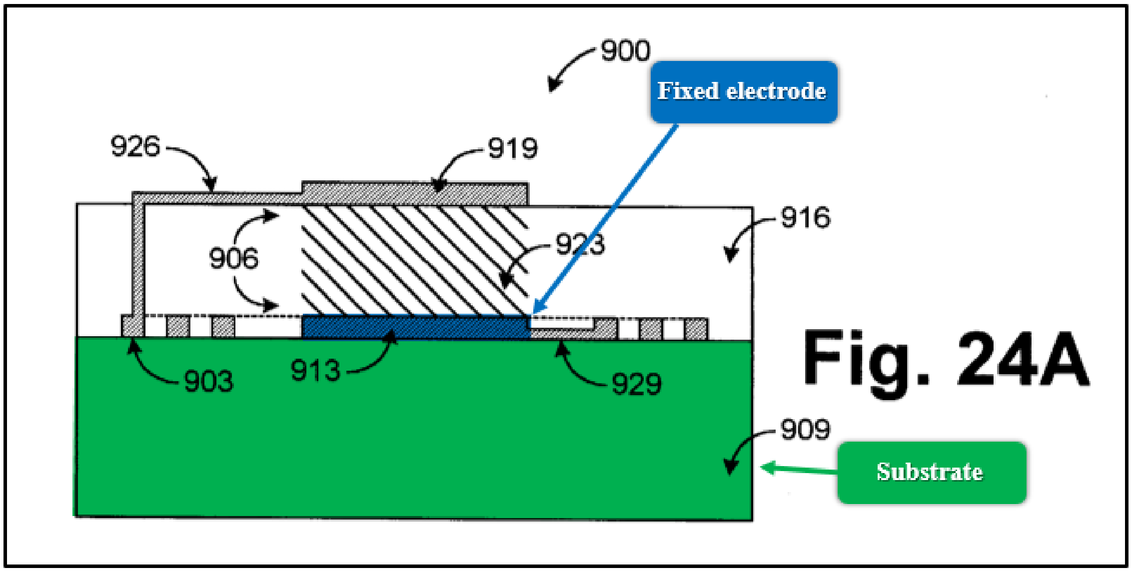
C. Claims 2 and 3

Claim 2 depends from claim 1, further reciting "wherein said sensor is a capacitive sensor having a fixed electrode and a moveable electrode." Claim 3 depends from claim 2, and further recites "wherein said fixed electrode is formed on said substrate." These claims are anticipated for the same reasons as claim 1 and as explained below.

Allen-379 discloses capacitive pressure and temperature sensors having a first plate and a second plate. *See* limitation [1d] above. In both, shown below in annotated Figures 21B and 24A respectively, the "first plate" of the capacitor is "affixed to the substrate" and is the claimed "fixed electrode." Allen-379, 19:38-39, 21:41-45; *c.f.* '670 patent, 7:33-35 ("The fixed electrode 66 of the pressure sensor 18 is defined by a conductive layer formed on the upper face 48 of the substrate 20."); Allen Decl. ¶¶ 317-320

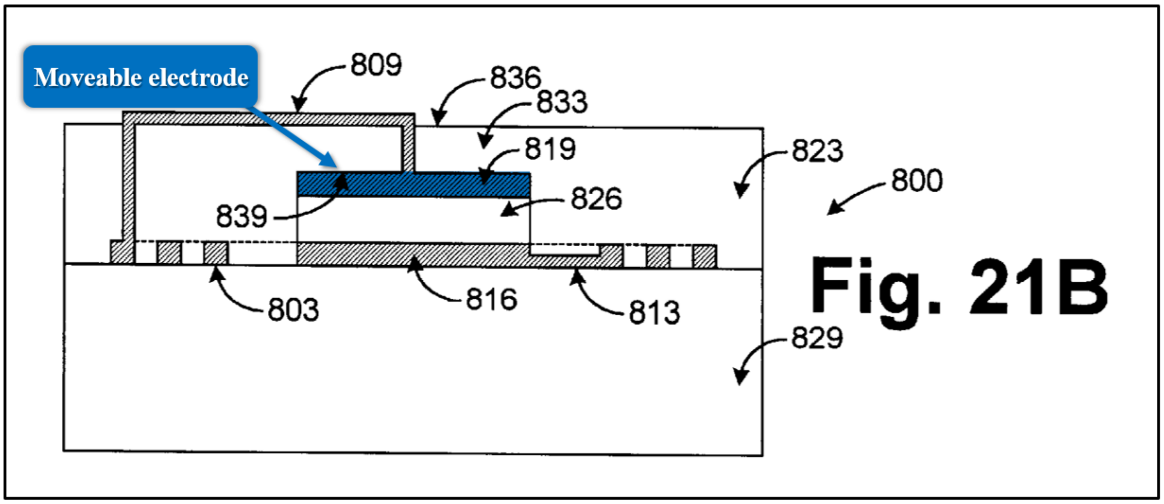


Allen-379, Fig. 21B (annotated); Allen Decl. ¶ 319.

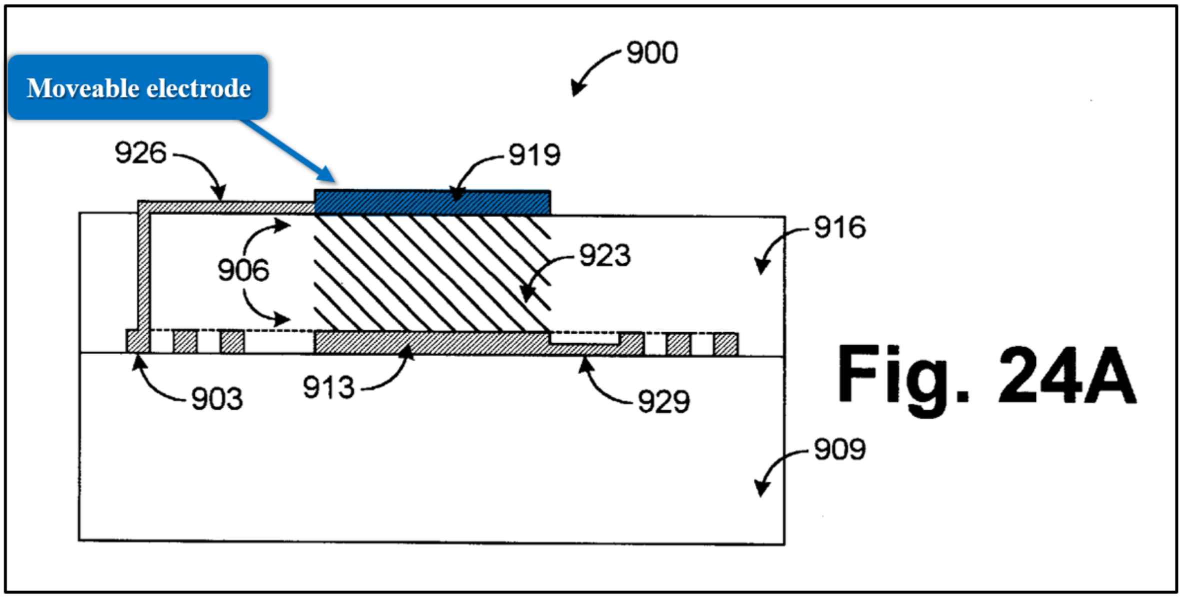


Allen-379, Fig. 24A (annotated); Allen Decl. ¶ 320.

Also in both, the "second plate" is a "moveable electrode." Allen Decl. ¶ 321. In the capacitive pressure sensor in Figure 21B, the second plate is attached to a diaphragm that is "moveable upon the application of a pressure." In the capacitive temperature sensor in Figure 24A, the second plate is attached to a dielectric layer 923 and moves in response to temperature (by thermal expansion).



Allen-379, Fig. 21B (annotated); 19:35-39, 19:42-47; Allen Decl. ¶ 322.

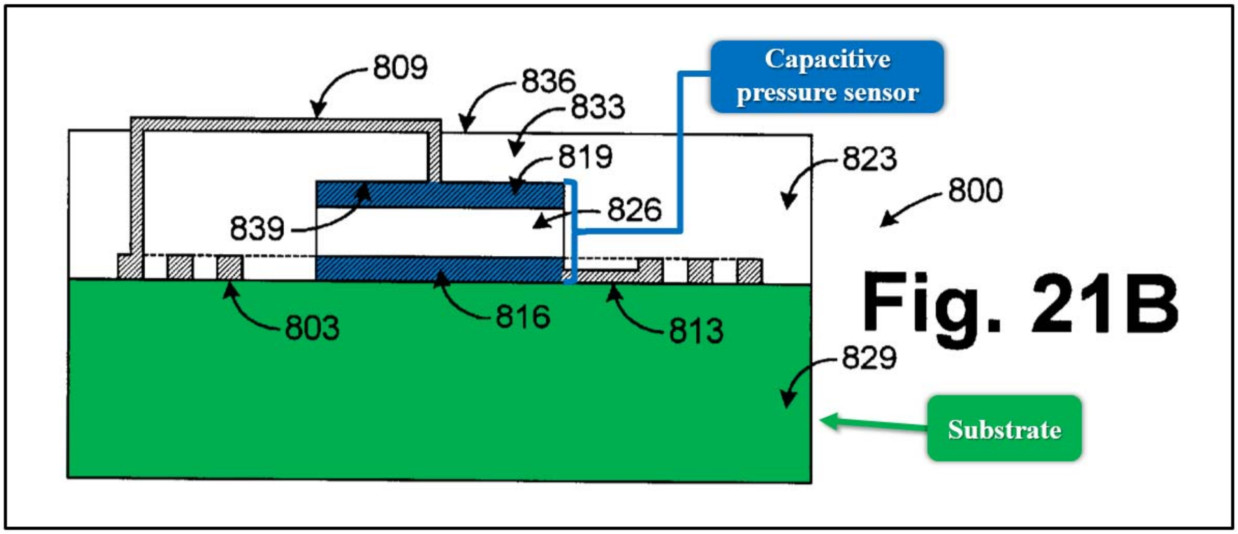


Allen-379, Fig. 24A (annotated), 20:45-58, 12:25-28; Allen Decl. ¶ 323; *c.f.* ’670 patent, 13:12-16 (moveable electrode of temperature sensor moves in response to thermal expansion).

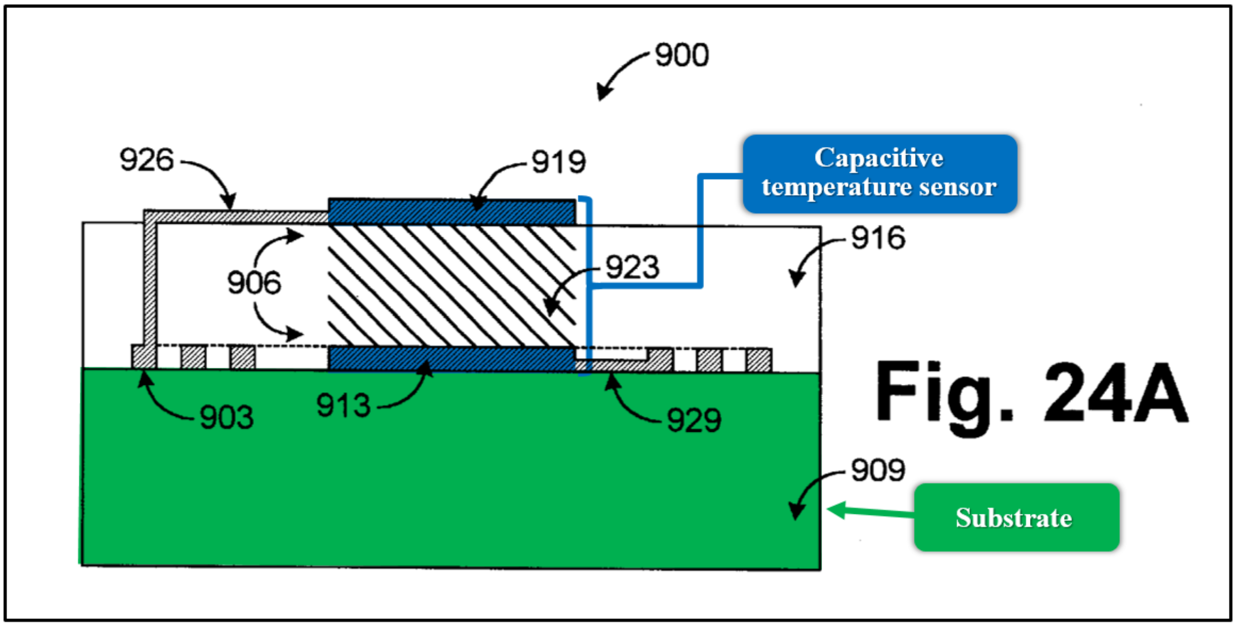
D. Claims 4 and 5

Claims 4 and 5 each depend from claim 2, further reciting "wherein said sensor is a pressure sensor" and "wherein said sensor is a temperature sensor" respectively. Claims 4 and 5 are anticipated for the same reasons as claim 2 and as further explained below.

As discussed with respect to claim 2 and limitation [1d] above, Allen-379 discloses a "surface [micro]machined pressure sensor" and a "surface [micro]machined temperature sensor." These are shown in annotated Figures 21B and 24A respectively below.



Allen-379, Fig. 21B (annotated), 19:30-42; Allen Decl. ¶ 325.



Allen-379, Fig. 24A (annotated), 21:36-41, 21:51-54; Allen Decl. ¶ 327.

E. Claim 21

Claim 21 depends from claim 1, further reciting "wherein said sensor device is wireless." Claim 21 is anticipated for the same reasons as claim 1 and as further explained below.

Allen-379's pressure and temperature sensors are "sensors for ***wirelessly*** sensing pressure, temperature, and other physical properties in a specific environment." Allen-379, 1:14-16, 2:26-28 (pressure sensor is "self-contained having no leads"), 2:42-44 (temperature sensor is "self-contained having no leads"); *see also, e.g., id.*, claims 1, 8 ("A sensor for ***wirelessly*** determining physical properties of a medium…"); Allen Decl. ¶¶ 329-330 (introductory citations apply to surface micromachined sensors because they include a LC resonant circuit).

F. Claim 22

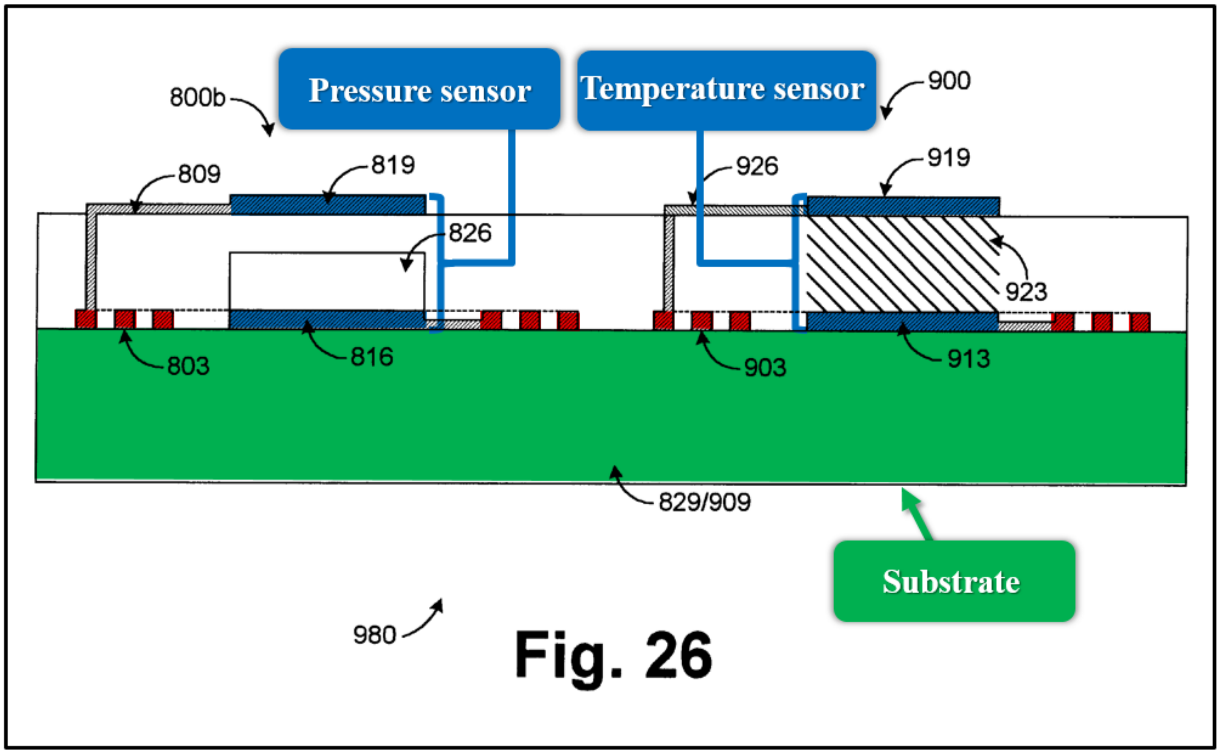
Claim 22 depends from claim 1 and further requires that the "sensing device is monolithic." Claim 22 is anticipated for the same reasons discussed above with respect to claim 1, and as further explained below.

Allen-379's surface micromachined sensors, including pressure sensor 800, are formed as a progression of steps using "surface machining techniques" that construct the sensor as one relatively rigid, batch-fabricated package, without flexible joints or flexible lead sets. Allen-379, 23:65-67; '327 provisional, 2 (Ex. 1003) (provisional application to the '670 patent, defining "*Monolithic*: constructed of one relatively rigid, substantially batch-fabricated package, without a flexible joint or flexible lead set interconnecting separately-fabricated sections (e.g., an anodically-bonded, glass-and-silicon package"); Allen Decl. ¶¶ 332-333; *see also* '670 patent, 6:55-58 (contrasting a "monolithic cap layer" with a non-monolithic cap layer that is "fabricated at separate process steps, together forming a complete cap layer after processing is finished"). Indeed, Allen-379 discloses that all components of its micromachined sensors (e.g., the integrated inductor, capacitive sensor, and electrical connections) are manufactured as part of the same fabrication process. *See generally*, Allen-379, 23:65-24:61 (describing exemplary manufacturing steps A-H to form the pressure sensor device 800). That process includes a succession of layers deposited on the substrate followed by subsequent processing steps to form a monolithic device, without any separately fabricated sections. *Id.*; Allen Decl. ¶¶ 334; *see id.* ¶ 335 (above description applies to both pressure and temperature surface micromachined sensor embodiments).

G. Claims 23, 24 and 25

Claim 23 depends from claim 1 and recites "[t]he sensor device of claim 1 further comprising at least two sensors." Claims 24 and 25 each depend from claim 23, further reciting "wherein said two sensors sense the same physiologic parameter" and "wherein said two sensors sense different physiologic parameters" respectively. Claims 23, 24 and 25 are anticipated for the same reasons as claim 1, and as further explained below.

Allen-379 teaches a "combination pressure and temperature sensor 980," which includes two surface micromachined LC tank resonators formed on "a combined substrate 829/909." Allen-379, 22:57-62. As shown in annotated Figure 26 below, this combination sensor device includes a first capacitive sensor that is responsive to pressure and connected to a first integrated inductor, and a second capacitive sensor 900 that is responsive to temperature and electrically connected to a second integrated inductor. *Id.*; Allen Decl. ¶¶ 337-339.



Allen-379, Fig. 26 (annotated), 22:57-23:12; Allen Decl. ¶ 339.

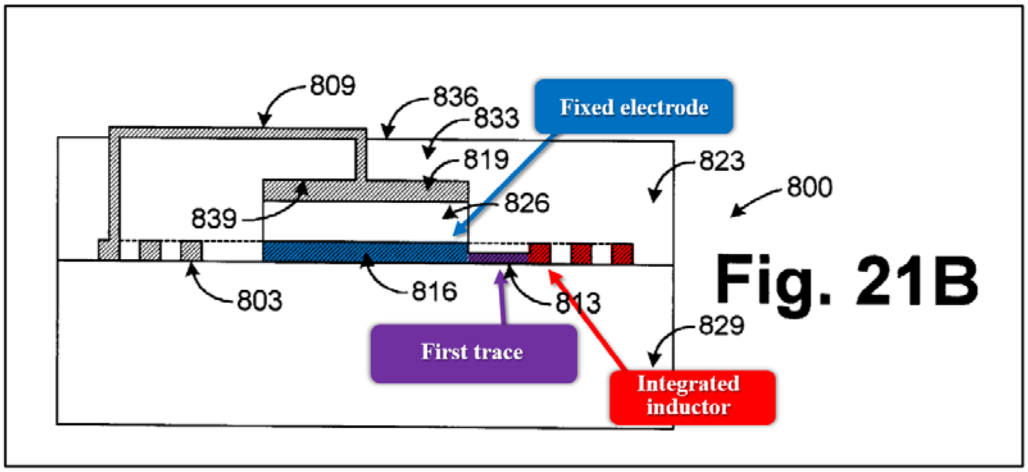
Notably, Allen-379 states that Figure 26 is illustrative of only one type of combination sensor, and that any two or more of its disclosed surface micromachined sensors "could be included in a combination sensor as shown." Allen-379, 22:66-23:8. Like in Figure 26 above, Allen-379 discloses that having two sensors on one device can be used to measure "several different physical characteristics," i.e., different physiological parameters as recited in claim 25, like temperature and pressure at the same time. *Id.*, 18:32-43, 19:4-9, 22:57-62; Allen Decl. ¶¶ 340-341.

Similarly, Allen-379 teaches that a combination sensor could include multiple pressure sensors in a single device. Allen-379, 22:66-23:8, 6:10-18; Allen Decl. ¶ 343. Allen-379 teaches using multiple pressure sensors in this way can be used to "provide redundant and more accurate measurement of a physical characteristic measured." *Id.*, 18:35-37, 6:10-18. "Redundant" measurements in this context would have been understood as using multiple sensors to sense the same physiological parameter, as recited in claim 24. Allen Decl. ¶ 343.

H. Claims 28 and 29

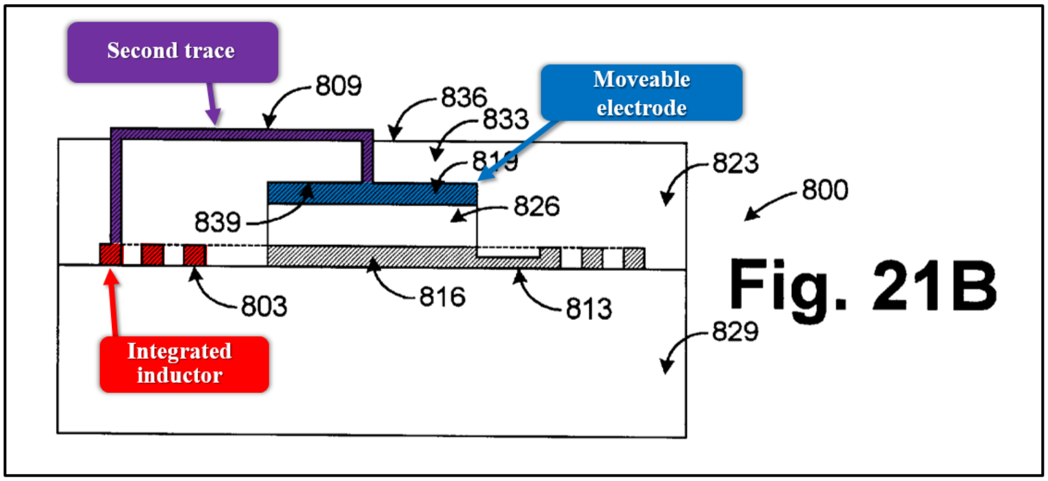
Claim 28 depends from claim 1, and recites "wherein said sensor is a capacitive sensor having a fixed electrode and a moveable electrode, said fixed and moveable electrodes being electrically coupled by first and second traces to said integrated inductor, said first and second traces being electrically isolated from one another." Claim 29 depends from claim 28, and further recites that "said traces are isolated by a dielectric layer therebetween." These claims are anticipated for the same reasons as claims 1 and 2, and as further explained below.

Allen-379's capacitive pressure sensor has a first plate 816 and a second plate 819, which correspond to the claimed "capacitive sensor having a fixed electrode and a moveable electrode" as discussed with respect to claim 2 above. *See* Claim 2 above. Allen-379 discloses that the first plate 816 of the capacitive pressure sensor (the claimed "fixed electrode") is electrically coupled to the integrated inductor by a first electrical trace 813 as shown in annotated Figure 21B below.



Allen-379, Fig. 21B (annotated), 19:22-24; Allen Decl. ¶¶ 345-346; *see also* discussion regarding limitation [1d] above).

The second plate 819 (the claimed "moveable electrode") is electrically coupled to the other end of the integrated inductor by a second electrical trace 809 as shown below.



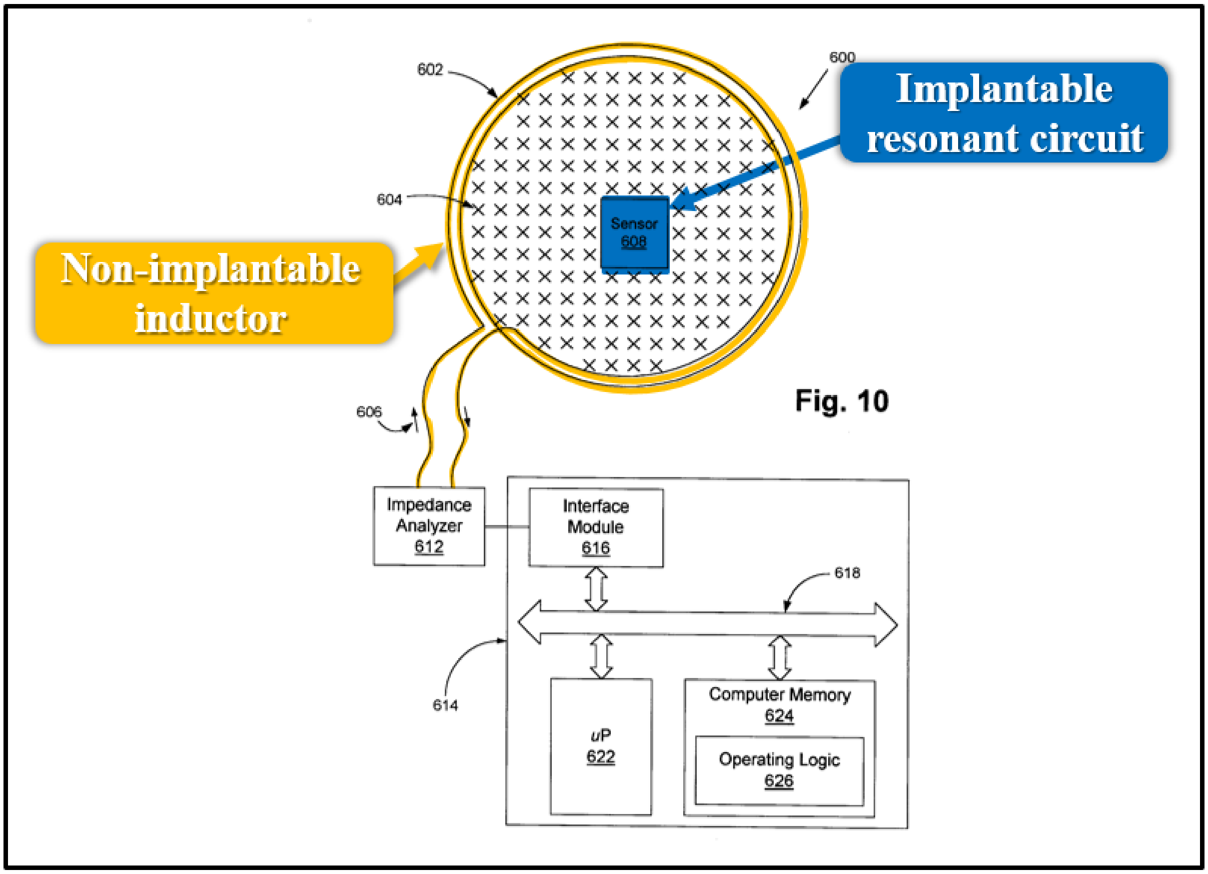
Allen-379, Fig. 21B (annotated), 19:22-24, 24:52-55; Allen Decl. ¶ 347.

Electrical traces 809 and 813 are electrically isolated from each other by the structural layer 823 and the cavity 826. Allen Decl. ¶ 348. Indeed, cavity 826 is filled with air, which is not conductive, and structural layer 823 can be a dielectric, including silicon dioxide or silicon nitride, which were (and still are) two of the most common materials used for electrical isolation in microfabricated devices. Allen-379, 20:24-27, 20:34-42, 20:51-59 (expressly incorporating by reference Madou, Ex. 1021); Madou, 90 (function of silicon dioxide and silicon nitride is "electrical and thermal isolation"), 94; Allen Decl. ¶ 348.

I. Claim 31

Claim 31 recites: "The sensor device of claim 1 as part of a sensing system further comprising a non-implantable readout device, said readout device including a second inductor adapted to magnetically couple with said integrated inductor to read changes in said LC tank resonator as a result of said sensor sensing the physiologic parameter of interest." This claim is anticipated for the same reasons as claim 1, and as discussed below.

Allen-379 discloses multiple "impedance excitation systems" that "may be applied in conjunction with any of" Allen-379's sensor devices. Allen-379, 15:1-8, 3:19-22; Allen Decl. ¶¶ 350, 357. One example is shown in annotated Figure 10 below, wherein the readout system includes a "transmitting antenna 602" (yellow), which Allen-379 states "in electrical terms is an inductor" (Allen-379, 18:4-8), an "impedance analyzer 612," a "computer system 614," an "interface module 616," a "data bus 618," a "processor 622," and a "computer memory 624." Allen-379, 15:5-25. Together, those elements form a "non-implantable readout device" including a "second inductor" (the transmitting antenna 602).



Allen-379, Fig. 10 (annotated); Allen Decl. ¶ 350.

The transmitting antenna forms an "electromagnetic field 604 [] when an excitation signal 606 is applied," depicted as x's within the perimeter of the transmitting antenna in Figure 10 above. Allen-379, 15:5-10; Allen Decl. ¶¶ 351-352. This magnetic field is configured so that when a LC resonant sensor device (e.g., the pressure or temperature sensor devices discussed above with respect to claim 1) is located within the perimeter of the transmitting antenna, "the inductor coil resident on the sensor 608 is ***electromagnetically coupled*** to the transmitting antenna 602." Allen-379, 15:15-17; *see also, id.*, 10:34-51, 16:46-61.

Allen-379 teaches that this electromagnetic coupling between the integrated inductor coil and the transmission coil can be used to "read changes in said LC tank resonator as a result of said sensor sensing the physiologic parameter of interest." Allen Decl. ¶¶ 353-356. For example, Allen-379 teaches that when a signal is applied to the transmission antenna "is equal to the resonant frequency of the resonant circuit of the sensor 608, then an increase in current of the excitation signal 606 is seen due to a corresponding drop in the impedance of the resonant circuit." Allen-379, 15:26-41. This allows for a detection of the resonant frequency of the implantable sensor (*id.*, 15:38-41), which can then be used to back calculate pressure or temperature measurements sensed by capacitive sensor within the implantable resonant circuit. *Id.*, 17:24-33, 10:47-51, 12:30-35; Allen Decl. ¶ 355. Indeed, with respect to pressure sensors, the "resonant frequency of the pressure sensor 100 changes with a corresponding change in pressure P" (Allen-379, 10:23-25) and, with respect to temperature sensors, the "resonant frequency of the resonant circuit of the temperature sensor" depends on the "temperature of the environment in which the temperature sensor" is placed. *Id.*, 12:30-35. Put simply, the resonant frequency of the sensors change in response to the physical parameter, pressure or temperature, being measured. Allen Decl. ¶ 355.

Figure 5 of Allen-379 provides a flowchart of the operating logic of the non-implantable readout device, including that it "determine[s] physical parameters," corresponding to the "desired physical parameters of the environment surrounding the sensor 608." *Id.*, 17:24-33, Fig. 5; Allen Decl. ¶ 356.

In addition to the foregoing, Allen-379 also discloses several other embodiments of non-implantable readout devices that satisfy the additional limitations of claim 31: they each comprise a "second inductor" in the form of a "transmission antenna 602," which detects changes in the resonant frequency of Allen-379's sensor devices through electromagnetic coupling. Allen Decl. ¶ 357; Allen-379, Figs. 13, 16, 18, 19, 16:15-17:6, 17:34-48, 17:62-18:30.

X. GROUND 3: CLAIMS 26-27 ARE UNPATENTABLE OVER ALLEN-379 AND RENAUD

A. Overview—Renaud (Ex. 1011)

U.S. Patent No. 5,488,869 ("Renaud") is § 102(b) prior art because it issued more than one year before the '670 patent's actual and earliest-claimed filing dates.

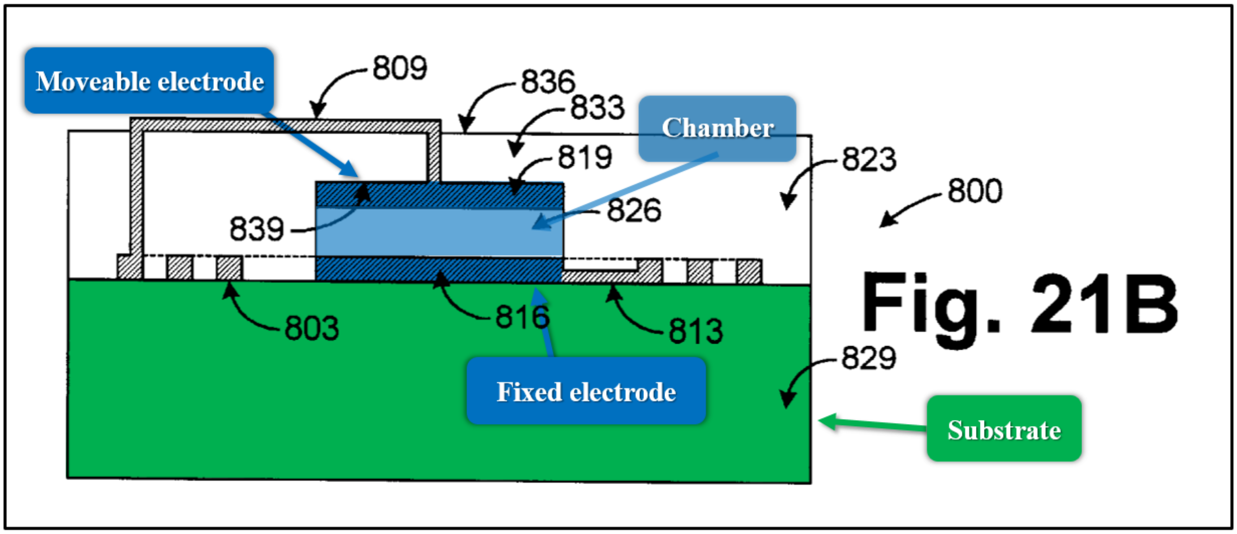
Renaud discloses an improved capacitive pressure sensor having a "fixed electrode" and "mobile electrode" arranged to "define a chamber" between them, and a "reference volume connected to said chamber," i.e., the claimed displacement cavity. Renaud, Abstract, 2:36-48. Renaud recognizes that such reference volumes were already known (when filed in 1994), and proposed an improved volume formed as a "groove running around the fixed electrode" in the semiconductor substrate. Renaud, 2:53-55; Allen Decl. ¶¶ 127-129.

B. Claims 26 and 27

Claim 26 depends from claim 1, further reciting "wherein said sensor is a capacitive sensor including a fixed electrode and a moveable electrode, said fixed and moveable electrodes defining a chamber therebetween, said chamber being in fluid communication with a displacement cavity." Claim 27 depends from claim 26, and further recites "wherein said displacement cavity is defined within said substrate."

Claims 26 and 27 would have been obvious for the same reasons already discussed for claim 1 over Allen-379, and further in view of Renaud as further explained in the following paragraphs. As already established, Allen-379 teaches claim 1. Moreover, as demonstrated with respect to claim 2 above, Allen-379's capacitive pressure sensor has "first and second plates 816 and 819," where the first plate is formed on the substrate 823 (a "fixed electrode") and the second plate is affixed to a moveable diaphragm 833 ("moveable electrode"). *See* Claim 2 above.

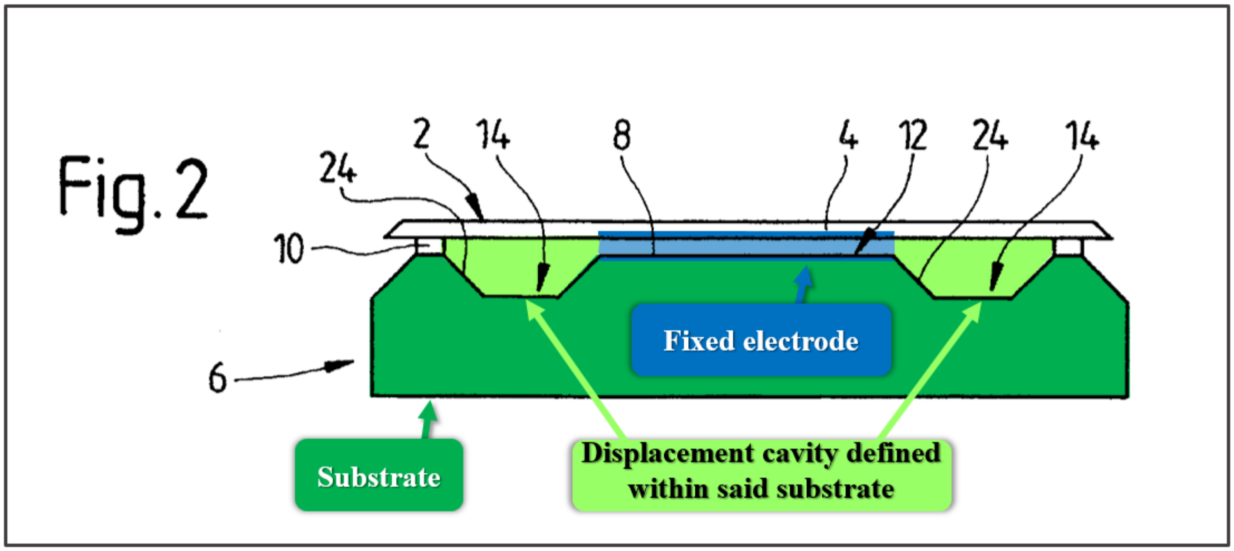
As shown in annotated Figure 21B below, the space between these electrodes defines a "cavity 826" which discloses the claimed "chamber."



Allen-379, Fig. 21B (annotated), 19:27-29, 19:33-35, 19:39-42; Allen Decl. ¶ 360.

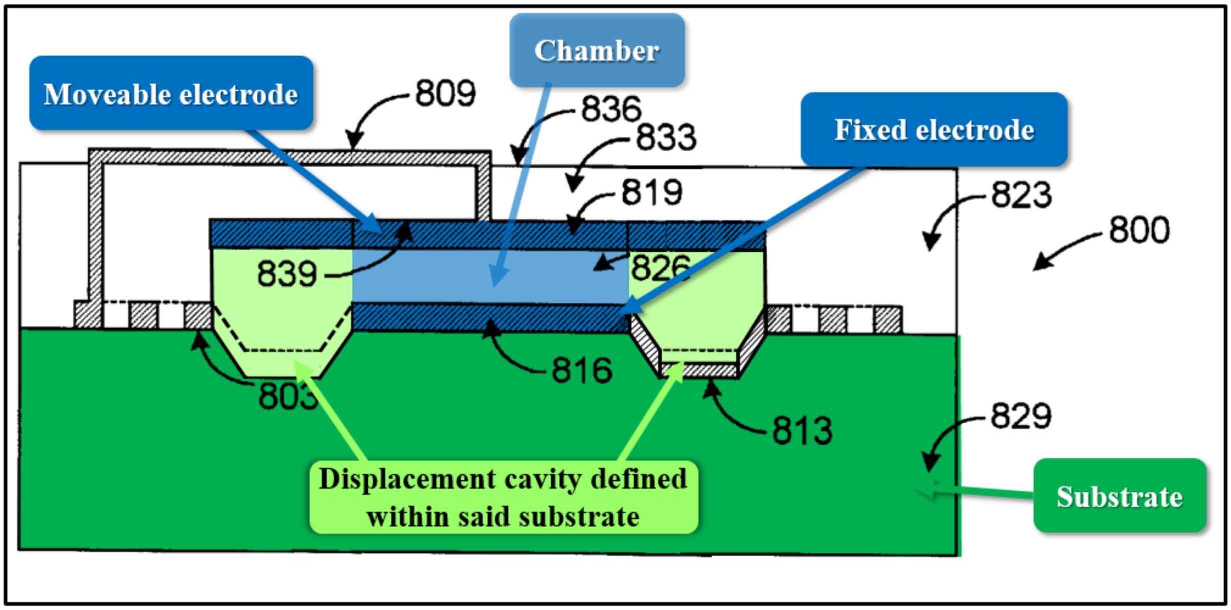
Thus, Allen-379's sensor has the claimed chamber (cavity 826) that is defined between the fixed and moveable electrodes (plates 816 and 819). Allen-379 does not, however, expressly disclose a "displacement cavity" in the substrate and in fluid communication with the chamber as required by claims 26 and 27. Allen Decl. ¶ 361. However, that would have been an obvious modification in view of Renaud.

Like Allen-379's capacitive pressure sensor 826, Renaud discloses a capacitive pressure sensor includes "a ***mobile electrode 4***" formed on a semiconductor "membrane 2" and a "***fixed electrode 8***" formed on a "substrate 6." Renaud, 3:56-61, 4:5-6. As shown in annotated Figure 2 below, the fixed and mobile (i.e., "moveable") electrodes define a "***chamber 12***" between them, and the chamber is connected to a "***cavity forming the reference volume 14*** which is placed" in the substrate 6.



Renaud, Fig. 2 (annotated), 4:1-16 ("The sensor also comprises a reference volume 14 in contact with the chamber 12 to reduce the pressure of the gas contained in the chamber 12 which result from the degassing which occurs during the manufacturing of the sensor 1."), 4:55-59 ("[V]olume 14 is composed of a groove which extends around the fixed electrode 8."), Abstract, 5:51-56, 8:12-17, 2:53-55, 5:51-56, 6:23-30 (groove 14 is etched in the substrate); Allen Decl. ¶ 362-364.

Applying the teachings of Renaud to Allen-379's surface micromachined capacitive pressure sensor, the resulting device would be of the form below:



Allen Decl. ¶ 365 (modifying Allen-379, Fig. 21B in view of Renaud).

C. Motivation To Combine Allen-379 and Renaud

A POSITA would have been motivated to combine Allen-379 with Renaud. Allen-379 and Renaud both disclose ***micromachined*** capacitive pressure sensors having fixed and moveable electrodes separated by an air gap chamber, where the fixed electrode is formed on the surface of a substrate. Allen-379, 1:32-33, 19:17-46, Fig. 21B; Renaud, 3:56-4:16, Fig. 2. Thus, a POSITA would have understood that Allen-379 and Renaud are analogous art, and would have expected that the teachings of one could be applied to the other without unexpected results. Allen Decl. ¶ 367.

Furthermore, Allen-379 recognizes that its capacitive pressure sensors do not provide exact readings of pressure, and discloses the use of multiple sensors "in the same environment at the same time" in order to provide "more accurate measurement of a physical characteristic measured." Allen-379, 18:33-37. However, such a solution has significant drawbacks in that it requires "configuring each sensor 608 to operate within a specific unique frequency band in a scheme much like frequency multiplexing" and multiplies the overall size of the device. *Id.*, 18:40-55. Thus, a POSITA would have been motivated to look to other known methods improving the accuracy of a capacitive pressure sensor device. *See ABT Sys., LLC v. Emerson Elec. Co.*, 797 F.3d 1350, 1360 (Fed. Cir. 2015) ("[A] court … may find a motivation to combine prior art references in the nature of the problem to be solved.") (citations omitted). That would have led a POSITA to Renaud, which describes such an improvement. Allen Decl. ¶¶ 368-370.

Renaud teaches that during the manufacture of surface micromachined pressure sensors, like in Allen-379, "degassing can occur within the structure of the sensor leading to the creation of residual pressure inside the chamber." Renaud, 1:54-56. The residual gas in the chamber causes the sensor not to provide an "exact reading of the absolute pressure" and affects the "stability and/or the reproductibility [sic] of the readings" of the sensor. *Id.*, 1:55-60. One improvement to address these problems, known even at the time Renaud was filed in 1994, was to use a displacement cavity or, as Renaud calls it, a "reference volume" that increases the total internal volume of the sensor, and as a result decreases the effect of pressure caused by any residual gas. *Id.*, 1:53-65; Allen Decl. ¶¶ 370-371.

A reference volume increases temperature stability (i.e., a given change in temperature will have a smaller effect on internal pressure), and reduces the percentage change in volume for a given diaphragm (moveable electrode) deflection, further mitigating the undesirable effects caused by gas inside the device. Allen Decl. ¶¶ 368, 370. And while reference volumes were known, Renaud offers an improved displacement cavity that is etched into the substrate "by a groove running around the fixed electrode," which "provides the advantage of reducing the size of the active part of the measuring capacitator without reducing the sensitivity of the sensor so that the relative sensitivity of the sensor according to the invention is increased." Renaud, 2:53-60. Thus, a POSITA would have been motivated to combine Renaud and Allen-379 because Renaud provides a way to improve the readings of Allen-379's surface micromachined pressure sensor devices without needing to use multiple sensors. Allen Decl. ¶¶ 369, 372.

Notably, a POSITA would have understood applying Renaud's teaching to Allen-379 to be obvious because the use of a displacement cavity was a well-known solution for a common problem in a micromachined capacitive pressure sensor. As already mentioned, Renaud discussed it in his prior-art section in 1994. Likewise, the '670 patent addressed the same problem with the same solution years later, calling it a "displacement cavity" and did not tout it as an innovation of any kind. '670 patent, 9:2-40 (explaining that its displacement cavity eliminates the "negative effects of any residual gas"). Thus, it would have been obvious to use the displacement cavity taught in Renaud (or any similar teaching or common knowledge in the art, for that matter) to improve the sensitivity of the micromachined pressure sensors disclosed in Allen-379. Allen Decl. ¶¶ 370-371.

Furthermore, a POSITA would have found it obvious that the devices in Allen-379 could be improved in the same way as Renaud in simple and economical ways. Allen Decl. ¶¶ 372-373; Renaud, 2:26-35 (explaining that its reference volume can be formed using a "simplified and economical method of manufacturing"). For example, in the modified device of Allen-379 in view of Renaud shown in the previous section above, a POSITA would have understood that Allen-379's planar inductor coils could be deposited slightly further away from the fixed plate of the capacitor, and a groove could be etched within the substrate around the fixed plate as taught by Renaud. Allen Decl. ¶¶ 365, 374. As further taught by Renaud, a POSITA would have found it "very simple" to create a displacement cavity in this way as it uses only "conventional semiconductor material micromachining techniques." Renaud, 3:24-29, 5:51-6:48; Allen Decl. ¶ 374. Indeed, Allen-379 itself discloses that its micromachined pressure sensor is fabricated using photolithography and etching steps, which are the same processes described by Renaud in forming its reference volume within the substrate. *See* Allen-379, 23:64-24:40 (describing a "Method of Manufacture of Surface Machined Sensors"); Renaud, 5:51-6:44; Allen Decl. ¶ 374. As a result, a POSITA would have been motivated to combine Allen-379 and Renaud because the resulting combination involves only the use of known techniques to improve a similar method and would have been reasonably expected to succeed. *Id.*

XI. NO SECONDARY CONSIDERATIONS EXIST

There are no secondary considerations known to Petitioner or alleged by Patent Owner. Should Patent Owner proffer any evidence of secondary considerations in its Preliminary Response, that evidence should not be considered for institution purposes, or Petitioner should be given leave to file a reply with rebuttal evidence. *See Garmin Int'l, Inc. v. Wis. Archery Prods., LLC*, IPR2018-01137, Paper 11 at 29 (P.T.A.B. Dec. 11, 2018). If Patent Owner cites the commercial success of Petitioner's product accused of infringement, Petitioner disputes that (1) its products practice the claims of the '670 patent and (2) any nexus exists between the commercial success of Petitioner's products and the claimed inventions of the '670 patent, and should be permitted a reply to rebut such allegations.

XII. THE BOARD SHOULD REACH THE MERITS OF THIS PETITION

As mentioned in the Related Proceedings section above, this petition is being filed concurrently with another. Together, the two petitions present grounds over four unique and different primary references. The Board should therefore institute each petition on the merits rather than exercise its discretion under § 314(a) to deny either one.

As an initial matter, the art presented concurrently in each petition was not "previously" presented in IPRs. *Intel Corp. v. Hera Wireless S.A.*, IPR2018-01700, Paper 9 at 25 (P.T.A.B. Apr. 19, 2019) ("The petitions were filed on the same day, eliminating any concern that either petition relies on 'the same or substantially the same prior art or arguments previously … presented to the Office.'" (citing 35 U.S.C. § 325(d)) ("*Intel*"). The only art presented across both petitions that was even before the Office was Park. But Park was not discussed by the examiner at all and was not the basis of any rejection during prosecution. *Apple Inc. v. Qualcomm Inc.*, IPR2018-01316, Paper 7 at 25 (P.T.A.B. Jan. 18, 2019) ("The fact that neither [Applicant Admitted Prior Art] nor Majcherczak was the basis of rejection weighs strongly against exercising our discretion to deny under 35 U.S.C. § 325(d).").

The Board has discretion to deny institution under § 314(a), but the follow-on petition situation of *General Plastics* does not apply here. *See General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 (P.T.A.B.

Sept. 6, 2017). Nonetheless, Petitioner recognizes that "multiple, concurrent proceedings per patent presents a significant burden for the Board," especially when there are "other related patents also each challenged by multiple petitions at the same time." *E.g.*, *Comcast Cable Commc'ns LLC v. Rovi Guides, Inc.*, IPR2019-00224, Paper 10 at 3 (P.T.A.B. Apr. 3, 2019).

For example, in *Comcast*, the Petitioner filed *six IPR petitions challenging the same patent claims*, as well as *nearly two dozen other petitions* challenging five other asserted patents. *Id.,* 3.[4] The Board refused to deny the petitions outright, but ordered the petitioner to rank its "six Petitions in the order in which it wishes the panel to consider the merits." *Id.*, 4.

In contrast, Petitioner is filing just two petitions against the one asserted patent. This case is more akin to *Intel*, where the Board was faced with just two petitions. The Board did "not regard the two proceedings as 'vexatious multiplication of proceedings,'" and instituted on the merits. *Intel* at 25-26. Here too, there is no vexatious multiplication of proceedings. Petitioner is filing IPRs shortly after being accused of infringement, before the patent owner's infringement positions have solidified. IPRs are meant to be an alternative to district-court litigation, but to be an alternative (*i.e.*, to obtain a stay), the IPR needs to be filed as

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[4] Comcast filed 28 separate IPRs against six asserted patents.

soon as practicable. Here, the Complaint was served in February of this year, and other than a venue dispute, the parties have done nothing in the litigation. Given the early stage of the district court litigation, and the fact that there are only two petitions here, it would not be wasteful of the Board's or the parties' resources to institute both IPRs—especially since any denied ground will not be subject to the IPR estoppel. *See Shaw Indus. Grp. v. Automated Creel Sys., Inc.,* 817 F.3d 1293, 1300 (Fed. Cir. 2016).

The grounds presented in the two petitions are different, even more so than in *Intel*. The Park grounds (in the other petition) is based on Park, which is prior art under 35 U.S.C. § 102(b) and cannot be antedated by Patent Owner. In contrast, Petersen (also in the other petition) is § 102(e) art that Patent Owner may attempt to antedate, and Petersen includes a displacement cavity (but not one that is within its substrate like Renaud's) that is not disclosed in Park.

Likewise, one of the primary references in this petition, Allen-379, is not a § 102(b) reference, and Patent Owner may attempt to antedate it.

Akar (in this petition) is the only primary reference to expressly disclose a displacement cavity defined within its substrate. All the other grounds rely on a secondary reference for that disclosure. And in another example, the Allen-379 ground in this petition challenges claims 5, 22-25, and 28-29, which are not challenged in any other ground, because Allen-379 expressly discloses the relevant features (*e.g.*, monolithic structure, surface machined temperature sensor, etc.).

For the above reasons, and respecting the finite resources of the Board, Petitioner respectfully asks the Board to reach the merits and institute both of its petitions.

XIII. CONCLUSION

For the above reasons, the Board should institute *inter partes* review of all challenged claims of the ’670 patent on the grounds presented in this petition.

Respectfully submitted,

Dated: July 15, 2019

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CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that this petition complies with the word count limitation of 37 C.F.R. § 42.24(a)(1)(i) because the petition contains a total of 13,777 words, which is the sum of 13,520 words calculated by Microsoft Word's word-count feature and 257 words hand-counted in the figures. This total excludes the cover page, signature block, and the parts of the petition exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF SERVICE

The undersigned certifies that a complete copy of this petition for *Inter Partes* Review of U.S. Patent No. 6,926,670 and all Exhibits and other documents filed together with this petition were served on the official correspondence address for the patent shown in PAIR and a courtesy copy to Integrated Sensing Systems, Inc.'s current litigation counsel:

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